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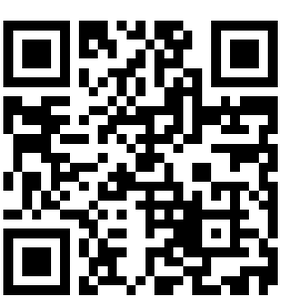

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INDEX TO VOL. XLIV. (New Series.)

A

Abbott, W. L., Central Station Economies, 691, 727
Ablett, C. A., Testing Electrically-Driven Mills, 465, 485
Abridged Patent Specifications, see ELECTRICAL PATENTS

Accumulators:
at Birmingham University, 2
Care of, 336
Charging of Small Accumulators, The, 30
for Crane Work, 365
Daniell Cell, Improvements in the, 246
D.P., The, 20, 117, 517, 803
for Driving Corn Mill, 697
Dry Battery, The, 285, 507, 648
Electrodes, Separating and Insulating of, 167
in Ferndale Collieries Power Station, 507
with Gas Engines, 609, 647
Patents, New, see ELECTRICAL PATENTS
for Petrol-Electric Driving, 186
Problems of, 296
Railway Classification, Rates for, 252
for Ritten Electric Railway, 114
Rogerson, W. M., Remarks on, in I.E.E. Address, 665
for Siemens Signal Machine, 261
in the South Bulli Colliery, Australia, 298
Storage Battery Wisdom, 655
Thullier, G., Report on, 336
Titanium-Carbide, The, 269
for Traction, 554, 565, 927
for Train Lighting, 264, 539
Tudor, The, XL. No. 2, 567
Weston Normal Cell, Cadmium Amalgams and the, F. E. Smith, 618

Acoustic Tuning in Wireless Telegraphy (The Cantz Method), 495
Adams' Motor Starting Switch for Printing Machines, 123
Adams' Pillar Type Motor Panels, 757
Adams, Prof., Standardisation in Engineering, 539
Addresses, Change of, &c., 340, 425, 459, 486, 497, 495, 554, 618, 728, 802, 822, 877
Adjustable Screen Photometer Head, 917
Advance in a Quarter of a Century, E. G. Tidd, 720
Advantages of the Electric Car, 295
Advertising, 734
A.E.G. Electric Water Heater, XIV., No. 4
Aero Exhibition, 802
Aeronautics and Wireless Electricity, 141
Agricultural Co-operation and Electricity, 537
Airships, Wireless Signalling for, 439
Allcock, J., Report on Cardiff Tramways Finance, 879
Allcutt, E. A., The Electrical Equipment of Birmingham University, 2
All Motor Fire Station at Charlton, 726
Alternating Current, Magnetic Testing of Iron with, A. Campbell, 410
Alternating and Direct Current Machinery, Shop Testing of, J. W. Rogers, 728
Alternating Current *v.* Direct Current for Railways, Debate on, 923
Alternators, see DYNAMOS, &c.
Aluminium Electric Wires, 212, 326, 815
Aluminium Industry on Tyneside, 732
American Electricity in Sheffield, 904
American Electric Railway Scheme, 566
American Government's Electric Trading, 680
American Mines, Electricity in, G. R. Wood, 270
American Notes, 100, 126, 152, 184, 223, 269, 295, 349, 398, 435, 473, 515, 554, 593, 635, 668, 709, 733, 766, 795, 827, 863, 923
American Plant in Canada, 828
Ammeters and Voltmeters, British Standard Specification for, 490
Another veteran Electrician, 406
Anti-spooling Looms, 527
Application of Electric Motors to Industrial Service, The, E. B. Parsons, 487
Appointments, 515, 540, 554, 629, also see "Personal" in each issue
Appointments Vacant, see each issue
Appreciation of British Electricians, 565
Apprenticeship Course for Telephone Engineers, V. D. Cousins, 915
Apprenticeship Question, The, 486, 498, 565
Arabian Nights improved, 445
Arc, Electric, Metal Electrodes for, 767

Arc Lamps:
in Berlin, 64, 267
Board of Trade Regulations for, 249
Bremer, The, 599
in Brussels, 64, 267
Carbons and the Admiralty, 776, 784
in Cardiff, 35
in the City (London), 64, 267
in Cologne, 64, 267
Crompton-Blondell, The, 399
Davy, The, XIV., No. 3
in Dresden, 64, 267
in Düsseldorf, 64, 267
Estimate for Installations, 918
Foster, The, 822
Improved Method of Suspending, IX., No. 7
in L.C.C. Tramways Central Repair Depot, 407
London Electric Firm's Lamp Lowering Gear, 789
in Munich, 65, 268
in Paris, 65, 269
Patents, New, see ELECTRICAL PATENTS
Railway Classification Rates for, 252
for Stage Lighting (Frances & Sons), 221
Rieder, C., Remarks on, 894
Titanium Carbide, 269
in Vienna, 64, 268
Wilckes-Martin Plant for Manufacture of Carbons, 554
Arc, The Tantalum, 767
Arc-drive, Electric, on the Air, No. 27
Armature, Locating Faults in, A. R. Woolhall, 420, 620
Arm Indicator, The, 467
Arrangement of Instrument Leads for Switchboard Testing, 156
Artists as Aid to Publicity, 734
Art of Illumination, The, 295
Artificial Loading of a 240-Volt Lighting Generator, 161
Artificial Thunder-storm, 904
Ashworth, J., Electricity and Gradual Mining, 294
Assessing Wear and Tear, 107
Associated Electric Contracting Plants, 254, 257
Atkinson, A. A., and W. Hughes, Electrical Symbols in Sines, 278
Atmospheric Electricity, 767
Attraction to Deeds, 747
Audible Tramway Signals, 713
Australasian Electricity, 605
Australian Old Engineers, 903
Automatic Electric Transportation, 683
Automatic Point Working on Electric Tramways, S. Bruce, 144
Automatic Street Gas Lighting, 732
Avon Industry, The, 296
Awards, 186, 622, 859

B

Bailey, J. W., The Exhaust Steam Turbine, 765
Baker, T. F., Telegraphy, Patents, 776, 784
Ball Gearing, Positive, 503
Bande Electric Pendule, XIV., No. 5
Barber, A. T., Development of the Marine Steam Turbine, 603
Barcelona, An Electrical, 503
Barnard, A. H., A 2,500 Volt Direct Current System, 908
Batteries, Dry, Characteristics of, F. H. Loveridge, 507
Batteries, Secondary, see ACCUMULATORS
Batteries, Several Machine, for Schools, 261
Batteries, Tee Manufacture, 297
Battleships, Turbine for, 668
Bernstein, L., Transmission of Fault Location, 215
Birmingham Portland Int. Assoc., 173
Birmingham University, The Electrical Equipment of, E. A. Allcutt, 2
Bishops Stortford Schools, The, 889
Blackpool for Motor-boats, 270
Blackman, A. S., Steam Turbines from the Users' Point of View, 2, 5
Blackness, Electrolyte, 505, 733
Board of Trade Conference on Tariff, 507
Board of Trade Regulations, 69, 249

Boilers:
Boiler Construction, Electricity in, 688
Canal Water for Condensing at Rochdale, 700
in Canal Side Collieries Power Station, 507
and Coal Transportation, 578
at the Loch Ty Coal Mines, 292
Rating of, 691
Rogerson, W. M., Remarks on, in Presidential Address, 664
at the Stockton New Generating Station, 628
Stirling, The, 567
Water Softening Apparatus for Lancashire Boilers, 15A, 41A

Book Reviews:
Appendices Course of Experimental Physics, &c., J. L. Mayam, 149
Books Received, 41, 127, 198, 220, 254, 280, 340, 375, 419, 439, 501, 633, 771, 825, 852, 884, 891, XI. No. 27
Chats on Electricity, F. Proctor, 825
Continuous Current Dynamos and Motors, W. R. Lydall, 340
Electric Cables, D. Cook and F. J. O. Perry, 633
Electricity in the Service of Man, Dr. Wallace, 852
Electron, The, 501
Encyclopédia Pratica per le Industrie Calvano-plastiche, L. P. Cortese, 340
Engineering Units of Measurement, J. Rattray, 375
Examination Questions in Electrical Engineering, 375
Jack Carstairs of the Power House, S. Sandys, 501
Journal of the I.E.E., &c., 500
Local Government Review, The, 547
Lo Zuco, Prof. R. Vinci-Bey, 549
Mechanical World Pocket Diary, &c., 549
Patent Road to Fortune, 501
Practical Electricians' Pocket Book, &c., 927
Physical Review, The, 501
Post Office Electrical Engineers' Journal, 500
Surveying and the Civil Engineer, The, 549
Wireless Telegraphy and Wireless Telephony, Dr. Kennelly, 549

Boy Scouts, The Fuze, 693
Boston Street Subway, Electrical Equipment of, 150
Bottled Electricity, 158
Brodtk's Fittings for Indirect Lighting, XIV., No. 2
British Cabinets, 776, 784
British Coal Mines, Reports on Electricity in, 182, 229
British Columbian Advance, 849
British and Continental Tramways, A. B. Fearnley, 448
British Electricians, Appreciation of, 565
British Standard Specification for Ammeters and Voltmeters, 490
British Westinghouse Co.'s Transformer, 581
Brooks' Oil Engine Research Department, 293
Brown, Prof., His Work in Testing Station, 756
Brown's "Automatic" Point Working on Electric Tramways, 144
Brussels, see DYNAMOS
Brussels Exhibition, 14, 97
B.T.-H. Conclusions Current Ampere Hour Meter, 789
Bruce, P., and J. C. Macfarlane "C.M.B." Patent Direct Current Rotary Transformer, 36
Bull Rings, see Dynamos, &c.
Bull's Steps, see Dynamos, &c.
Burbidge's Sheaves, Electrical Retardation for, 218
Burnt Factories and Electricity, 340, 559

C

Cables:
Board of Trade Regulations for, 249
For the Tees-side Power Scheme, 925
Collins' Shaft, W. Copeland, 175
Council Lines, Wires and, 709
Copper Wire Standards Committee, 499
in Derbyshire Collieries, Installation, 507
at Glasgow, 556
for Public Lighting Transmission, 815
Kapp, Dr., Remarks on, 716
Lead Sheaths, 575
Modern Systems, 8
in New South Wales Coal Mines, Rules for Installation of, 181
Patents, New, see ELECTRICAL PATENTS
Protective Devices for Insulated Cables, 553
Rules, 1, 17
Rogerson, W. M., Remarks on, in Presidential Address, 665
Sheaths, Lead, 796
Shipboard, 895
Telephone, Electrolytic Corrosion in, E. Miller, 193
at Tewkesbury, 908
Wave in Shaft, Remarks on, at Presidential Address, 669

Cadmium Amalgams and the Weston Normal Cell, F. E. Smith, 618
Cambridge, A. M., on the Testing of Iron with Alternating Current, 410
Campbell, A., Measurement of Wave Length for High Frequency Electrical Oscillation, 69
Campbell, Archibald, Portrait, 825
Canada, Electricity in, 605
Canada, Radio-Electric Power in, see W. H. White, 201
Canal, Insulated Wooden, 525, 754
Canals, Electrical Traction on, &c., 562
Canal Carbon Scheme, 205
Canada, Mineral, Use, 733
Canada, Water in, 605
Canvassers Notes, 12
Capital Ticket Office, The, 535
Carbons and the Admiralty, 776, 784
Carbon Resistance, 529
Cardiff Tramways Finance, Report by Mr. J. Allcock, 879
Car Equipment, 1,200 Volt Direct Current, F. E. Case, 456
Cars, Electric Tee, portrait of, 683
Cars, Integral Welding of, see T. W. Hinkle, 208
Case, F. E., 1,200 Volt Direct Current Car Equipment, 686
Cars (Engines, &c., 165, 186, 229, 375, 423, 439, 460, 462, 529, 544, 560, 585, 606, 627, 672, 748, 771, 801, 852, 887, also X. No. 1, XIV. No. 2, XI. No. 3, XIV. No. 4, X. No. 20, XIII. No. 25, XI. No. 27
Cathode, 705, 680
Cathode Substitute, Non-combustible, 508
Cement, Insulating, Material for Metallic-Filament Lamps, 709
Central Battery Systems, The, 823
Centrifugal Pumps in France, 605
Central Repair Depot, L.C.C. Tramways, W. E. Boland, 407
Central Station Commercial Development in Great Britain, L. H. Lewis, 668
Central Station and the Contractor, 211
Central Station Economics, W. L. Abbott, 691, 727
Central Stations and Co-operation, 474
Central Stations as Schools, 605
Chalmers, A. S., Fyfe Electrics in Nyassa-land, 570
Characteristics of Dry Batteries, F. H. Loveridge, 507
Charging of Small Accumulators, The, 30
Charlton All Motor Fire Station, 726
Cheap Units, A. M. Taylor, 18, 30
Cheltenham Electricity Works, 809
Chicago Electrical Show, 675
Child & Co.'s Wind Turbine, 885
Chinese Market, The, 645, 684
"C.M.B." Patent Direct Current Rotary Transformer, J. C. Macfarlane and P. Burge, 36, 549
Coal Mining Industry, Electricity in the, 775; also see I.E.E. and Mining
Coal Tar's Coils, The, 58, 141
Coal versus Water, 496, 185
Collective Hydro-Electric Plant, 413
Colby, T. A., Single Phase Electric Traction, 809
Colliery Shaft Cables, W. Copeland, 175
Colliery Ventilating Plant, Determination of Efficiency of, 253
"Collingwood's" Electrical Equipment, The, 587
Collis, A. G., High Tension Switchgear, 676
Colloids, Organic, Conductivity of, 708
Colman Bay's Profit and Loss, 679
Coming Expansion, The, 785
Compound Lines, Rim on, 679
Commutators, see DYNAMOS, &c.

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Companies' Meetings, Reports, &c.

Aberdeen Suburban Tramways, 355
Adelaide Electric Supply, 770, 800, 846
African Transcontinental Telegraph, 129
Allgemeine Elektrizitatsgesellschaft, 757
Anglo-American Telegraph, 155
Anglo-Argentine Tramways, 43
Argentine Electric, 657
Auckland Electric Tramways, 355
Baker-street and Waterloo Railway, 198, 236, 359
Berliner Elektrizitatswerke, 767, 798, 865
Bombay Electric Supply and Tramways, 72
Bordeaux Electric Trams, 706
Bournemouth Electricity, 131
Bradford Electric Supply, 747
Brightside Foundry, &c., 276
Brisbane Electric Light, 595, 831
Brisbane Electric Tramway, 46, 516
British Columbia Electric Railway, 104, 356, 832, 849
British Electric Traction, 19, 72
B.T.H., 355, 445
Bromley (Kent) Electric Light and Power, 394
Brown, Boveri & Co., 735
Buenos Ayres Tramways, 132
Calcutta Electric Supply, 100, 201, 318, 475, 860, 914
Canadian General Electric, 75
Cape Electric [illegible]
Chicago Open, Boston and [illegible] Railway, 199, 236, 359
Chicago City [illegible], Electric Supply, 475
Chatham and [illegible]
Chelsea [illegible]
Chile Exploration [illegible]
Chloric Electric [illegible]
City of London [illegible]
City and South [illegible]
Cleveland and [illegible] Power, 595; XII., No. 19, 6
Commercial, Leeds, 7.
Compania Mexicana [illegible] Electric Co., 316
Consolidated Electrical, 316, 475
Cuban Telephone, 767
Cordoba Light, &c., [illegible], 749
Crompton & Co., 502
Deutsche Gasglühlicht A. G., 798
Duck, Kerr, & Co., 475
Direct South Telegraph, 275
Direct West India Cable, 146
Drake and Eccarius, 555, 636
Dublin and Lucan Electric Railways, 130
Eastern Extension and Telegraph, 661
Edison & Swan, 636, 705
Edmundson's Electricity, 73, 102
Electric Bond and Share Co. of New York, 669
Electric Construction, 73, 102
Electric and General Investment, 19, 44
Electrical Securities Trust, 865, 896
Electric Supply of Victoria, 237, 275
Electric Theatres, 475
Electrical, 832
Electrolytic Alkali, 636, XII., No. 19
Elektrische Licht und Kraftanlagen A.G., 865
Elektrizitats A. G. vorm Cuno[illegible] 798
Elektrizitats A. G. vorm S. Schuckert und Co., 865
Elektrizitatswerk Siegerland, 767
Ferranti, Limited, 595
Folkestone Electricity Supply, 436
General Electric, 73, 102
Great Northern, Piccadilly, &c., Railway, 199, 236, 359
Halifax and Bermudas Cable, 436
Henley's, W. T., Telegraph Works, 155
Hobart Electric Tramways, 21
Hove Electric Lighting, 437
Imperial Tramways, 132
India Rubber, &c., 832
Isle of Thanet Electric Tramways, 867
Isle of Wight Central Railway, 275, 316
Johnson-Lundell Electric Traction, 475
Kabelwerk Rheydt A. G., 735
Kalgoorlie Electric Tramways, 355
Kalgoorlie Power and Lighting, 155, 475
Kensington, &c., Electric Lighting, 130
Lanarkshire Tramways, 275
Lancashire Electric Power, 156, 862
Lech Elektrizitatswerk A. G. of Augsburg, 829
Lisbon Electric Tramways, 4.5
Liverpool Overhead Railway, 130, 198, 275
London, Brighton and South Coast Railway, 199
London Street Tramways, 304
London United Tramways, 3.9
Madras Electric Tramways, 46, 104
Manx Electric Railway, 806
Marconi's Wireless Telegraph, 38
Melbourne Electric Supply [illegible], 868
Metropolitan District Railway, 359
Metropolitan Electric Supply, 156, 199
Metrowood Railway, 502
Mexican Tramways, 280
Monte Video Tramways, 360
Montreal Light, &c., 502
National Telephone, 44, 72, 128
Neuere Ideen der Elektrizitats und Elektrizitat, 829
Newcastle-upon-Tyne Electric Supply, 103
New General Traction, 72
Northampton Electric Light and Power, 237
North Metropolitan Electric Tramways, 503
North Metropolitan Electric Power, 502
North Western Electric Power, 237
Notting Hill Electric Lighting, 44
Oriental Telephone, &c., 595
Oxford Electric Supply, 44
Para Electric Railways, &c., 269, 516
Perth (W.A.) Electric Tramways, 156
Pueblo Tramways, &c., 316, 360
Pueblo Electrical Development Syndicate, 355
Regent Bosch Automobile [illegible]
Rheinisch-Westfalisches Elektrizitatswerke A.G., 865
Rio de Janeiro Tramway, &c., 129, 156
River Plate Telephone, 555, 595, 747
Rosario Electric, 555, 595
St. James's and Pall Mall Electric Light, 103
Schlesische Akkumulatorenwerke A. G., 735
Siemens Elektrische Betriebe A. G., 865
Siemens und Halske, 737, 832

Companies' Meetings, etc. (continued):

Singapore Electric Tramway, 155, 199
Smithfield Markets Electric Supply, 800
South American Light and Power, 155
South Metropolitan Electric Light, &c., 223, 316, 382, 516
Stettiner Elektrizitatswerke, 798
Sunderland District Electric Tramways, 926
Tokio Electric Light, 517
Tramways, 237
Underground Electric Railways, 355, 436
United Electric Co., 316, 555, 595
United Electric Railways of Caracas, 595
United River Plate Telephone, 747; XII., No. 19
Uxbridge and District Electric Supply, 156, 642
Venezuela Telephone, &c., XII., No. 19
Venezuelan Electricity A. G., 735
Vereinigte Elektrizitats A. G., 735
Victoria Falls and Transvaal Power, 73, 101, 113, 161
Water Power and Gas Electrical Generating Stations, 200
Wellington (N.Z.) Electric Tramways, 275
[illegible] Electric, &c., 200
[illegible] Electric A. G., 735
[illegible]
[illegible] 475, 555
[illegible] 2, 867
[illegible] 873, 912
[illegible]
[illegible]
[illegible]
[illegible] speech is re
[illegible]
[illegible]
[illegible] 506
[illegible]
[illegible] Alternators.
[illegible]
[illegible] Power E. Light 320
[illegible] 443
[illegible]
[illegible]
[illegible]
[illegible]
Consolidated Power and Lighting Co. and Tramway, A. R. Lea[illegible]
Continental Power, 73, 102, 448, 831
Contract Labour [illegible]
Contracts for Other United States Railways, 916
Corporation of the United States, Tax, 211
Cuban Telephone, Valuation, 923
Cuban Telephone Valuation, 923
Cuttriss & Colver's Steel Cables, 175
Copper, 122, 203, 429, 502
Copper Cable Socket, 825
Copper Wire Specification, 402, 720
Corn Mill, Electrically Driven, 697
Corona Phenomena, 100

Correspondence.

Apprenticeship, 498
Armature, Locating Fault in, 620
Bow Trolley, The, 458
Brussels Exhibition, 151, 458
Cheap Units, 10
Control of Public Services by Commission, 539
Dirt Extractor, 400
Electric Lighting Acts (Amendment) Bill, 71, 99
Electrical Preparation of Shells, 529, 580, 882, 915
Electrical Driving of Textile Factories, 818, 850
Electricity in Venice, 578
Engineers and Government, 418
Government and Electric Enterprises, The, 158
Greater London Railways, A, 558
Home Office Regulations, 30
Income Tax Assessments, 660
Institute of Mining Electrical Engineers, 378
Insulated Wire for Cables, 774
Is Central Station Work Played Out? 127
I Told You So—Bow Trolley System, 458
Japan-British Exhibition, 550
Lightning Conductors, 498, 538, 578, 690, 722, 739, 786, 878, 915
Malden Works, The, 620
Methods and Practice in the German Electrical Industry, 914
Present Aspect of Electric Lighting, 851
Pumps and Mains for Electrification, 278
Question No. 1168, 71
Question No. 1200, 499
Question No. 1201, 656, 690
Question No. 1205, 722
Rating and Taxing of Electric Motors, 99
Street Lighting Alfresco, 704
Trades' Exemption, 127
Tramway Rolling Stock Mileage, 459
Uniform Cable and Wire Sections, 378
Water Power Rights, 152
Welshman's Opinion, 7
What is Electricity? 8
Work Performed, 656
Wiring New Zealand Cottage, 359

Corrosion of Metal Structures by Electrolysis, A. A. Knudson, 255
Corrosion of Metals Underground by Electrolysis, A. A. Knudson, 208
Corrosion of Steel Wire Ropes, M. T. Murray, 671
Coupling Electromagnetic Disturbance, 446
Cost of Delivered Coal Ordnance, 917
Cost of Energy, 703
Cost of Soft Soldering, 366
Cotton Weaving by Electricity, 205, 207
Cotton Trade, Electricity in the, 44
Cousins, W. De, Apprenticeship Course for Telephone Engineer, 315
Crompton Co., Colour Scheme and Tubes, &c., 192
Crane, Electrical, Steel Frame for Electrical
Curie's Method of Accurate Tuning in Wireless Telegraphy, 495
Current Consumption, R. S. Fidler, 447
Curtis Turbine, The, XII., No. 5

D

Defender Dynamo for Motor Cars, 824
Delap's Fleet Tramway Scheme, 278
Dalrymple, J., Car Maintenance at Glasgow, 70
Dalziel, J., & J. Sayers, Single-phase Electrification of the Heysham, &c., Branch of the Midland Railway, 692
Dangerous Gas Failure, A, 645
Daniell Cell, Improvements in the, 246
Danvers, Harnessing the, 174
Darlington Waterworks, Electricity at, 472
Davies, E. H., Central Station Development in Great Britain, 668
Davies, F. H., The Electrical Pyrometer, 369
Deferred Maintenance, Cost of, 493
Dehydrisation of Transformer Oil, 680
De Muralt, C. L., Electrification for Trunk Lines, 426
Denison, R. B., Researches on the Relative Rates of Migration of Ions in Aqueous Solution, 16, 100A
Department of Mines, Canada, Report on the Electric Furnace at Domnartvet, 612
Depreciation of Tramways, 872
Destroying Insect Pests, 711
Detail, Attention to, 743
Determination of Train Resistance, E. I. Wenger, 684
Development, Electrical, in Victoria, H. R. Harper, 389
Development of Electrical Undertakings, S. J. Watson, 607
Development of the Marine Steam Engine, A. T. Batter, 606
Development by Power Gas, 406
Development of Radiotelegraphy, Prof. Stroud, 754
Development of the Telephone Industry, L. E. Wilson, 750
Dial Indicators, A Source of Error in, J. F. van Leuhaven, XII., No. 7
Distances, Electrical Production of, 753
Dick Kerr Electric Locomotives for Canada, 381
Dickson, C. B., Steam Turbines as Applied to Marine Propulsion, 712
Difficulties on Shipboard, 173
Diminishing Fixed Capital, 549
Direct and Alternating Machinery, Shop Testing of, J. W. Rogers, 728
Distillation by Electricity, 299
Distracted Industry, An, 41
Domestic Outlet, The, 659
Dommarfvet, Sweden, The Electric Furnace at, E. Haanel, 612
Dorman & Smith's Switches, &c., 422
Doubting Philosopher, The, 285
Dressmaking by Electricity, 705
Dry Batteries, Characteristics of, F. H. Loveridge, 507
Dual Service in Factories, 254, 257
Duration, &c., of Metallic Filaments, 775
Durtnell, W., Electrical Propulsion of Ships, 324, 339
Dust Extractor, 460
Dutch East Indies Market, The, 840
Dykes, A. P., & H. W. Handcock, The Present Aspect of Electric Lighting, 743, 745, 775, 826, 851

Dynamos, &c.

Air Gap of Induction Motor, Effect of, on, 551
Alternating Current Generators, German, 860
Alternators, A Method of Compounding by Means of Condensers, 7
in American Mines, G. R. Wood, 220
Application of Electric Motors to Industrial Service, The, E. B. Parsons, 187
Artificial Loading of a High-tension Generator, 161
Asynchronous Generators, 780
Bergmann Split-phase Motor, 296
at Birmingham University, 2
at Bradford Electricity Works, 685
Breakdowns of, Report on, 390
Breweries, Motors in, 829
in the Camerate (Italy) Power Station, 925
in Cleveland (U.S.) Power Station, 766
C.M.B. Auto-Converter, 36, 349
in the Colorado Yule Marble Co.'s Quarries, 259
Crompton, The, 399
Deri, The, 715
Dick-Kerr Motors for British Columbia Electric Railway, 381
Direct Current Machines, German, 859
for Domestic Use, 655
for Driving Corn Mill, 697, 722
Entz Booster, The, 693
in Ferndale Collieries Power Station, 567
Field Coils, Impregnation of, 636
and Fly-wheel Speeds, 525
at Frinton Electricity Works, 437
General Features and Design of German Machinery, 859
at Glassington Power Station, 695
in G.N.R. of America Power House, 819
Parthenon, The, 912
Pontypridd, 351
Lift Motors on the Vienna Trackless Trolley System, 449
Line Construction, The, 715
Ignoul Motor Starters, Vol., No. 6
Impey, The, 707
in Illinois Steel Co.'s Work, 750
Induction Motor, 551, 859
Intermediate Contracts for Motors, W. B. Ince, 475
Kemp, Dr., Remarks on, 713
Kinzle Variable Speed Alternating Current Motor, 920
Lahmeyer, The, 707
Lancashire Dynamo and Motor Co., 160
Lechner, C. A. V., Variable Speed Alternator, 129
Locating Fault in Armature, A. R. Woodhall, 420, 620
at the Lochgelly Coal Mines, 292
in Loray Mill, Costs on, 278
Marine Propulsion by Electric Motor, H. A. Mavor, 852
Mugley & Vandervell's Single Magnet System, 167
for Mining, 624
Motor Cable Drives, Value of, 923
Motors in Breweries, 829
Motors for Cement Mills, 526
in New South Wales Coal Mines, Rules for the Installation of, &c., 189
Non-attendance Plant, A, 149

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Dynamos, &c. *(continued)*:
in Northern Colorado Power Co.'s Station, IX., No. 7
for Nyassaland Power Scheme, 376
Oerlikon, The, 263, 565
at the Packard Motor Car Co.'s Works, 912
Patents, New, see ELECTRICAL PATENTS
Peebles Polyphase Induction Motors, 501
in the Peerless Electric Co.'s Stations, 415
Petrol-Electric Motors, 325, 589
in Phelps' Publishing Co.'s Building, 157
Phœnix, The, XI., No. 5
Pressure, Change over, 631, 656
for Rail-less Trolley System, 449
Railway Classification, Rates for, 252
Rapid-running Motors, 702
Rating and Taxing of Motors, 99
Repulsion Motor, The, 791
Rotary Converters, Six-phase *v.* Three-phase, 272
in Savoy Generating Stations, 367
Scott–Mountain, The, 821
Sheep Shearing, 620
Single-phase, 486, 593, 715, 809
Squirrel Cage Rotor, Failure to Start of, 196
for Steel Mills, 635
at the Stepney New Generating Station, 628
for Tasmanian Power Scheme, 586
Testing of, J. W. Rogers, 728
Three-phase Induction Motor for Cage Winding, 13A
for Train Lighting, 539, 653
Turbo-Generators, 796, 860
at Twickenham Electricity Works, 608
for Use on Ships, 328, 334, 728, 863
on Warships, 728
Watson, S. J., Remarks on Motors, &c., in Presidential Address, 609
Westinghouse Three-phase Alternators, 515
When to Instal a Generating Plant, 486
Worm Gearing for Electric Motors, 511
for Yakima Valley Irrigation Works, 296

E

Earthing Middle Wire of 460–230 Volt Three Wire System, 392
Earthquake Alarm, The Maccioni, 405
Earthquakes and Electricity, 405
Economical "Turn-down" Lamps, 382
Economical "Wireless," 446
Economies, Central Station, W. L. Abbott, 691, 727
Economising Oil in Power Stations, 713
Economy, False, 679
Effect of Electrical Operation and Permanent Way Maintenance of Railways, C. A. Harrison, 692

Electrical.

Accidents, 166, 181, 188, 264, 357, 367, 382, 399, 434, 522, 535, 560, 704, 724, 744, 752, 762, 776, 825, 830, 862
Advance at Buenos Ayres, 506
Advertising, 795
Actions in the Law Courts, 599; also see LEGAL INTELLIGENCE
Apparatus and Prevention of Accidents, F. E. Law and W. Sewell, 878
Appliances for Motor Cars, 666
Arc, Metal Electrodes for, 767
Barometer, An, 206
Breakdowns, 365, 390
Car, Advantages of the, 293
Circuit Breakers, Australian Duties on, 639
Coal Cutters, 473, 575
Cooking, see "Heating"
Cranes, see "Halauge"
Development in Victoria, H. R. Harper, 389
Developments at Bradford, 685
Disinfecting Fluid at Poplar, 548
Drive in Mills, 173, 398, 611, 718, 765, 803, 818, 850
Drive on Ships, 173, 398, 723
Drive for Steam Pumps, Substitution of, 431
Driving, Petrol, F. M. Green, 186
Energy Directly from the Coal Mine in Colorado, IX., No. 7
Energy in Factories, H. O. Wraith, 586
Engineers' New Home, 280
Engineers' Training, &c., 406, 487, 526
Enterprise in Japan, 255
Enterprise in Turkey, 17, 380
Equipment of Birmingham University, 2
Equipment, Protection of, P. M. Lincoln, 532
Equipment of Street Subway in Boston, 150
Equipment, Witton-Kramer, XI., No. 4
Exhibition, 325, 455, 473, 520, 535, 536, 628, 640
Experiments and the Government, 468
Experts, An Appreciation of, 473
Fans, 434, 454, 567, 575, 590, 765
Fire Alarms in New York, 318
Furnaces, 147, 219, 370, 452, 525, 606, 612, 667, 718, XIII., No. 7
Generating Plants, Assisted, 254, 257
Generation of Ozone, 398
Generator, The Sun as, 89
Goods in America, Tariff on, 295, 350
Goods, Railway Classification Rates for, 252
Haulage, 41A, 165, XIII. No. 7, 303, 357, 365, 434, 473, 514, 527, 553, 555, 567, 575, 599, 627, 718, 789, 821, 826
Heating, 61, 57, 145, 158, 219, 263, 328, 340, 342, 396, 526, 596, 757, 765, 790, 829, 873, 890; also XIV. No. 3, XIV. No. 4, XIII. No. 7
Home, Leicester Model, 763
House, Catford, 776, 807
Ignition, Hall System of, 501
Ignition of Internal Combustion Engines, J. W. Warr, 646
Industry, A Survey of the, R. K. Morcom, 681
Industry, The German, 86, 856, 883, 910
Industry, &c., The Influence of Metallic Filament Lamps on the, 12
Installation in Italy, A. Morris, 925
Instruments, Source of Error in, J. F. van Lonkhuyren, 298
Inventions at the White City, 122
Inventions and the Training of the Electrical Engineer, &c., Fleming, 487
Irrigation, 698, 700
Laboratory, A Popular, 225
Lamps, Taxation of, in Germany, 248
Lifts, see "Haulage"
Loans, Anticipating, 525
Locomotives, 63, 114, 381, 420, 605, 701, 717, 733, 819, 921
Machinery, Assessment of, 491
Machinery in Finland, 248
Machinery, Insurance of, 390
Machinery in Mexico, 359
Machinery in Portugal, Trade in, 97
Machinery for the Transvaal, 205
Navvy, 349
Operation of Textile Factories, H. W. Wilson, 117
Organ Blowing Equipments, 592, 795
Patents, see ELECTRICAL PATENTS
Plant at Durham Mines, 527
Plant in Italy, 98, 925
Plant, A Non-attendance, 149
Production of Diamonds, 753
Production of Nitrous Compounds, 719
Projects for 1910, 759, 786
Power for Light and Tramways, W. M. Rogerson, 663
Power Scheme for Trowood, Victoria, Shelving of, 366
Power Signalling, 406
Power in Steel Plants, R. Tschentscher, 450
Productions at the Physical Society's Exhibition, 847
Properties of Flame, The, Prof. H. A. Wilson, 142
Propulsion of Ships, see "Electricity on Ships"
Prosperity and Copper, 205
Pumps, VIII. and IX. No. 7, 225, 230, 245, 263, 318, 342, 357, 396, 431, 434, 461, 472, 499, 541, 557, 567, 701, 713, 821, 861, 895
Punkah (The Bandy), XIV. No. 5
Pyrometer, The, F. H. Davies, 369
Reduction of Iron Ore, J. W. Richards, 147, 870
Refrigeration for Butchers' Shops, 218
Shipments, Resonance, 781; Concession for, 586
Shock, Schafer's Method of Resuscitation from, 520
Shot Firing, 861
Showroom at Putney, 726
Signalling, 150, 189, 298, 406, 418, 430, 546, 694, 725, 726, 798, 828, 904
Signs, 414, 795
Sinking Engine, 434
Smelting, 142, 157, 164, 405, 450, 485, 525, 532, 606, 612, 721, 796, 800
Standardising, 325, 606, 668
v. Steam Drive, 864, 887
v. Steam-driven Winding Engine, 314
Steel, 829
Terminology, 892
Ticket-issuing Machine, An, 430
Timing of Motorists, 346
Trade and Railway Rates, S. Whettall, 252
Trading by American Government, 680
Tramways, Point Controllers for, J. P. Tierney, 905
Transmission of Photographs, 758
Transportation, Automatic, 683
Trolley Cars, Rail-less, 449
Undertakings, Assessment of, 491
Undertakings, Development of, 607
Units and Symbols, 701
Vehicle, The, J. H. Vail, 435
Wires, Aluminium, 212, 326, 815
Writing, 445

Electrical Patents:

Accumulators, &c.—Van Radenz & Co. and M. Metz, 167; General Electric Co. (U.S.A.), 204; Nya Ackumulator, Akt Junger, 322; A. Schautz, 402; H. Hunte, 402; Accumulatoren fabrik A. G., 480; H. de Martes, 482; J. Spiliotopol, Berlin, 522; T. McNaughton, 676; L. V. Basset, 805
Alternating Currents, Storing and Distributing, A. M. Taylor, 773
Aluminium, G. & F. Horn, 709
Arc Lamps—M. Korting, 203; H. P. Bleckly & W. Brown, 204; G. Cornaro, 204; B.T.H. Co., 321; H. J. J. Jaburg, 602; Siemens-Schuckertwerke G.m.b.H., 740; T. L. Carbone, 740; S. C. Mount and the Beck Flame Lamp, 835; B. Duschnitz, 835
Air Baths, W. Otto, 709
Apparatus for Electrical Separation—Huff Electrostatic Separator Co., 561
Apparatus for Producing Continuous Oscillations, H. Manders, 641
Asbestos Fibre for Insulating Purposes, H. L. Owen, 400
Batteries, see "Accumulators"
Blocking Single Line Railway, Siemen und Halske, 401
Brakes, O. H. Baldwin, 167; G. W. Birkett, 241; Electric Control, Ltd., 902
Cables—C. J. Beaver & E. A. Claremont, 204; R. K. Gray, 241; C. J. Beaver & E. A. Claremont, 561; British Insulated & Helsby Cables, 902; E. Witzenmann, 929
Car Indicator, H. E. Fisher, 835
Ceiling Roses, F. G. Bazell, 805
Cinematograph Apparatus, Dr. Pierimi, 442
Circuit Breakers, Electric Manufacturers Co., 401; Veritys, Ltd., 902
Clamping Devices for Fittings, Siemens Bros. & J. S. Huddleston, 561
Clocks—H. O. Jackson & T. McNaughton, 676; T. J. Murray, 676
Clutches, M. Green, 804
Collectors, E. M. Schollenberger, 928
Conductors—P. MacGahan, 361; Hon. C. A. Parsons, &c., 402; R. H. Gray, 442; J. Ormston & W. E. Charlton, 560; F. E. Saunders, 642; C. Vernier, 709; British Aluminium Co. & F. Horn, 709
Conduit Jointing, T. G. Hann, 402
Contact Breakers—R. W. Grant, 675; J. A. Schneider, 929
Contact Keys, M. C. Conner, 835
Contact Ploughs, J. G. Brill Co., 321
Controllers—C. H. Spencer, 641; A. West, 773; B.T.H. Co., 870; H. B. van Daalen, 900
Control Systems—C. G. Lohay, 402; W. Robinson, 835
Cooking and Heating Apparatus—E. Coiseur, 204; G. Cooper & F. C. Sharp, 282; R. G. Pheysey, 442
Counters, M. S. Conner, 902
Cranes—A. E. G., Berlin, 361; A. E. G., Berlin, 481; J. Marshall, J. Fleming & R. Anderson, 481; E. M. Holme, 522; Maschinen und Dampfkesseltabrik Guilleaume Werke, 561
Cutouts, E. Weckmar, 675
Distribution Systems, General Electrical Co. (U.S.A.), 204; J. S. Peck, 241; Dr. S. Guggenheimer & C. Gossen, 282; B.T.H. Co. & E. B. Wedmore, 442; J. S. Beck, 835; B.T.H. Co., 901
Divers, Telephone and Light Equipment for, 929
Draining Manholes of Electric Circuit Systems, O. Livingston & A. J. Smith, 773
Drilling Machines, Siemens Bros. Dynamo Works, 482
Driving Gear, G. F. C. Pollet, 361
Dynamometer, A. E. S. Craig & Acer, Ltd., 204
Dynamos and Motors, Lancashire Dynamo & Motor Co. & R. S. McLeod, 166; A. H. Midgley & C. A. Vandewell, 167; N. W. Storer, 167; General Electric Co. (U.S.A.), 167; M. Hartenheim, 168; Akt Brown-Boveri, 203; Siemens-Schuckertwerke, 241; Johnson Lundell Electric Traction Co. & W. A. Price, 241; A. E. G., Berlin, 241; A. C. King, &c., 241; B.T.H. Co., 281; D. Timar & C. von Dreger, 281; A. E. G., Berlin, 321; Siemens-Schuckertwerke, 360; P. L. R. Fraser & the Tudor Accumulator Co., 361; W. A. Trier, 362; B.T.H. Co., 400; H. Leitner, 401; Siemens Bros., 401; Hon. C. A. & G. L. Parsons & Hon. C. A. Parsons & A. H. Law, 401; G.E. Co. (U.S.A.), 402; H. E. Day, 441; R. Moser, 441; G.E. Co. (U.S.A.), 479; Dr. M. Breslauer, 482; Siemens Bros.' Dynamo Works, 482; E. G. Cleverly & F. I. Anderson, 522; W. Macdonald, 601; W. Stansfield & J. J. Hatt, 602; A.E.G., F. Karl-Ufer, 602; Brown, Boveri & Co., 602; A. Boeckel, &c., 641; W. A. Stevens, 641; A. Boeckel, 641; J. G. V. Lang, 674; Zucker Fabrik Frankenthal, 675; A. E. G., Berlin, 675; L. A. Hames, 676; Siemens-Schuckertwerke, 708; F. R. Kunkel, 709; Aktiengesellschaft Brown, Boveri & Co., 709; B.T.H. Co., 772; Siemen & Halske, A.G., 773; Felten & Guilleaume Lahmeyerwerke, A.G., 773; W. Stansfield & J. J. Hatt, 835; G. Deran, 836; J. Garty, 869; W. Stansfield & J. J. Hatt, 870; B.T.H. Co., 870; Siemens-Schuckertwerke G.m.b.H., 870; B. G. Lamme, 900; B.T.H. Co., 901; Siemens-Schuckerlwerke, 902; W. P. Durtnall, 928; B. G. Lamme, 929; Société Anonyme d'Ougrée Marihaye, 929; B.T.H. Co., 929; Allmanna Svenska Elektriska Aktiebolaget, 929
Electrodes, C. C. Connor, J. W. Stubbs & th Electrolytic Alkali Co., 482
Electrolers, R. S. Woods, 440
Electrolytic Devices, W. B. Thorpe, 928
Electromagnetic Callboards, J. Appleby & A. E. Drew, 676
Electroplating, A. Gerburg, 482
Energy, limiting the Supply of, G. Wilkinson, 773
Fittings, J. J. Rawlings, 675
Former-wound Coils, Insulating, Siemen & Halske, A.G., 773
Friction Couplings, La Société anonyme electricite Electromechanique, 360
Switchboards, H. Brand, 521
Furnaces, &c.—G. Cornaro, 204; E. Osterle, 321; Grondel Kjellin Co. & J. Harden, 360; Röchlingsche Eisen und Stahlwerke, 480; C. Bingham, 560; Aktiebolaget Elektrometal, 676; M. Ruthenburg, 869
Fuses, H. J. Fuller, 522
Galvanic Dry Batteries, G. L. Patterson, 927
Galvanising Apparatus, G. A. Beckett, 481
Grinding Machines, G. Robson & F. Marshall, 522
Heating Apparatus, R. G. Pheysey, 442; G. Cooper, &c., 675; A. Ponzini, 836; J. A. Abbott, 870
Heating Coil Protecting Devices for Weak Current Circuits, Siemens und Halske, 282
Incandescent Lamps—Société Française d'Incandescence par le Gaz, and B.T.H. Co. & H. H. Needham, 204; C. Trenzen & F. R. Pope, 241; S. Marietti, 282; E. Böhm, 322; J. Nelson & Drake & Gorham, 321; Siemens Bros.' Dynamo Works, &c., 401; W. Schaffer, 441; E. A. Kruger, 480; W. C. Arsem, 481; T. Birchall, 482; A. E. G., F. Kad Ufer, 602; E. B. Wright, 602; Gluklampenwerk Anker G.m.b.H., 641; T. McKenna, 709; L. A. Williamson, 835; W. Heinrich, 835; F. Farber, 835; C. Stearn, 835; J. Meazaros, 869; Société Française d'Incandescence par le Gaz, 870; H. J. Fuller, 900; F. W. Suter, 929
Ignition Apparatus, &c.—J. G. Hay, 167; J. D. Bell, 204; E. Deniéport, 282; W. Mulholland, 320; E. Deniéport, 361; A. W. Bird, 440; A. J. Postans, 441; L. Kirby, 480; Chicago Coil Co., 482; L. H. Wattles, 482; R. Bosch, 560; F. Elektrischer Zunder, 601; R. F. Hall, 602; L. H. Hounsfield, 675; W. A. Trier, 709; J. D. Bell, 740; C. Cecil, 929
Indicators, A. Whalley, 804; J. Sax & Co., 927
Induction Coils, H. F. Bigge, 321; Chicago Coil Co., 482; R. R. Harper, 482; H. F. Bigge, &c., 676
Insulating—Siemen & Halske, A.G., 773; Felten & Guilleaume Lahmeyerwerke, A.G., 773
Insulators—R. Gremer, 400; A. M. Bourke, 709
Interrupters—T. McClelland, 902; L. J. B. Drault, 929
Lamp Brackets, J. J. Rawlings, 835
Lamp Shades, D. L. J. Broadbent, 902
Life Guards for Cars, H. W. Johnson & W. Steele-Brown, 322
Light Fittings, A. T. Woodhall & A. Emery, 562
Lighting—G. Thomson, 360; Siemens Bros.' Dynamo Works, 480
Lightning Arrester, G.E. Co. (U.S.A.), 676
Magnetic Blowouts, T. von Zweigbergk, 561
Magnetic Clutches, H. W. Ravenshaw, 281
Magnetic Induction Machines, R. Bosch, 241
Magnetic Separators, E. Osterle, 321
Metallic Filament Lamps, see "Incandescent Lamps"

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Electrical Patents (*con'tinued*):
Meters, &c.—B. T. H. Co. & A. G. Martin, 167; H. Aron Elektricitatszahlerfabrik, 167; J. A. Stoneham & F. A. Stoneham, 241; Dr. S. Giggenheimer & C. Gossen, 282; G. Hookham, 361; W. B. Thorpe, 442; Siemens-Schuckertwerke, 482; H. Landis & K. H. Gyr, 641; W. Smith, Lewisham, 674
Motor Controllers, Siemens Bros., Ltd., & F. O. Thompson, 641
Multiple Contact Vibrator, F. J. Clarke, 642
Overhead Conductors—E. M. Munro & The Railless Electriction Co., 740; British Insulated & Helsby Cables & J. W. Astley, 805
Planing Machine, Vickers, Son & Maxim & A. D. Williamson, 167
Polarised Morse Sounders, &c., C. C. Vyle, 361
Producing Periodical and Intermittent Motion, W. Vetter & C. Murer, 600
Protective Devices for A.C. Systems, A.E.G., Berlin, 521 and 676
Pumps, A. B. Mallinson, 772; W. A. Stevens, 835
Recording Current Leakage in Circuits, Arhingten Coal Co. & T. McKie, 167
Rectifiers, T. J. Murphy, 740
Regulating Devices, B.T.H. Co., 901
Regulators, G.E. Co. (U.S.A.), 441
Relays—M. S. Conner, 521; M. S. Conner, 740; Siemens & Halske, 835
Regulation of Power Factor in Alternating Current Systems, B.T.H. Co., 675
Resistances, W. A. Phillips & F. R. Bacon, 442
Rotary Brushes, Light Electric Motor Co., 675
Rotor Windings, Siemens-Schuckertwerke, 870
Safety Lamps, G. Wolters Weitmar, 561
Signalling Systems—A. T. Blackall & C. M. Jacobs, 281; A. C. Davey, 282; A. Degener-Böning, 440; G.E. Co. (U.S.A.), 442; G.E. Co. (U.S.A.), 480; E. P. Jeli-Revdey, 480; H. C. Wilson & C. R. B. Claplin, 481; T. Macdougal & J. Chambers, 522; G. H. Brown, 561; A. Muirhead, 602; G.E. Co. (U.S.A.), 641; F. Cumont, &c., 676; R. A. Fessenden, 709; H. W. Price, 835; E. W. Smith, 902; R. Rutherford, 929
Sheathing Electric Wires, J. J. Rawlings, &c., 676
Ships' Telegraphy, P. R. Keppie, 482
Situndum, G. Cooker & F. C. Sharp, 522
Spinning Frames, Driving of, J. & T. M. Greeves & R. V. Eves, 241
Starting and Reversing Devices, Electric Pulley Block Co., 902
Suspension Devices for Supplying Current from Overhead Wires, A. Schweiger, 675
Switch Boxes, C. Wurt & Co., 676
Switches—L. Sunderland & G. C. Pillinger & R. F. Venner, &c., 166; G. Cooper & F. C. Sharp, 167; W. Barraclough, 204; Cutler-Hammer Manufacturing Co., 241; G. Rosenbusch, 241; J. S. Peck, 241; O. Timar & C. von Dreger, 281; General Electric Co. (U.S.A.) 281; Verity, Ltd., & W. G. Pipkin, 360; Sandycroft Sandy Co. & T. M. Dutton, 360; F. S. Horrocks & T. C. Letts, 361; C. G. Lohay, 402; Siemens Bros. & B. J. Payne, 441; E. Garside, 441; H. W. Cox, 442; A. P., G. C. & P. A. Lundberg, 481; Lodge Bros., 481; E. G. Bryant & R. H. Pearson, 482; W. H. Hood, 522; H. E. White, 560; F. W. W. Baker & G. Pearce, 561; T. von Zweigberk, 561; V. Hope, 641; R. Jackson & C. Gaffney, 707; W. M. Mordey, 707; H. J. Fisher, &c., 709; T. J. & E. Rorke, 709; T. Birchall, 740; Nalder & Thompson, 741; G. Sweetster, 835; Cardwell, Bowman, Ford-Lloyd, Ltd., 870; A. H. Curtis, 870; Cutler-Hammer Manufacturing Co., 900; W. H. Flood, 900; R. Hacking, 900; Siemens Bros., Ltd., 900; Veritys, Ltd., 928; A. S. Cubitt, 929; W. E. Richter, 929
Telegraphy—Dr. Schiessler, 400; P. P. O'Neill, 402; Marconi Wireless Telegraph Co., 482; A. Muirhead, 602; A. M. Bourke, 709; T. Clark, 929
Telephony—Dr. Schiessler, 400; P. B. Clarke, 482; R. R. Harper, 482; M. S. Conner, 521; Siemens & Halske, A.G., 561; E. Egner & J. G. Holmstrom, 602; A. M. Bourke, 709; International Telephonometer Co., 740; Siemens Bros. & Co., 772; Siemens & Halske, 835; E. A. Graham, 870; M. C. Conner, 900; R. H. Davis, 929
Terminals, C. J. Beaver & Co., 709
Thermopiles, A. Ritterhausen, 522
Time Relay for Electric Currents, D. Timar & R. Ziegler, 320
Trams, Driving, &c.—F. Wagner, 676; W. Robinson, 835
Tramway Points, G. H. Butterworth, 870
Transformation of Electric Currents, H. Taylor, 168
Transformers—F. Conrad, 322; H. F. Bigge, 321; H. F. Bigge, &c., 676; J. P. Annacker, 773; A. M. Taylor, 773
Transforming Electrical Energy into Heat Energy, C. O. Bastian, 560
Transmission of Power from a Prime Mover to a Load, A. C. King, F. Hamer & J. King, 241
Trolley Frogs, 322
Trolley Heads, F. G. Holmes, 641
Trolley Poles for Trams, S. Bryan, 400
Trolley Wheels, G. Krebs & Co., 929
Trolley Wires, H. Schutte, 928
Tungsten, Siemens & Halske, 480
Turret Clocks, E. J. O. Newett, &c., 602
Typewriter Operating Attachment, G. A. Mayrand, 402.
Vehicles, Signalling on, C. W. Mallins, 709
Welding, A. G. Stahlwerke Weissenfels, 282
Wire-covering Machines, C. Demuth, 401
Wireless Telegraphy—Marconi Wireless Telegraph Co. & H. C. Round, 360; G. Marconi, &c., 400; S. Eisenstein, 602; R. A. Fessenden, 709; W. Burstyn, 773; G. Marconi, 870; R. A. Fessenden, 870
Wire Supports, C. C. Gould, 441
Wire-winding Machine, A. E. Wilderspin & E. S. Hough, 321
Wiring, A. E. Lamkin, 870; J. S. Highfield, 929

Electrical Tenders:
at Aberdeen, 517
for the Admiralty, 436
in Africa, 80, 238, 394, 397, 476, 556, 637, 738, 770 897, 927
at Alloway, 24
at Altrincham, 49, 106
at Altringham, 595
in America, 276, 554, 593, 701
in Australia, 22, 23, 24, 50, 51, 52, 79, 80, 108, 133, 166, 276, 317, 356, 394, 395, 476, 517, 556, 595, 599, 637, 638, 661, 706, 738, 770, 801, 833, 867, 896
in Austria, 316, 638
at Axbridge, 317
in the Bahamas, 517
at Barnstaple, 106, 203, 238
in Batavia, 556, 595
at Barking, 25
at Battersea, 25, 202
at Bedford, 25, 108
at Belfast, 238, 317, 517, 556, 832, 868, 897
in Belgium, 50, 79, 107, 134, 135, 166, 202, 276, 317, 356, 394, 476, 706, 738, 770, 801, 833, 867
for Bentley Colliery, 638
at Birkenhead, 108
at Birmingham, 52, 77, 706, 738
at Blackburn, 77
at Bradford, 77, 135, 706
at Bray, 556
in Brazil, 317, 356, 436
at Bridlington, 897
at Brighton, 136, 517
at Bristol, 394, 638
B.T.H. Co.'s Contracts, 476
in Buenos Ayres, 833
at Burnley, 52
at Burslem, 133
at Bury, 22, 80
at Buxton, 135
for Cambrian Collieries Co., 833
in Canada, 107, 238, 395, 436, 476, 517, 554, 556, 738, 770, 801, 864, 897
in China, 166, 203, 317, 770
at Colchester, 80, 738
at Coupar Angus, 108
at Croydon, 203
in Cuba, 107
at Darlington, 80, 276
in Denmark, 51
at Derby, 49, 52, 80, 135
at Devonport, 24
at Dewsbury, 80, 133
for Dolcoath Mines, 280
at Dover, 22, 166
at Droxford, 108
at Dublin, 25, 77, 106, 202, 203, 238, 356, 661, 706, 738, 770
at Dudley, 80, 556
at Dundee, 52, 276, 595
at Eastbourne, 897
at Eccles, 77
at Edinboro', 48, 203, 706, 738
at Edmonton, 106, 706, 738
at Egremont, 23
in Egypt, 637
at Epsom, 637
at Erith, 52, 135, 927
in France, 51, 107, 134, 238, 395, 476, 595, 637, 661
at Frodingham, 556, 638
at Fulham, 80
for G.P.O., 50, 77
in Germany, 23, 50, 107, 166, 238, 276, 317, 356, 394, 476, 638
at Gillingham, 52
at Glasgow, 24, 80, 436, 476, 638, 672, 738
at Grimsby, 24, 52
at Harlingden, 22, 137
at Hastings, 133
at Hellingly, 78
at Heston, 52
at Heywood, 801
at Hindhead, 897
in Holland, 51, 202
at Huddersfield, 133, 134, 638, 897
at Hull, 78, 801
at Ilford, 136
in India, 280, 395, 599, 637, 661, 706, 738, 770, 801, 833, 897
at Inverness, 706, 738
at Isleworth, 52
in Italy, 107, 133, 166, 202, 476, 517, 556, 595, 637, 867, 897, 926
at Keighley, 106, 135, 556, 672
at Keynsham, 80
for Kilkenny Asylum, 738
at Kingston, 638
in Korea, 476, 517
at Larne, 80
at Lauder (Scotland), 22
at Leeds, 203, 276, 316
at Leamington, 52, 80
at Leith, 202
at Leyton, 52, 78, 80, 276, 316, 595, 706
at Liverpool, 476
at Llandudno, 637
for L.C.C., 22, 25, 52, 78, 80, 108, 109, 136, 238, 276, 316, 356, 394, 637, 638, 672, 706, 738, 770 801, 833, 897
at Londonderry, 22
at Longton, 52
at Lowestoft, 638
at Luton, 637
in Madrid, 706
at Maidenhead, 108
at Maidstone, 136, 166
at Manchester, 22, 77, 106, 133, 517
at Mansfield, 108
at Margate, 51,
at Merthyr Tydfil, 556
for Metropolitan Asylums Board, 706, 801
for Metropolitan Railway Co., 476
at Mexbrough, 25, 80, 136
for Mexico, 738
at Mile End, 106
at Minworth, 135
Mirrlees-Watson Co.'s Contracts, 476
at Mountain Ash, 595
at Newark, 52

Electrical Tenders (*con'tinued*):
in New Zealand, 238, 356
at Northallerton, 80
for Northampton Polytechnic, 738
for North-Eastern Railway, 706, 738
in Norway, 476, 595
at Paddington, 638
for Panhard and Levassor, 770
at Plymouth, 51, 133, 276
at Pontypridd, 22, 77, 357
at Poplar, 276, 316
at Radcliffe, 639
at Rhyll, 238
at the River Plate, 476
at Rochdale, 78, 80
at Rotherham, 48, 106, 108, 476
in Roumania, 202, 833
at Rugby, 51
in Russia, 107, 166, 738
at St. Pancras, 137, 517
at Salford, 22, 48, 80, 108, 166, 317
at Saltley, 136
at Samarkand, 770, 800, 833
at Sculcoates, 25
in Servia, 276, 317
at Shanghai, 770
at Sheffield, 77, 133, 166, 706
at Shrigley, 135
at Southampton, 24, 52
at Southport, 108
at Southwark, 136
in Spain, 51, 107, 166, 395, 397, 476, 517, 556, 595, 637, 638, 661, 706, 770, 801
at Spennymoor, 52
at Stepney, 52, 80, 833
at Stirling, 51
at Stockport, 166
at Sunderland, 48, 638, 706, 738
at Swansea, 22, 51, 80, 109, 476
at Swinton, 24
in Switzerland, 134, 166
in Tasmania, 136, 476, 661, 706, 738, 770, 801, 833
at Tewkesbury, 436
at Torquay, 135
at Treforest, 106
in Turkey, 166, 356, 394, 556, 595, 638, 661, 706, 738, 770, 801
in Venezuela, 276
at Wakefield, 738
at Wallasey, 395
at Walsall, 24
at Warminster, 52
for War Office, 638
at Warrington, 637
at Watford, 801
at West Ham, 49
at West Hartlepool, 80
at Whitechapel, 738
at Whitehaven, 25
at Wigan, 78, 80
at Wimbledon, 136
at Wishaw, 52, 357, 833
at Wolverhampton, 238
at Woolwich, 52, 80
at Worcester, 80
at Worksop, 108
at Worthing, 395
at Yarmouth, 133
at York, 517, 638
Electrically Driven Mills, C. A. Ablett, &c., 406, 465, 485; also see "Factories" under ELECTRICITY.
Electrically Heated Household Appliances, A. G. Jones, 873
Electricians, British, Appreciation of, 565

Electric Lighting:
at Aberdare, 799
at Aberdeen, 21, 238, 340, 357, 379, 395, 596
at Acton, 276, 317, 518, 866
at Adelaide, 846
in Africa, 73, 202, 240, 279, 376, 438, 478, 519, 704, 737, 831
at Ainsworth, 638
at Aldershot, 317
at Alvaston, 556
at Amble, 276, 317, 395, 437, 703, 799, 895
in America, 65, 150, 152, 155, 157, 184, 211, 223, 269, 295, 307, 316, 435, 474, 496, 539, 554, 640, 668, 733, 766, 777, 904, 923
at Amsterdam, 831
at Arbroath, 74
at Ardsley, 703
in Argentina, 555, 558, 637, 705, 831, 896, XI. No. 27
at Ashford, 74
at Aspull, 596
at Aston, 75, 477, 556, 670
in Australia, 128, 155, 237, 240, 275, 279, 340, 355, 358, 359, 389, 396, 397, 475, 478, 518, 519, 583, 595, 671, 704, 770, 800, 846, 868, 896, 903
in Austria, 64, 267, 397, 597
at Axbridge, 40
at Aylesbury, 103
at Ayr, 103, 238, 640, 895
at Bacup, 395
at Ballina (N.S.W.), 396
at Ballyclare, 556
at Balmain, 704
at Baltimore, 668
at Bangor, 276
at Barking, 165
at Barnes, 357, 895
at Barnet, 130
at Barnsley, 238, 276, 670
at Barnstaple, 20
at Barrow, 437, 477, 596
at Bath, 75, 130, 201, 437, 703, 759, 895, 926
at Battersea, 181
at Beckenham, 71
at Bedford, 44
at Belfast, 238, 317, 736
in Belgium, 64, 267
at Bentley, 703
at Berkhamsted, 357, 703
in Berlin, 64, 267, 304
at Bermondsey, 477, 703, 830

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Electric Lighting *continued*:
at Berwick, 103
at Bexhill, 44, 437, 895, 926
at Bielitz, 735
Bills for, 58, 71, 85, 93, 99, 622, 635, 660, 759, 768, 786, 829
at Birkenhead, 425
at Birmingham, 2, 20, 201, 473, 515, 605, 764, 826, 830, 921
at Bishop's Stortford, 74, 787, 889, 926
at Blackpool, 20, 74, 194, 594
at Blaenau Festiniog, 130
at Blaydon, 667
Board of Trade Regulations, 70, 249
at Bo Imm, 74, 736
in Bolivia, 396
at Bolton, 238, 425
at Bombay, 72
of Boston Subway (U.S.A.), 150
at Boulder (W.A.), 358, 478
at Bournemouth, 895
at Bradford, 202, 238, 437, 477, 605, 638, 645, 685
at Bradninch, 737
at Braunton, 638, 736
at Bray, 131, 276, 395, 556
in Brazil, 97, 279, 516
at Bridlington, 45, 395, 518, 703, 799
at Brighouse, 317, 357
at Brighton, 20, 239, 437, 518, 638, 703, 866, 926
at Brisbane, 595
at Bristol, 277, 477
in British Columbia, 240, 438, 704, 768
at Brixham, 787
at Bromley, 396, 518
at Brumby, 277, 761
at Bruneck, 735
at Buckfastleigh, 437
at Brussels, 64, 267
in Buenos Ayres, 20, 358, 506, 558, 831
at Bukarest, 831
at Bulawayo, 704
at Burnley, 45, 202, 703
at Burslem, 104
at Burton, 277, 866
at Bury, 437
at Buxton, 130
at Calcutta, 100, 201, 318, 475, 518, 800
at Caldy, 242
at Camberley, 830
in Canada, 74, 164, 279, 405, 438, 478, 502, 558, 606, 646, 769, 777, 800, 867
at Canterbury, 638
at Cape Town, 202
at Cardiff, 35, 395, 477, 556, 638
at Carlisle, 103, 201, 477
at Carmarthen, 866
at Carnarvon, 866
at Cattord, 776, 807
at Cavenham, 895
at Charlton (Victoria), 396
at Cheltenham, 809
at Chesham, 762
at Chicago, 496
at Chichester, 477
in Chili, 156, 198
in China, 478, 645
at Chipping Norton, 787
at Chopwell, 134
at Church, 736, 761,
of Churches, 840
in the City (London), 156, 245, 267, 277, 518, 866
at Cleckheaton, 45
at Cleethorpes, 638, 670
at Clevedon, 357, 703, 761
at Cleveland (U.S.A.), 766
at Cobham, 768
at Colchester, 75, 736, 744
at Cologne, 64, 267
at Colorado, 269
at Colwyn Bay, 679, 736
Companies' Meetings, see COMPANIES' MEETINGS
Contracts, see ELECTRICAL TENDERS, &c.
at Cookstown, 239, 596
at Cordoba, 637
in Costa Rica, 318
at Coventry, 20
at Cowdenbeath, 277
at Crefeld, 735
at Creswick (Victoria), 518
at Crompton, 638
at Darlington, 44, 74, 165, 277, 317, 437, 703, 736
at Darwen, 104
at Dawlish, 74, 556, 787
at Derby, 44, 74, 131, 557, 736, 760
at Detroit (U.S.A.), 65, 223, 307
at Deutsch Gabel, 735
at Dinas Powis, 131
at Doncaster, 103, 895
at Dover, 75,
at Dresden, 64, 267
at Dublin, 165, 239, 277, 317, 395, 830, 895
at Dudley, 277, 477, 515, 557
at Dundalk, 736
at Dundee, 44, 103, 239, 317, 437, 596, 768, 799
at Dunedin, 769
at Dunstable, 130
at Dusseldorf, 64, 267
at Dyart, 396
at Eaglehawk (Victoria), 240
at East Ham, 518
at Eccles, 74, 165, 396, 703
Economy in (Drake & Gorham's System), 221
at Edinburgh, 131, 596, 799, 866, 895
at Elland, 866
at Epping, 787
at Epsom, 164, 477, 639
at Exeter, 20
at Failsworth, 74, 239
Failure to Obtain Light in Haulage House of Coal Pit, 763
at Fareham, 75, 202, 239, 557, 596, 736, 866
at Farnham, 20, 760
at Farnworth, 340
at Finchley, 75, 557
Flat Rates for, 660, 743
at Folkestone, 436
at Footscray, (Victoria) 396
in France, 64, 267, 605, 831
at Fremantle, (W.A.) 358
at Frimley, 703, 786
at Frinton, 164, 437
Electric Lighting *continued*:
at Frodsham, 670, 761
at Frome, 75
at Fulham, 130, 164
and Gas, see GAS SUPPLY, A
in Germany, 64, 267, 394, 522, 795, 849, 871
at Gillingham, 75
at Glamorgan, 131
at Glasgow, 239, 277, 711, 871
at Gloucester, 45, 142, 164, 557
at Gorseinon, 859
at Gravesend, 277, 477
at Grantham, 465
at Grassington, 20, 596, 689, 695
at Greenock, 44, 596
at Greystones, 799
at Grimsby, 670, 768, 799, 926
in Guadalajara, 358
at Hackney, 865
at Halifax, 44
at Hammersmith, 670
at Hampstead, 477, 536, 799, 830
at Hanoverswirth, 46, 862, 891
at Hanley, 44, 131, 557, 477, 670
at Harrogate, 775, 842
at Haslemere, 366, 536
at Haslingden, 44
at Hastings, 44, 357, 762
at Havant, 768, 787
at Hay, 277
in Hayti, 478
Headlight Testing Rack, 123
at Hessle, 164, 557
at Heywood, 74
at Hindhead, 201
Hints to Consumers on, 269
in Holland, 240, 831
at Holsworthy, 239
Home Office Regulations, 510
Home Office Returns of, 425
at Hornsey, 164, 765, 926
at Horsham, 437, 866
at Hove, 45, 437
at Huddersfield, 131, 736, 866
at Hull, 164, 277, 557, 670, 926
at Ilford, 165, 239, XI. No. 23
at Ilfracombe, 201
Income Tax Assessment of Works, 491, 497
in India, 72, 100, 318, 356, 369, 396, 475, 478, 518, 558, 831
at Ipswich, 201, 477
in Isle of Wight, 654
at Islington, 627
in Italy, 98, 279, 359, 478, 867
in Japan, 269, 517, 518
at Johannesburg, 438
at Kalgoorlie (W.A.), 155, 397, 475
at Keighley, 45, 357, 358, 768
at Kendal, 557
at Kettering, 357
at Kilmarnock, 396
at King's Lynn, 104, 277, 477, 866
at King's Norton, 922
at Kingston, 670, 895
at Kirkintilloch, 639
at Kirkcaldy, 74
at Lambeth, 670
at Lanchester, 44
at Launceston (Australia), 397
at Launceston, 103
at Leamington, 164, 861
at Leeds, 396, 596, 712
at Leek, 44
at Leicester, 518, 765, 768
at Lewisham, 45
at Liss, 74
at Littleborough, 703
at Liverpool, 425, 639
at Llandilo, 358
at Llanelly, 20
at Llandilofawr, 830
at Lochee, 437
in London, City of, 64, 156, 246, 267, 277
at Londonderry, 278
at Longton, 44, 201, 239, 518
at Loughborough, 74
at Lourenco Marques, 478
at Lowestoft, 103, 437, 596, 736, 895
at Luton, 201
at Madras, 100, 359
at Maesteg, 317
at Maidstone, 164, 639
at Maldon, 239
at Malvern, 396, 477
at Manchester, 68, 166, 425, 634, 700, 796, 895
at Mansfield, 278, 358, 518
at Market Harborough, 20
at Maryborough (N.S.W.), 359
at McDougall's Chemical Works, 765
at Melbourne, 279, 359, 478, 583, 868
at Merthyr, 518, 703
at Messina, 867
at Mexborough, 131, 477
in Mexico, 358, 359, 478, 516, 800, 867
at Middlesbrough, 164, 239, 278, 557, 736, 768, 786, 830
at Middleton, 317, 703, 787
at Mirfield, 358
at Morecambe, 20, 130
at Morley, 75, 839
at Mortlake, 895
of Motor Cars, 120, 122, 229
at Munich, 64, 267
at Mussoorie, 518
at the National Pageant of Wales, 188
at Navan, 639
at Neath, 103
at Netrigh, 74, 102
at Newcastle-on-Tyne, 103, 699, 795, 890
at Newcastle Uulyn, 477, 703
at Newcastle (Ireland), 396, 557, 670
at Newport (Mon.), 74, 670
at New Romney, 74
at New York, 766
in New Zealand, 397, 478, 597, 769, 896
at Northampton, 237, 358
in Norway, 867
at Norwich, 639
at Nottingham, 317, 703
at Nuneaton, 768
at Ogmore, 477
at Oldham, 20, 74, 278, 425, 557, 703, 830, 866
Electric Lighting *continued*:
at Ontario, N., 867
at Ormskirk, 760
at Orpington, Cape Colony, 240
at Oswaldtwistle, 20, 205, 358, 557
at Pembroke, 673, 704
at Paignton, 278
at Paisley, 768
in Palestine, 44
at Para, 640
at Paris, 64, 267
at Patent Office Library, 711
at Peasmarsh, 596, 800
at Penrhyn, 278
at Penzance, 74
at Plymouth, 278, 358, 739
at Pontefract, 518
at Pontlot, 98
Population of, 663
at Portadown, 596
at Portsmouth, 278, 317
at Prescot, 45, 478, 737
at Prescot, W. M. Register, 663
and Power Cables, Paper Insulated Mode of, 157
Present Aspect of, 744, 776, 826, 851
at Preston, 149, 258
Provisional Orders for, see BILLS
at Pudsey, 516, 800
at Putney, 720
at Quebec, 769
at Ramsgate, 239, 639, 768, 787
at Rathmines, 239
at Rathvilly, 358
at Reading, 278, 596, 862, 895
at Redcar, 736
at Redditch, 478
at Redhill, 239, 704
at Reef Plain, 130
at Rochdale, 239
at Rome, 478
at Rosebeath, 478
at Rosslyn, 557, 705
at Rosyth, 437
in Roumania, 831
at Rowley, 508, 596
at Rugby, 20
at Rumworth, 750
in Russia, 359, 831
at Rythope, 596
at St. Albans, 670
at St. Catharines, Canada, 397
at St. Helens, 670
at St. Ives, Cornwall, 164
at St. Marylebone, 645, 768, 895
at St. Pancras, 166, 438, 704, 768, 799, 830
at Saltburn-by-Sea, 104
at Sandbach, 20, 425, 477, 786
at Sandown, 830
at Sandycroft, 278
at Sandy Point, Cape Colony, 279
at Sandhill, 164
in Saxony, 519
at Sheerness, 74
at Sheffield, 44, 104, 131, 278, 396, 437, 640, 761
at Shepparton (Victoria), 397
at Shipley, 704
at Shops, 328
at Shoreditch, 365, 437, 520, 670
at Shrewsbury, 20
Smith's Cyclops Exhibit at White City, 33
at Singapore, 831
at Skipton-in-Craven, 74
at Spennithorne, 762, 784
at Southampton, 20, 201, 477, 639
at Sunderland, 125, 518
at Sutton, 830
at South Shields, 131, 437, 594, 596, 639, 764
in Spain, 97, 279, 637, 765, 770
at Stalybridge, 518
at Spencerville, Mass., 157
at Stanstead, 74
at Steep, 74
at Stepney, 365, 628, 670, 704, 866, 895
at Stirling, 20, 799
at Stockton, 278, 830
at Stoke-on-Trent, 75, 131
at Stourbridge, 239, 317
at Strabane, 478
at Stretford, 639
at Stroud, 74
at Sunderland, 671, 830
at Swansea, 20, 74, 358, 639
at Swindon, 438
at Swadlincote, 926
in Switzerland, 164, 240, 867
at Sydney, (N.S.W.), 359, 478, 671, 800
at Taunton, 104, 278, 478, 926
at Tavistock, 396
Tenders for, see ELECTRICAL TENDERS
at Tiflis (Russia), 359
at Tiverton, 74
at Todmorden, 278
at Tokyo, 517, 518
at Tonbridge, 799
at Toronto, 438, 558
at Torquay, 396, 503, 736, 867
at Totnes, 150
of Trains, 150, 318, 518, 539, 558, 635, 653, 705, 803
at Tunbridge Wells, 201, 736
in Turkey, 17, 318
at Tynemouth, 131
at Uttoxeter, 639
at Uxbridge, 156, 462
in Victoria, 128, 237, 275, 389, 396, 397, 478
at Vienna, 64, 267, 597
at Walsall, 75, 104, 558, 799, 830
at Walthamstow, 165
at Warrington, 787
at Watford, 278, 396, 396, 768, 799
Waves Power for, 660
at Westminster, 396, 737, 867, 895
at Wellington (N.Z.), 397, 597
at Wembley, 768
at West Ashford, 103
at West Ham, 46, 94, IX. No. 6; 438
at West Hartlepool, 558
at Westhoughton, 558
at Westminster, 597, 639
at Weybridge, 478
at Whitby, 558

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Electric Lighting (*continued*)

at Whitchurch, 131, 639, 704
at Widnes, 239, 596, 700, 787
at Wigan, 45
at Willesden, 655, 663
at Wimbledon, 76, 724
at Winnipeg, 867
at Witham, 671
at Wolverhampton, 75, 799
at Wood Green, 44, 68, 201
at Woolwich, 671, 768
at Worcester, 396
at Woking, 318
at Worsley, 926
at Worthing, 202, 558
at Wrexham, 20
at Yarmouth, 102, 671
at York, 20, 44, 131, 518, 619, 768, 831, 867
at Youlgreave, 704
at Ystradgynlais, 737

Electric Traction:

at Abbazia, 735
at Aberdeen, 47, 240, 318, 355, 357, 447, 596, 639
Accidents, see ELECTRICAL ACCIDENTS
Accumulators for, 554
at Adelaide, 519, 558
in Africa, 202, 438, 558, 661, 737
at Alberta (Canada), 240
in America, 21, 63, 96, 100, 126, 150, 152, 173, 184, 4X, No. 7, 223, 260, 295, 309, 360, 407, 426, 435, 445, 458, 473, 493, 515, 559, 594, 596 597, 645, 668, 683, 684, 686, 701, 717, 735, 766, 796, 819, 827, 848, 863, 892, 904, 924
at Amsterdam, 769
in Argentina, 240, 360, 438, 559 705, 769
at Auckland (N.Z.), 559
in Australia, 46, 103, 128, 156, 240, 254, 280, 355 389, 396, 516, 519, 558, 597, 803, 834
in Austria, 397, 448, 671, 704, 717, 735
Automatic Electromagnetic Switch for, 204
Automatic Point Working, 144
at Ayr, 104, 478, 640
at Bacup, 104, 165
Baker Street and Waterloo Railway, 199, 236, 359, 761
at Barnsley, 132
at Bath, 104
at Belfast, 317, 357, 397, 736, 802, 867
at Bermondsey, 519, 704
Bills for, 246, 258, 445, 752, 759, 786
at Birkenhead, 425
at Birmingham, 635, 890
at Blackburn, 425
at Bologna, 519
at Bolton, 425
at Bombay, 72
at Boston (U.S.A.), 150, 184, 223
at Bournemouth, 103, 582, 519
Box Collector and Frobey, 448
at Bradford, 21, 103, 437, 558, 762
Brakes for, 167, 301
in Brazil, 129, 360, 519, 671, 866
at Breslau, 735
at Brighton, 165, 518
at Brisbane (Queensland), 46, 516
in British Columbia, 165, 348, 356, 360, 381, 396, 721, 831, 862, 849, 867
at Brunneck, 735
in Buenos Ayres, 319, 438, 445, 506, 558, 769
at Burry Port, 47
at Bury, 76
at Camborne, 47, 279
in Canada, 206, 240, 280, 319, 327, 381, 396, 405, 683, 702, 704, 769, 777, 862, 867
at Cannock Chase, 132
on Cairds, 438
at Caracas, 595
at Cardiff, 47, 76, 438, 556, 879
in Canary Islands (Las Palmas), 559
Central London Railway, 258, 445
Charing Cross and Hampstead Railway, 199, 236, 359, 762
at Chatham, 103
in Chicago, 236, 669, 733, 797, 864, 892
in Clyde, 132, 156, 198, 280
in China, 97, 280, 645
City and South London Railway, 103, 129
at Colchester, 77, 556
Collett, T. A., Single-Phase Electric Traction, 809
at Colinton, 132
Constant Voltage Train Lighting System, 264
Companies' Meetings, see COMPANIES' MEETINGS
Companies' Stock and Share List, see each issue
Continental and British Tramways, A. R. Fearnley, 448
Contracts for, see ELECTRICAL TENDERS
at Cordoba, 637
Cost of Detailed Maintenance, 493
at Cretield, 735
at Crewkerne, 47
Current Consumption on, R. S. Pilcher, 447
Currents and Corrosion, 208, 255, 327
at Darlington, 47, 76, 104, 437
at Darven, 105
in Denmark, 769
at Deptford, 704
at Derby, 47, 132
at Deutsch Gobel, 735
at Devonport, 762
at Doncaster, 105, 240
at Dover, 279
at Dublin, 130
at Dudley, 515
at Dukinfield, 47, 76, 202
at Dundee, 101, 176, 359
at Dunfermline, 318
at Dysart, 396
at East Ham, 485, 518, 558, 769
and East London Railway, 141, 165
at East London, 737
at Edinburgh, 76, 165, 318, 522,
Effect of, &c., on Railways, 692
Electrical Power for, W. M. Rogerson, 663
and Electrolysis of Winnipeg Water Mains, &c., 327, 721
at Elsenham, 132
at Enfield, 21
at Exeter, 76

Electric Traction (*continued*):

at Falkirk, 47, 76
Farthing Fares, 776
Fell, A. L. C., Tramway Problems in the Future, 407
at Fife, 21, 165
in Finland, 765
at Fleetwood, 668, 827
in France, 213, 319, 397, 671, 706, 916
G.B. System of, The, 510
at Geelong, 597
in Germany, 114, 286, 338, 406, 445, 449, 519, 605, 747, 755, 767, 829
at Glasgow, 48, 70
at Gloucester, 48, 670
and Great Northern Railway, 206
Great Northern Railway of America, Electrification of, C. T. Hutchinson, 819, 848
Great Northern, Piccadilly and Brompton Railways, 199, 236, 359
at Greenwich, 704,
at Guiseley, 47
at Gwendreath, 47, 132
at Halesowen, 48, 318
at Hallam Stede, 767
at Hamburg, 829
at Hammersmith, 21
at Hampstead, 597
at Handsworth, 519, 635 787, 862, 890
on Hexham, &c., Branch of the Shotton Railway, 692
at Heywood, 76
at Highgate, 279
High Voltage, 175
Hogg, C. P., Remarks on, 743
in Holland, 737, 769
Home Office Returns of, 425
at Horncastle, 132
at Horsens, 21
at Hove, 396
at Huddersfield, 630
at Hull, 132, 279
in Hungary, 240, 735
Hutchinson, C. T., Electrification of the Great Northern Railway of America, 819
at Hyde, 47, 76
at Ilford, 103, 518, No. 23
Income Tax Assessment of Lines, 491, 497, 872
at Ilkeston, 165
in India, 46, 72, 100, 597, 653, 705
Integrating Wattmeters on Cars, 368
Ireland, W. E., Central Repair Depot, L.C.C. Tramways, 407
at Ipswich, 202 477
in Isle of Man, 803
in Isle of Wight, 834
in Italy, 114, 319, 597, 438, 479, 539, 640, 735, 717
in Japan, 280, 518, 671, 744, 847
at Johannesburg, 438, 558
at Kidderminster, 560
Kapp, Dr., Remarks on, 717
at Kenilworth, 132
at Kilmarnock, 104
at Kirkcaldy, 74
at Lancaster, 76
at Lanchester, 76, 105
at Lancaster, 47
at Las Palmas, 559
at Leeds, 47, 518, 596
for Legal Actions, see LEGAL INTELLIGENCE
at Leiston, 769
at Lincoln, 202, 510
at Liskeard, 475
at Liverpool, 130, 198, 240, 275, 425, 558, 639
and London, Brighton and South Coast Railway, 199, 260, 456, 545, 661, 758, 803, 807
and L.C.C., 89, 132, 165, 240, 274, 350, 372, 374, 391, 397, 407, 479, 485, 579 (ed), 671, 704, 769, 809, 831, 867, 872
London United Tramways, 359
at Lowestoft, 104
at Madras, 46, 100
at Manchester, 68, 425, 566, 700
at Matlock, 47
at Melbourne (Victoria), 103, 128, 254, 360, 389
and Mersey Railway, 692
at Merthyr, 132
Metropolitan District Railway, 41, 359, 430, 546, 807, 825
Metropolitan Railway, 102, 367
at Mexborough, 47,
in Mexico, 279, 516, 800
and Midland Railway, 692
at Millstadt, 735
at Milnrow, 787
at Moncton (Canada), 280
at Montevideo, 360, 438, 559
at Morecambe, 104, 786
at Moscow, 237
at Mossley, 47, 76
at Munich, 829
in the Netherlands, 319
Newcastle-on-Tyne, 47, 105, 359, 390, 437, 514, 634
at Newport (Mon.), 76
at Nordernei (Germany), 403
in New Zealand, 276, 455, 597
in New York, 63, 96, 100, 126, 152, 184, 223, 296, 668, 797, 827
at North Cobalt, 319
and North-Eastern Railway, 393, 692, 732
in Norway, 360, 486, 769
at Nottingham, 48, 703, 787
at Ontario, 240
at Oswaldtwistle, 104
at Ottawa, 319
at Paddington, 519, 597
in Para, 360, 516
Peckham Gears and Trucks, 221
at Perth, 240
at Perth (W.A.), 156
at Pittsburg, 21, 223
at Plymouth, 359
Point Controllers for, 905
at Poole, 382
at Portland, 104
at Portsmouth, 132, 240
in Portugal, 475
Power for, W. M. Rogerson, 663

Electric Traction (*continued*)

at Pressburg, 735
at Preston, 227, 318, 425, 768
at Pretoria, 737
Provisional Orders, for, see BILLS
at Pudsey, 516, 803
at Queenstown, 76
Railless, 148, 438, 491, 558, 776
at Ravensmarsh, 132
at Rawtenstall, 165, 787
at Reading, 47
at Redditch, 396
at Redruth, 47
at Rhondda, 786
at Rhode Janeiro, 129, 438, 519
Rhyl Electric Railway, 104, 519
at the River Plate, 21, 360, 644
at Rochdale, 47, 76, 774
Rogerson, W. M., Remarks on in Presidential Address, 665
Rolling Stock Mishaps, S. Robinson, 174
at Rosyth, 47
at Rotherham, 76, 558
in Russia, 286, 360, 397, 519, 769, 831
at St. Pancras, 47, 331, 519
at St. Petersburg, 280, 360
at Salford, 558, 425
in the Salzkammergut, 735
Scott's Patent Flexible Suspension, 654
at Sheffield, 118, 458
Signals for, 712, 732
at Singapore, 155, 199
Single-Phase, 486, 692, 717, 809
at Southampton, 319, 761
at South Petherton, 47
at South Shields, 21, 47, 76, 671, 762
in Spain, 97, 205, 438, 637, 803
at Stalybridge, 47, 76, 736
at Stretford, 761
Surface Contact Stud System, The, 94
at Sunderland, 47, 926
Surface Contact Systems, 94, 510
at Swansea, 639
in Sweden, 705, 717
at Swindon, 438
at Swinton, 47
at Sydney (N.S.W.), 240
in Switzerland, 132, 438, 565, 577, 597, 671, 705, 717, 798
at Tenbeth, 76
at Tetney, 735
in Tasmania, 21
at Taunton, 438
Tenders for, see ELECTRICAL TENDERS
at Thanet, 132
Third Rail System, A New, 796
Thiel, E. G., Remarks on, 720
at Toronto, 832
at Torquay, 46
Trailer Returns, see each issue
Tramway Rolling Stock Mishaps, 459
on Trunk Lines, 426
Trolley Wire, Standardisation of, 720
in Turkey, 47
Twelve Hundred Volt Direct Current Car Equipment, E. J. Case, 686
at Tynemouth, 602
on Tyneside, 237
in the Tyrol, 734
Useful Traction Diagram, A, 466
in Venezuela, 438, 705
in Victoria (Australia), 389
at Walsall, 132
at Wandsworth, 519
at Warrington, 768
at Watford, 768
at Wellington (New Zealand), 597
at West Bromwich, 104
at West Ham, 47, 94, 104, 485, 769
at Whitworth, 104
at Winnipeg, 327, 832
at Wolverhampton, 77, 517, 776
at Woodwich, 479, 671, 704
at Yardley, 890
at York, 202, 319, 359, 558 671, 737

Electricity:

and Agriculture, 286, 295, 489, 537, 698, 700, 719
in American Mines, G. F. Wood, 230
in the Argentine, XI. No. 27
Atmospheric, 767
in Australia, 605; *also* ELECTRIC LIGHTING and ELECTRIC TRACTION
in Boiler Construction, 688
Bottled, 158
Canada's Export of, 502
and Canadian Mining, J. Ashworth, 294
Cheap, 871
at Chopwell Mines, 307
and Christmas, 803
in the Coal Mining Industry, 575
and the Cotton Weaving Industry, 205, 207
in Cotton Mills, 668
and the Countryside, 689
at Darlington Water Supply Works, 472
Distillation of Turpentine by, 299
Domestic, 222, 398
Dressmaking by, 505
and Earthmakes, 495
in Factories, &c., 31, 117, 153, 157, 173, 174, XIII. No. 7, 223, 236, 318, 325, 348, 349, 350, 381, 384, 398, 406, 430, 435, 472, 485, 486, 533, 586, 594, 611, 645, 667, 668, 687, 690, 709, 711, 718, 732, 765, 790, 803, 818, 826, 850, 851, 871, 891, 921
in the Fernhale Collieries, 567
and Fertilisers, E. K. Scott, 295
Future of, The, 457, 871
in Germany, 86, 202, 522, 702, 856, 883, 910, 914; *also see* ELECTRIC LIGHTING and ELECTRIC TRACTION
Glass which Conducts, 246
at Harton Colliery, 434
in the Home, 33, 57, 296, 307, 379, 398, 733
in Ironworks, 851
in Japan, 253; *also see* ELECTRIC LIGHTING and ELECTRIC TRACTION
at the Lochgilly Coal Mines, 292
on the Manchester Ship Canal, 796
in Medicine, 30, 98, 365, 865, 893

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Electricity *(continued)*:
in Mining, 126, 141, 164, 175, 182, 185, 189, IX. No. 7, 206, 213, 225, 229, 230, 233, 292, 294, 298, 303, 307, 319, 326, 339, 349, 359, 378, 398, 405, 420, 434, 445, 461, 473, 473, 525, 526, 527, 528, 545, 549, 553, 555, 566, 567, 575, 586, 599, 606, 634, 645, 667, 679, 711, 713, 726, 758, 764, 765, 771, 821, 826, 861, 863, 865, 866, 872, 882, 899, 904
in New South Wales Coal Mines, 126, 189, 213, 326
in Newspaper Offices, 157, 752
in the Paper Mill, XIII. No. 7
v. Petrol, 296
Profitable, 871
Progress in, Sir J. J. Thomson, 270, 287
and the Problems of Life, 285
in Quarrying, 903
to the Rescue, 839
in Rolling Mills, 406, 485, 718
on Ships, 29, 59, 173, 205, 256, 285, 328, 334, 339, 398, 587, 593, 723, 808, 850, 852, 863, 882, 915
from the Sun, 89, 286, 646
in Spain, 839; *also see* ELECTRIC LIGHTING and ELECTRIC TRACTION
Supply Tariffs, &c., 65, IX. No. 6, 610, 734
in Textile Mills, 645, 657, 679, 711, 818, 850
and Tramway Committees, 566
and Transport, 807
in Turkey, 739
Voting by, 743
What is it? 338
Wind Turbines for Generating, 17, 885
Electrification of the Ferndale Collieries, W. H. Patchell, 567
Electrification of the G.N.R. of America, C. T. Hutchinson, 819, 848
Electrification Impracticable, 669
Electrification of Ironworks, 839
Electrification of Ormsby Rolling Mills, 472
Electrification of Salt Works, 732
Electrification of Swiss Railways, 577
Electrification for Trunk Lines, L. L. de Muralt, 426
Electrified Newspaper Office, An, 157
Electrifying Naples, 445
Electrifying Tramway Trolley Standards, 776
Electro-analytical Determination of Lead as Peroxide, Dr. Sand, 811
Electro-analytical Separation of Metals, Dr. Sand, 100A
Electro-deposited Alloys, Conditions which Determine the Composition of, S. Field, 100A
Electrolysis of Lighting Mains, 392
Electrolysis and Metals, 208, 255, 327
Electrolysis of Winnipeg Water Mains, L. A. Herdt, 326
Electrolytic Bleaching, 565, 733
Electrolytic Corrosion of Telephone Cables, E. Miller, 193
Electrolytic Disinfecting Fluid (Poplar Health Department), 548
Electrolytic Lightning Arresters, 96
Electrolytic Wattmeters (Mr. Thorpe's), 527
Electromagnetic Clutches (S. M.), 547
Electromagnetic Disturbance, Cosmic, 446
Electron o ile Instruments, A. Hecker, 195
Electrophone, Reporting by, 382
Electron, The, 807
Electron, Transformer Notes and Calculations, 525, 575, 616, 687
Elektron Conductor, The, 767
Elleo Invisible Lamp Lock, 660
Ellis, H. S., Electrical Conditioning Oven, 145
Emergency Committee, The, 903
Emmett, W. L., Electrical Propulsion on Naval Vessels, 833
Energy, Cost of, 733
Engineering, Illuminating, Up-to-date, Prof. S. P. Thompson, 810
Engineering of Ordnance, The, 59
Engineering Prospects in Ireland, 720
Engineering, Standardisation in, Prof. Adams, 529
Engineering Standards Committee, 535
Engineers, Consulting, 680
Engineers and Government, 418
Engineers, Sales, 446
Engineers, The Training of, 206
Engine Room Management, C. R. Brosius, 293

Engines:
Belliss-Morcom, The, 473, 567
Curtis Turbine, The, XIV. No. 5, 156, 685
Development of the Marine Steam Engine, 606
Electrical Ignition of Internal Combustion Engines, J. W. Warr, 646
Erhardt & Schmer Gas Engine, VII. No. 7
Exhaust Steam Turbine, The, J. W. Bailey, 765
in Ferndale Collieries Power Station, 567
Flywheel Speeds, 325
Gas, VII. No. 7, 328, 486, 496, 609
at Grassington Power Station, 695
in Illinois Steel Co.'s Works, 450
at the Lochgelly Coal Mines, 292
Lubrication of, 807
Melville-Macalpine Reduction Gear, 911
Oil, 63, 328
Petrol, 186, 372
Petter Patent Oil Engine, 63
Rogerson, W. M., Remarks on, in Presidential Address, 664
Scott Mountain, The, 821
for Use on Ships, 328, 334, 808, 863
at the Stepney New Generating Station, 628
Suckling Water Tube, 343
Sulzer, The, 567
Stuart Turner, The, 589
Turbines, 2, 5, 17, XIV. No. 5, 156, 235, 334, 398, 413, 421, 515, 586, 608, 628, 636, 664, 668, 673, 685, 695, 712, 713, 727, 796, 808, 812, 862
on Warships, 723
Watson, S. J., Remarks on Engines in Presidential Address, 608
Willans, The, 421
Wind, 17, 446, 885
Winding, 314, 325, 827

English Tantalum Lamp Works (Siemens), 467
Entz Booster, The, 693
Equipment and Working Results of the Mersey Railway, J. Shaw, 692
Erhardt-Schmer Gas Engine, VII. No. 7
Error, Source of, in Dial Indicators, XII. No. 7
Estimate for Arc Lamp Installations, 918
Ethics of Power Production, 337
Europe's Hydraulic Power, 776
Exhaust Steam Turbine, The, J. W. Bailey, 765
Everett-Edgcumbe Adjustable Screen Photometer Head, 917
Everett-Edgcumbe Portable Direct Reading Lamp Photometer, 917
Exhibitions, 14, 33, 97, 98, 122, 154, 220, 325, 334, 365, 455, 458, 473, 486, 520, 535, 576, 589, 597, 628, 649, 660, 666, 668, 670, 673, 719, 724, 726, 765, 802, 828, 834, 847, 851, 863
Expansion, The Coming, 785
Extended Uses of Electricity on Board Ship, J. McLaren, 328
Eyesight and Mercury Lamps, 680

F

Facilities at Continental Ports, 921
Factories, Dual Service in, 254, 257
Factories, Electrical Energy in, H. O. Wraith, 586
False Economy, 679
Fans, Electric, Their Use and Abuse, Drs. Sartory and A. Filbasier, 454; *also see* "Fans" *under* ELECTRICAL
Farthing Fares, 776
Fatalities, Live Wire, 206
Fault Location, Principles of, J. Bernstein, 215
Fearnley, A. R., Continental and British Tramways, 448
Fell, A. L. C., Tramway Problems in the Future, 407
Ferndale Collieries, Electrification of the, W. H. Patchell, 567
Ferranti Motor Starters, 526
Fertilisers, Electrically Produced, E. K. Scott, 295
Field, S., Electro-deposited Alloys, &c., 100A
Filbasier & Sartory, Drs., Electric Fans, 454
Finland, Electrical Machinery in, 248
Fire Brigades' Tournament, 829
Fires, 41, 560, 661, 700
Flame, The Electrical Properties of, Prof. H. A. Wilson, 142
Flat Rate *v.* Contract System, 743
Fleming, Dr., Electrical Inventions and the Training of the Electrical Engineer, 487
Fleming, Dr., Quantitative Measurements in Radio-telegraphy, 877
Fletcher, Fletcher & Co., New Laboratory, 627
Flicker, Photometer, The, 839, 890
Fluxite Soldering Paste, 418
Foster Transformer, The, 622
France, Centralising Supply in, 605
Francis & Sons' Hand-feed Arc for Stage, &c., Purposes, 221
Frequency, High, &c., F. P. Vaughan, 781
Fuel Capital, Diminishing, 549
Fuel Economics, 141
Furnaces, Electric, see ELECTRICAL
Furnaces, Electric, at Domnarfvet, Sweden, E. Haanel, 612
Furnace Practice, 219
Fuses, Single and Stranded Low-tension, W. T. MacCall, 748
Future of Electricity, The, 457, 871

G

Galvanising, Improved, 865
Gas Detector, The Holmes', 660
Gas *v.* Electricity, see ELECTRICAL LIGHTING and GAS SUPPLY, &C.
Gas Engines, see ENGINES
Gas Failure, Dangerous, 645

Gas Supply, &c.:
at Ainsworth, 638
at Barnsley, 670
at Birmingham, 605, 795
Bills for, 786
at Bishop's Stortford, &c., 787
at Chipping Norton, 787
on the Continent, 64, 267
at Cookstown, 596
at Dundee, 596
at Havant, 787
at Longton, 44
at Middlesbrough, 786
at Middleton, 787
at Manchester, 634
at Newcastle, 732
at Norwich, 639
at Salford, 786
at Warrington, 787
at Witham, 671

Gathering Mine Locomotive, 420
G.B. Tramways System at Lincoln, 510
Generating Plants, Assisted, 254, 257
German Electrical Industry, The, 86, 202, 856, 883, 910, 914; *also see* ELECTRIC LIGHTING and ELECTRIC TRACTION
German Notes, 702, 735, 767, 798, 829, 865
German Patent Laws, 871
Germann, T., & S. M. Hills, Insulating Materials, 115
Girdling Outer London, 526, 538
Glass which Conducts Electricity, A, 246
Gloucester's Bad Example, 142
Glover's Almanac, XIV. No. 1
G.M.B. Direct Current Rotary Transformer, J. C. Macfarlane & H. Burge, 36
Good Servant, A, 619
Government Contracts, 405
Great Northern Railway of America, Electrification of, C. T. Hutchinson, 819, 848
Great Northern Railway and Tram Competition, 206
Greenock Electrical Exhibition, 455
Greenwood Slipper Brake, 301
Grounding the Secondary, 669

H

Haanel, E., The Electric Furnace at Domnarfvet, Sweden, 612
Hampstead Exhibition, 536
Hancock, H. W., & A. H. Dykes, The Present Aspect of Electric Lighting, 743, 745, 775, 826, 851
Harbee, Testing Condensers for Leakages, 35
Harnessing Our Streams (Grassington Lighting), 695
Harnessing the Danube, 174
Harper, H. R., Electrical Development in Victoria, 389
Haslam-Schontheil Bulkhead Fittings, &c., 462
Headlight Testing Rock, 123
Harrison, C. A., Effect of Electrical Operation and Permanent Way Maintenance of Railways, 692
Harton Colliery Electrification, 405, 434
Heating Material, A New Electric, 158
Heat Transmission, Prof. Dalby, 578
Hecker, A., Electromobile Instruments, 195
Herdt, L. A., Electrolysis of Winnipeg Water Mains, 327
High Potential, High Frequency, F. P. Vaughan, 781
High-tension Currents in Steel Rolling Mills, 174
High-tension Insulator, 9, 840
High Tension Switchgear, 66, 87, 676
High Tension Transmission, P. H. Lomas, 90
High Voltage on Railways, 173
Hillman, H. W., Electricity in the Home, 379
Hills, S. M., & T. Germann, Insulating Materials, 115
Hird, W. B., Interpole Generators and Motors, 455
H.M. Inspectors of Mines Reports on Electricity in Coal Mines, 182, 229
Hoadley, E. E., The Influence of Metallic Filament Lamps on the Electrical Industry, &c., 12
Hoedt, C. de, Problems of Power Generation, &c., 732
Hollingsworth, E. M., Modern Cable Systems, 8
Holophane Glass, Fittings for, 11
Holophane Globes and Reflectors, 918
Holmes' Gas Detector, 660
Home, Electricity in the, 33, 57, 296, 307, 379, 398
Home Office Order, 510
Hope's Patent Unit System, 421
Household Appliances, Electrically Heated, A. G. Jones, 873
Human Battery, The, 797
Humble, W., & A. A. Atkinson, Electrical Signals in Mines, 298
Hutchinson, C. T., Electrification of the G.N.R. of America, 819, 848
Hydraulic Power, Europe's, 776
Hydro-Electric Development in Quarrying, S. S. Stone, 259
Hydro-Electric Enterprise in Italy, 565
Hydro-Electric Plant, Collective, 413
Hydro-Electric Plant for Mexico, 698
Hydro-Electric Power in Canada, Sir W. H. White, 291
Hydro-Electrics in Nyassaland, A. S. Chalmers, 376
Hydro-Electricity in Tasmania, 586, 807

I.

Igranic Motor Starter, VII. No. 6
Illuminating Engineering, Up-to-date, Prof. S. P. Thompson, 810
Illumination, 205, 744
Improved Galvanizing, 865
Improved Method of Suspending Arc Lamps, IX. No. 7
Improving the Status, 903

Incandescent Lamps:
Carbon Filament Lamps on the Continent, 64, 267
Geipel's Turn Down Lamps, 382
German Tariff, The, 248
Elleo Invisible Lamp Lock, 660
METALLIC FILAMENT:
at Aberdeen, 357
Action at Law for Alleged Infringement, 640, IX. No. 9, 705, 839, 868
at Birmingham, 826
at Bradford, 605, 638
R.T.H. Tungsten, XI. No. 1, 422
Cement Jointing, Material for, 70A
on the Continent, 64, 267
Duration of, 775
Hancock and Dykes' Paper on, 743, 745
Holophane Fittings, for 11
Influence of Metallic-Filament Lamps on the Industry Electrical, E. E. Hoadley, 12
at Leamington, 861
at Manchester, 634, 827
Mending, 775
Metaffect, The, 62
Metalik, The, 346, 775
Metfil, The, 67, 517
and the New Consumer, 663
Osram, The, 546, 659
Patents, New, see ELECTRICAL PATENTS
Rogerson, W. M., Remarks on, in Presidential Address, 665
Sunbeam, The, 660
Sun Electrical Co.s Self-Adjusting Nipple for, XIV. No. 1
Tantalum, XI. No. 5, 123, 221, 467, 635, 660, 668, 775, 790
Transformers for, 622, 634
Tungsten, The, XI. No. 1, 95, 157, 260, 346, 373, 398, 422, 539, 734, 767, 775, 864, 924
Variation of, 775
Welsbach, The, 445
Wilkinson, G., and R. McCourt, Paper on, 842
at Willesden, 663
Nernst, The, 474
Patents, New, see ELECTRICAL PATENTS
Power Characteristics of the Tungsten Filament, 95
for Railway Carriages, 539
Testing the Vacuum of, 702
Thompson, Prof., Remarks on, 810

Income Tax Assessment, 491, 497, 872
Indian Electricity Act, The, 336
Indication Block Instruments, Moore & Powles, 725
Industrial Service, The Application of Electric Motors to, E. B. Parsons, 187
Insect Pests, Destroying, 731
Institution and its Mission, The, 881
Institution of Electrical Engineers and Electricity in Mines, 872
Instrument Leads for Switchboards, Arrangement of, S. Lees, 196

Digitized by Google

Instruments, Electromobile, A. Hecker, 195
Insulated Wire for Canada, 525, 754
Insulating Materials, T. Germann and S. M. Hills, 115
Insulation Testing Set, The Union, 542
Insulator, An Improved Form of High-Tension, 9
Insulator, An Unbreakable, 790
Insulators, High-Tension, 840
Insurance of Electrical Machinery, 390
Integrating Wattmeters on Cars, T. W. Hinkle, 368
Internal Combustion Engines, Electric Ignition of, J. W. Warr, 646
Institution of Electrical Engineers and Electricity in Mines 872
International Exchange of Power, 903
Inter-Competition, Municipal, 645
Interpole Generators and Motors, W. B. Hird, 455
Invention and Industrial Progress, J. E. S. Lockwood, 526
Ions in Aqueous Solution, Relative Rates of Migration of, Dr. Denison
Ireland, Engineering Prospects in, 720
Ireland, W. E., Central Repair Depot, L.C.C. Tramways, 407
Ironclad Distribution Fuse Boxes (Hope's), 421
Iron, Magnetic Testing of, with Alternating Current, A. Campbell, 410
Iron, Magnetic Testing of, Prof. Brown, 756
Iron Ore, Electric Furnace Reduction of, J. W. Richards, 147, 370
Iron and Steel, Electric Smelting in Production of, E. J. Ljungberg, 452
Irrigation Canal, 605
Is Central Station Work Played Out ? 58, 127
Italy, Electrical Installation in, A. Morris, 925
Italy, Electrical Plant in, 98, 925

J

Japan, Electrical Enterprise in, 255
Jewett, F. R., The Essential Requirements of the Modern Telephone Cable, VIII. Aug. 6
J.H.S., High-Tension Switchgear, 66, 87
Jones, A. G., Electrically Heated Household Appliances, 873
Jordan, F. W., An Instrument for Measuring the Strength of an Intense Horizontal Magnetic Field, 69

K

Kapp, Dr., Address at Annual Dinner of the I.E.E., 840
Kapp, Dr., Presidential Address to the I.E.E., 711, 713
Kennedy, D. H., Telephone Exchange Fires, 61
Keys and Keyways, British Standard Specification for, 535
Kinetic Co.'s Rotasphere, 886
Knudson, A. A., The Corrosion of Metal Structures by Electrolysis, 255
Knudson, A. A., The Corrosion of Metals Underground by Electrolysis, 208

L.

Laboratory, A Popular Electrical, 225
Labour Truce, 245
Lancashire Notes, 594, 634, 668, 700, 732, 765, 795, 821, 862, 891
Lavender, F. H. R., Researches in Metallic Filament Lamps, 775
Law, F. E., & W. Sewell, Electrical Apparatus and Prevention of Accidents, 878
Lighting Efficiency in Australia, 903

Leading Articles:

Agricultural Co-operation and Electricity, 537
Assessing Wear and Tear, 497
British Columbian Advance, 849
Cable Rates, 1
Coal Trade Crisis, 58
Coming Expansion, The, 785
Conservation of Water for Power, 29
Diamonds, Electrical Production of, 753
Domestic Electric Heating and the Central Stations, 57
Domestic Outlet, The, 655
Dual Service in Factories, 257
Electric Lighting Acts Amended, 85
Electric Lighting Bill, The, 58
Electric Smelting of Zinc, 721
Electrical Production of Diamonds, 753
Electricity and the Countryside, 689
Electricity in Medicine, 30
Electricity in the Navy, 29
Electricity in Textile Factories, 153
Electricity, The Future of, 457
Electrification of Swiss Railways, 577
Ethics of Power Production, 337
Expansion, The Coming, 785
Factories, Dual Service in, 577
Furnace Practice, 219
Future of Electricity, The, 457
German Electrical Industry, The, 86
Good Servant, A, 619
Institution, The, and its Mission, 881
Medicine, Electricity in, 30
Mining and Electricity, 185
Navy, Electricity in the, 29
Needs of Small Towns, 913
Overhead Railways, 817
Paris Scheme, The, 377
Power Production, Ethics of, 337
Railways, Overhead, 817
Reduction of Waste, 417
Servant, A Good, 619
Steam Turbines, 2
Swiss Railways, Electrification of, 577
Textile Factories, Electricity in, 153
Tramways Conciliation Board, 30
Waste, Reduction of, 417
Water for Power, Conserving, 29
Water Power Problems, 297
Water Power, A Set Back and Possibilities, 113
Wear and Tear, Assessing, 497
Zinc, Electric Smelting, of 721
Lead as Peroxide, Electro-Analytical Determination of, Prof. Sand, 811
Leakages, Testing Condensers for, 35
Lees, S., Arrangement of Instrument Leads for Switchboards, 176

Legal Intelligence:

Action under Mining Rules, 771
Armorduct Manufacturing Co. *v.* Fearnhead, 101
Bradford Electrical Engineering Co. (Meeting of Creditors), 880
Bremer Arc Lamp Patent Case, 599
British Aluminium Co., Application for Winding Up Order, 599
Coal Mines Regulation Act, Prosecution under the, 865
Electrical Contractors' Association *v.* Aberdeen Corporation, 379
Electrical Trades Union Prosecution, 844
G.E. Co. *v.* Bridges, 128
Gould *v.* Lehmers, 886
Harris, W. T. (in liquidation), 158
Holmes & Co. *v.* Associated Newspapers, 650
I.W. Electric Light & Power Co. *v.* Sandown Gas Co., 654
Kerley *v.* Robertson, 654
Liquidation, &c., 158, 340, 382, 462, 666, 702, 791
Metallic Filament Lamp Prosecution, 640, IX. No. 19, 705, 839, 888
Postmaster-General *v.* W. H. Russell, 229
Rochdale Canal Co. *v.* Crawford Spinning Co., 700
Roche *v.* London Electrobus Co., 43
Selden Patents, The, 474
Smith, S. E. (Failure in Business), 702
Stephens *v.* Dowsing Radiant Heat Co., 784
Tramway Cases, 71, 101, 668, 827
Urban Electric Supply Co. *v.* Beer, 465
Williams & Son *v.* Beckenham U.D.C., 71

Leicester Model Electric Home, 763
Lepine, L. J., & A. R. Stelling, Method and Practice in the German Electrical Industry, 856, 883, 910
Licensing Wiremen, 286
Lifts, electrically driven, 41a, 69a, 71; also see "Haulage" in Electricity
Lighting Tariffs, Simplification of, IX. No. 6
Lightning Arresters, XIV. No. 4, 90, 96, 339, 779
Lighting Conductors, 447, 498, 538, 578, 690, 722, 739, 786, 818, 915
Light Railways, 76, 105
Lincoln, P. M., Protection of Electrical Equipment, 532
Live Wire Fatalities, 206
Ljungberg, E. J., Electric Smelting in Production of Iron and Steel, 452
Loam, Anticipating, 525
Locating Fault in Armature, A. R. Woodhall, 420, 620
Lochgelly Coal Mines, Electricity at, 292
Lockwood, J. E. S., Utilisation of Natural Laws, 526
Lodge, Sir O., Cosmic Electromagnetic Disturbance, 446
L.C.C. Tramways Accounts, 89
L.C.C. Tramways Central Repair Depot, W. E. Ireland, 407
London Electric Co.'s Wire Table, XIV. No. 1
London, Public Lighting in the City of, Report on, 64, 267
London Traffic, 807
Long Distance Transmission, Notes on, E. K. Scott, 415
Long Distance Transmission on Overhead Lines, Dr. Marchant and E. A. Watson, 777, 812
Longridge, M., Report on Electrical Breakdowns, 365, 390
Lonkhaysen, J. F. van, Sources of Error in Dial Indicators, &c., XII. No. 7, 298
Losses in Radiotelegraphy, 839
Loveridge, F. H., Characteristics of Dry Batteries, 507
Low, A. R., Dimensions of Single-Phase Core and Shell Transformers, &c., 177
Low-Tension Fuses, Single and Stranded, W. T. MacCall, 748
Lubrication of Engines, 807
Lugard's Clutches, 547
Lundberg's Intermediate Switch, 502
Lunn, E., Notes on Condensing and Water Cooling Plants, 310

M

MacCall, W. T., Single and Stranded Low Tension Fuses, 748
Maccioni Earthquake Alarm, 405
Macfarlane, J. C. & H. Burge, "C.M.B." Patent Direct Current Rotary Transformer, 36
Maginnis, A. J., Marine Engineering, 154, 173
Magnetic Survey Yacht *Carnegie*, VIII. No. 7
Magnetic Testing of Iron, Prof. Brown, 756
Magnetic Testing of Iron, with Alternating Current, A. Campbell, 410
Magnetic Tests of Common and Silicon Steel, 99
Magnets, Demagnetisation of, 313
Maintenance Contracts, 205, 366
Maintenance, Cost of Deferred, 493
Majorana System of Wireless Telephony, H. J. Reiff, 494
Major's Insulating Varnish, 466
Manchester Electricity Accounts, 68
Manchester Exhibition, 535, 851
Marchant, Dr., & E. A. Watson, Long Distance Transmission on Overhead Lines, 777, 812
Marconi, A., Wireless Telegraphy, 844, 874
Marine Engineering, A. J. Maginnis, 154, 173
Marine Propulsion by Electric Motor, H. A. Mavor, 852
Marine Propulsion, Steam Turbines as Applied to, C. B. Dicksee, 712
Marine Steam Engine, Development of the, A. T. Barber, 606
Marryat-Place Gear Sets, XIV. No. 1
Materials, Insulating, T. Germann & S. M. Hills, 115
Mather, F.-T., Electricity in the Home, 307
Mavor, H. A., Marine Propulsion by Electric Motor, 852
May & Hawes, Messrs., Report on Bishops Stortford Scheme, 889
McCourt, R., & G. Wilkinson, Metallic Filament Lamps, 842
McLaren, J., Extended Uses of Electricity on Board Ship, 328
Measurement of Resistance, The, 923
Medicine, Electricity in, 30, 98, 365, 865, 893
Melville-McAlpine Gear, The, 863, 911
Mercury Lamps, 246, 634, 680, 767
Merryweather's "Hatfield" Pump, 461
Metal Electrodes for the Electric Arc, 767
Metallic Filament Lamps, The Influence of, on the Electrical Industry, E. E. Hoadley, 12
Metallic Filament Lamps, G. Wilkinson & R. McCourt, 842
Metallic Filament Lamps Described, see "Metallic Filament" *under* INCANDESCENT LAMPS
Metals, Corrosion of, by Electrolysis, A. A. Knudson, 208, 255
Meter Testing System, A New, 766
Methods and Practice in the German Electrical Industry, L. J. Lepine & A. R. Stelling, 856, 883, 910, 914
Mexican Projects, 376, 518, 698
Mexico, Trade with, 379
Michigan Power Companies, Amalgamation of, 474
Microphones, Bismuth for, 326
Midland Notes, 473, 514, 553, 635, 667, 699, 764, 795, 826, 861
Migration of Ions in Aqueous Solution, Relative Rates of, R. B. Denison, 16
Miller, E., Electrolytic Corrosion of Telephone Wires, VIII., Aug. 6, 193
Mines Commission Report, 566, 599
Mines, Gaseous, Motors for, 526
Mines, Inspection, Conference on, 528
Mining and Electricity, 185; *also see* "in Mining" *under* ELECTRICITY
Mining, Standardisation in, 606
"Model Engineering" Exhibition, 486, 589
Misplaced Electric Lamps, 871
Modern Cable Systems, E. M. Hollingsworth, 8
Mono-rail Criticised, The, 863
Monterey Floods, The, 316
Moore & Powles' Block Instruments, 725
Morcom, R. K., A Survey of the Electrical Industry, 681
Morris, A., Electrical Installation in Italy, 925
Motor Car Exhibition, 666
Motor Cars, Electric Lighting of, 120, 122
Motor Exhibition, The, 719
Motor Headlights, 246
Motormen's Working Hours, Correspondence on, 223
Motor Starting Switch for Printing Machines, 123
Muddled Reports, 605
Municipal Electrical Association, Annual Report of the, 15
Municipal Inter-Competition, 645
Murray, M. T., Corrosion of Steel Winding Ropes, 651
Myles, D., Marine Boiler Design, &c., 688

N

Naples, Electrifying, 445
Natural Laws, Utilisation of, J.E.S. Lockwood, 52
Navy, Electricity in, 29, 59; *also see* ELECTRICITY
Needs of Small Towns, 913
Nelson, R., Use of Electricity in Mines, 726
Newport Docks, Pumping Plant at, 263
New South Wales Coal Mines, Electricity in, 189
Newspaper Office, An Electrified, 157
New York Electrical Show, 640
Nitrous Compounds, Electrical Production of, 719
Nobel Prize, The, 839, 844
Non-flammable Celluloid Substitute, 308
Norway's First Single-phase Railway, 486

Notes:

Aeronautics and Wireless Electricity, 141
Agriculture and Electricity, 286
Aluminium Conductors, 326
American Government's Electrical Trading, 680
Another German Electrification, 406
Anticipating Loans, 525
Appreciation of British Electricians, 565
Apprenticeship, 486, 565
Arabian Nights Improved, 445
Artificial Thunderstorms, 904
Art of Illumination, The, 205
Attention to Detail, 743
Australia and Electricity, 605
Australia, Lighting Efficiency in, 903
Australian Official Engineers, 903
Barometer, An Electrical, 206
Bismuth for Microphones, 326
Bleaching, Electrolytic, 565
Board of Trade Commercial Intelligence, 807
Bonus and Penalty, 286
British Carbons, 776
British Electricians, Appreciation of, 565
Canada, Electrical Standardisation in, 606
Canada for Electricians, 405
Canada, Insulated Wire for, 525
Canada, Railroad Electrification in, 206
Canal Irrigation, 605
Canadian Common Sense, 405
Canadian Market, The, 743
Carbons, British, 776
Carbon and Silicon Resistance, 526
Catalogues, Standardisation of, 606
Cause of Offensive Odour with Mercury Lamps, 246
Celloline, 680
Central Stations as Schools, 605
Centralising Supply in France, 605
Championship for Electrical Brigade, 486
Cheap Electricity, 871
Chinese Market, The, 645
Churches, Lighting of, 840
Coal Settlement, The, 141
Coal *versus* Water, 446, 488
Colonies, Cooking in the, 526
Colonies, Hydro-electricity for the, 365
Colwyn Bay's Profit and Loss, 679
Commercial Lines, Run on, 679
Consulting Engineers, 680
Contract Systems *versus* Flat Rate, 743, 775
Copper, 205, 872
Cooking in the Colonies, 526
Cost of Production, 485
Cost of Sub-Station, 366
Cottage Industries, 205
Crane Work, Storage Batteries for, 365
Dangerous Gas Failure, 645
Danube, Harnessing the, 174
Dehydrisation of Transformer Oil, 680
Depreciation, A Question of, 485

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Notes (*cont. from*):
Destroying Insect Pests, 711
Detail, Attention to, 744
Development by Power Gas, 406
Difficulties on Shipboard, 173
Does it Pay to Condense? 485
Doubting Philosopher, The, 285
Drastic Step, A (Chicago Railways' Electrification), 566
Dry Accumulators, 285
Duration, &c., of Metallic Filaments, 775
Economical "Wireless," 446
Economising Oil in Power Stations, 712
Economy, False, 679
Efficiency, Wireless, 872
Engineers, The Training of, 236
Electric Drive on Ships, 173
Electric Drive in Spinning Mills, 173
Electric Drive in Textile Mills, 645, 711
Electric House, Cabled, 776, 807
Electric Lamps, Misplaced, 871
Electric Locomotives in Prussia, 605
Electric Ore Smelting, 405
Electric Pumps, New Use for, 245
Electric Writing, 145
Electrical Barometer, An, 206
Electrical Breakdown, 365
Electrical Brigade, Championship for, 486
Electrical Engineers' Training, 206, 405, 526
Electrical Exhibitions, 325, 565
Electrical Machinery for the Transvaal, 205
Electrical Smelting, 142, 405, 485, 525
Electrical Standardising, 325, 606
Electrical Traction, 744
Electrically-driven Mills, 485
Electrically-driven Rolling Mills, 406, 485
Electrically-propelled Ships, 205, 285, 808
Electricity and Agriculture, 286
Electricity in Australia, 605
Electricity, Cheap, 871
Electricity, Cutlery and Economy, 679
Electricity and Earthquakes, 405
Electricity, Future of, 871
Electricity in the Hospital, 365
Electricity in Mines, &c., 326, 445, 566
Electricity in Mining, 141, 329, 405, 445, 525, 566, 645, 711, 872
Electricity and the Problems of Life, 285
Electricity, Profitable, 871
Electricity to the Rescue, 839
Electricity on Ships, 173, 205, 285
Electricity and Tramways Committee, 566
Electricity and Transport, 807
Electricity, Voting by, 743
Electrification, Extent of Quarry, 904
Electrification of the Finnish Railways, 365
Electrification of Ironworks, 839
Electrification, National, 565
Electrified Tramway Trolley Standards, 776
Electrifying Naples, 445
Electrolytical Bleaching, 565
Electron, 807
Emergency Committee, The, 903
Engineers, Australian Official, 903
Engineers, Consulting, 680
Engines, Lubrication of, 807
Equipment, Quarry, 903
Europe's Hydraulic Power, 776
Example, A Good, 744
Exchange of Power, International, 903
Extent of Quarry Electrification, 904
Eyesight and Mercury Lamps, 680
False Economy, 679
Farthing Fares, 776
Fatalities, Live Wire, 206
Faults of Flicker Photometer, 839
Filaments, Metallic, Duration, &c., of, 775
Finnish Railways, Electrification of the, 365
Flat Rate *v.* Contract System, 744
Flicker, Photometer, Faults of, 839
Flywheel Speeds, 325
Foundry Electrification, 325
France, Centralising Supply in, 605
Fuel, Economies in, 141
Future of Electricity, 871
Gas Engine Developments, 486
Gas Failure, Dangerous, 645
Gaseous Mines, Motors for, 526
German Electrification, Another, 406
German Patent Laws, 871
Girdling Outer London, 526
Glass which Conducts Electricity, A, 246
Gloucester's Bad Example, 142
Good Example, A, 744
Government Contracts, 405
Great Northern and Train Competition, 206
Growing Demand for Power, 871
Harnessing the Danube, 174
Harton Colliery Electrification, 405
Headlights, Motor, 246
High Pressure, Safety in, 326
High Tension Currents in Steel Rolling Mills, 174
High Tension Insulators, 840
High Voltage on Railways, 173
Hydro-Electricity for the Colonies, 365
Hydro-Electricity, Tasmanian, 807
I.E.E., The, and Electricity in Mines, 872
Illumination, 205, 744
Improving the Status, 903
Industries, Cottage, 205
Industry's Future, The, 711
Insect Pests, Destroying, 711
Installations, Small, 743
Institution, The, 711
Institution and its Mission, The, 903
Insulated Wire for Canada, 525
Insulators, High Tension, 840
Inter-Competition, Municipal, 645
International Exchange of Power, 903
Iron and Steel Smelting, 485, 525
Ironworks, Electrification of, 839
Irrigation Canal on the Upper Swat Valley, 605
Labour Tenure, 245
Licensing Wiremen, 286
Lighting Churches, 840
Lighting Contract Rates, 775
Lighting Efficiency in Australia, 933
Lighting of Patent Office Library, 711
Lightning Conductors, 446, 498
Litigation, Welsbach, 839
Live Wire Fatalities, 205
Loans, Anticipating, 525
London Traffic, 807

Notes (*cont. from*):
Losses in Radiotelegraphy, 839
Lubrication of Engines, 807
Mechanical Earthquake Alarm, 405
Maintenance Contracts, Novel Form of, 366
Maintenance Contracts, 206, 366
Market, The Stock, 839
Mercury Lamps and Eyesight, 680
Mercury Lamps, Cause of Excessive Odour with, 246
Metallic Filaments, Duration of, &c., 775
Microphones, Use of, in Car, 206
Mine Signalling Apparatus, 4
Miners and Electricity, 525
Mines, Electricity in, 141, 326, 405, 445, 525, 566, 645, 711, 904
Mines, Motors for Gaseous, 525
Mining, Safety-lamps in, 606
Misplaced Electric Lamps, 871
Motor Headlights, 246
Municipal Projects, 605
Municipal Inter-Competition, 645
National Electrical Contract, 366
National Industrial Education League, 776
New South Wales, Reform in, 526
Nobel Prize, The, 839
Norway's Inland Steamship Railway, 486
Novel Form of Maintenance Contract, 366
Official Engineers' Appointments, 903
Oil in Power Stations, Economising, 712
Old Engineers, 776
Oppressive Odour with Mercury Lamps, 646
Organisation, Progressive, 744
Ozone, Electrical Production of, 526
Paper, Electricity and Economy, 679
Patent Exhibition, 871
Patent Office Library, Lighting of, 711
Peaceful Empire, 286
Petrol Electric Motor, 325
Photometer Faults, Flicker, 839
Pictures, Telegraphic, 776
Portable Lamps, Sparking of, 566
Power by Electricity in Workshops, 206
Power Gas, Development of, 406
Power, Growing Demand for, 871
Power, International Exchange of, 903
Powers to Over Page, 711
Power Stations, Economising Oil in, 712
Pressure, Water, Safety in, 807
Prize, The Nobel, 839
Production, Cost of, 485
Profitable Electricity, 871
Progress Vessel, 711
Promoting Organisation, 744
Prussia, Electric Locomotives in, 605
Prussian Main Line Electrification, 286
Quarry Electrification, Extent of, 904
Quarry Equipment, 903
Question of Depreciation, A, 485
Radiotelegraphy, Losses in, 839
Railroad Electrification in Canada, 206
Railway Electrification and Profit, 141
Railways, High Voltage on, 173
Refining Waste, 679
Rent and Penny Per Unit, 646
Reports, Municipal, 605
Resistance, Silicon and Carbon, 526
Rules in New South Wales, 526
"Run on Commercial Line," 679
Safety in High Pressure, 326
Sales Engineers, 446
Saving, 485
Shanghai Exhibition of Westminster, 486
Seventy Per Cent. Drop, 605
Shipboard, Difficulties on, 173
Ships, Electrically-Propelled, 205, 285, 808
Shunting Apparatus, Auto, 904
Silicon and Carbon Resistance, 526
Silundum, 525
Small Installations, 743
Small Stream Power, 646
Smelting, Electrical, 142, 405, 485, 525
Solar Seeds, 645
Spanish Market, The, 839
Sparking of Portable Lamps, 566
Spinning Mills, Electric Drive in, 173
Steels, Solar, 646
Standardisation of Catalogues, 606
Standardisation in Motors, 605
Status, Improving the, 903
Steel Rolling Mills, High Tension Current in, 174
Substrate of Ammonia, 206
Sunbeam Electricity, 285
Tasmanian Hydro-Electricity, 807
Thunderstorm, Artificial, 904
Telegraphing Pictures, 776
Textile Mill, Electric Drive in, 645, 711
Trackless Trolley Systems, 485, 776
Traction, Electric, 743
Traffic, London, 807
Traffic, Urban, 445
Training of Engineer, The, 206
Tramway Conductor and Electricity, 566
Tramway Extension, 485
Tramway Trolley Standards, Electrified, 776
Transformer Oil, 680, 712
Transformers, 525
Transport and Electricity, 807
Transvaal, Electrical Machinery for the, 205
Tubicaria Abroad, 445
Tungsten Lamps, 775
Urban Traffic, 445
Victoria (Tasmania) Irrigation, &c., Scheme, 566
Voting by Electricity, 743
Wages, Reducing, 679
Water-gases Coal, 446, 485
Water and Fire, 565
Weather Forecasting, 325
Welsbach Litigation, 839
Welsh Hydro-Electric Scheme, 765
When to Install a Condensing Plant, 486
Wind the Generator, 446
Wireless, 141, 173, 245, 446, 486, 566, 807
Wireless Electricity and Accumulators, 141
Wireless, Efficiency, 872
Wireless Telegraphy Progress, 173
Notes on Condensing and Water Cooling Plant, E. Lunn, 340
Notes on Long Distance Transmissions, E. K. Scott, 415
Novel Rope Railway, A, 894
Nyassaland, Hydro-Electrics in, A. S. Chalmers, 376

O.

Obituary:
Bolton, E. S., 771
Cockle, G., 771
Hart, O., 222
Harrison, H. L., 222
Jones, A. P., 583
Martin, F., 847
Rankine, A. M. W., 771
Rutherford, C., 536
Wyse, M., 222
Oil in Power Stations, Economising, 712
Operation of Electric Power, 635
Order, Engineer-in-Admiral, Electrical Propulsion of Warships, 273
Ordnance, The Electrical, 59
Organisation, Progressive, 744
Organisers, Electric, 502
Organised Cable Co., and Mr. Ellis, 798
Overhead Cable Pioneering, 744
Overhead Lines, Long Distance Transmission on, 777, 812
Overhead Wires, Electrification of, 172
Overtime, 924
Owner of Site, 566
Oxford, Electric Lighting of, 526, 585
Ozone, Electrical Production of, 526

P.

Paper, "M.B. Electricity in the XIII. No. 7
Paper Stock, Electric, 677
Parsons, Prof. C. A., on Application of Electric Motors to Printing Machinery, 187
Particulars, Supplementary, Rails and Brakes, 201
Parsons, W., The Electrification of the Tyneside Railways, 6
Patent Laws, German, 871
Patent Office Library, 711
Peat, Electricity at the Lochgelly Coal Mines, 232
Peat, U.S., Distribution and Application of Electric Power, 842
Peebles, Photometrical Observations, 501
Peebles and Clarke, 286
Peel, Electric Launch, H.M. Queen, 186
Petrol Electric Station, 572
Petrol Electrical, 206
Photographer, The Electric, 285
Photometer, Lucas Flicker, 839, 847, 891
Photometer, Portable Form of, Reading Lamp, Electrical Engineering, 917
Physical Society's Exhibition, 844
Pictures, Telegraphic, 776, 784
Pillar, Post Office, Consumption, 417
Pole, Cost of Poles and Electric Tramways, J. P. Lattey, 435
Portable Lamps, Sparking of, 566
Portable Photometer, Reading Lamp, Electrical Engineering, 917
Portable Photometer, Reading Lamp, Electrical Engineering, 917
Portsmouth, Electric Launch, H.M. Queen, 186
Post Office Pillar, Consumption, 417
Power, Cost of Production of, 485
Power, Electricity and Economy, 679
Power, Electricity and Earthquakes, 405
Power, Future of Electricity, 871
Power, Growing Demand for, 871
Power, Harnessing the Danube, 174
Power, International Exchange of, 903
Power, Profitable Electricity, 871
Power, Small Stream, 646
Power Stations, Economising Oil in, 712
Power Stations, Lubricating Oil in, 712

Power Supply and Transmission, &c.:
in Africa, 73, 102, 113, 160, 365, 376
in America, 142, 227, 272, 285, 291, 415, 515, 709, 734, 797, 819, 834, 926, 864, 923
in Argentina, 803
in Australia, 366, 478
in Austria, 75
in British Columbia, 768, 926
in Canada, 164, 291, 344, 366, 396, 397, 413, 478, 489, 561, 568, 646, 668, 704, 768, 777, 836, 923
in Chile, 836
Cost of, in the United States, 646
in Colorado, see Ref. to U.S.A.
in the Ferrule Collieries, 567
in England, 365
in France, 367, 877
in Germany, 767, 894
G.N.R. of America Line, 819
at Georgetown, 635
High Tension, P. H. Thomas, 90
How I Made my Paper on, 742
in India, 273, 834
International Exchange of Power, 903
in Italy, 359, 445, 566, 925
in Japan, 829
Kapp, Dr., Remarks on, 715
Long Distance Transmission on Overhead Lines, 777, 812
in Mexico, 358, 376, 478, 867, 896
in New Zealand, 397, 836
at Niagara, see "Canada"
Notes on, E. K. Scott, 415
Protection of Equipment for, 532
in Storm, 747, 769
in Sweden, 903
in Tasmania, 478, 586
in Wales, 569
Present Aspect of Electric Lighting, P. W. Sandford, K.A.V.P. Lecture, 748, 775, 775, 851
Pressure Change Over, 851
Preston Sewage Electric Light, 927
Principle of Fault Localisation, Bernstein, 215
Printing Machines, New Victor Starting Switch for, 124
Profitable Electricity, 871
Progress in Electrics, Sir J. J. Thomson, 270, 287
Promoting Organisation, 744
Protection of Electrical Equipment, P. M. Lincoln, 532
Prussian Main Line Electrification, 286
Psychology and Advertising, 774
Pyrometer, The Electrical, F. H. Davies, 369
Pyrometer Thermo-Electric, M. Pecheux, 798

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Q.

Quantitative Measurements in Radiotelegraphy, Dr. Fleming, 877
Quarry Equipment, 903
Quarrying, Hydro-Electric Development in, S. S. Stone, 259
Questions and Answers, see TECHNICAL PROBLEMS AND SOLUTIONS

R.

Radiology, &c. Congress, 724
Radio-Telegraphic Demonstration at [illegible], 366
Radio-Telegraphy, Developments of, Prof. Stroud, 754, 790
Radio-Telegraphy, Losses in, 829
Radiotelegraphy, Quantitative Measurements in, Dr. Fleming, 877
Radio-Telegraphy, Secrets by, 592
Radiotelegraphy, [illegible], 915
Radium, 829
Railless Electric Trolley Cars, [illegible]
Railway Carriage Lighting (Canadian Practice), 539
Railway Electrification and [illegible]
Railway Goods Clearing [illegible], 126
Railways, High Voltage on, 1
Railway Rates and the Electrical [illegible], S. Whitetail, 252
Rashleigh Phipps Electric Sign, [illegible]
Rays and Product of Uranium X, [illegible], 680
Recovery of Power from Exhaust Steam, W. M. Sanderson, 726
Recovery from Shock, 350
Reduction of Waste, 417, 679
Refuse Destructors, [illegible]
Regulators for Electric [illegible]
Reiff, H. J., The Majorana System of Wireless Telephony, 494
Remagnetisation of Magnets, [illegible]
Removals, see "Addresses, Change of"
Rent and Penny per Unit, 646
Reports, Muddled, 605
Researches on the Relative Rates of Migration of Ions in Aqueous Solution, [illegible]
Resistance, Silicon and Carbon, [illegible]
Resistance, The Measurement of, [illegible]
Resuscitation, Schafer's Method of, [illegible]
Reviews, see BOOK REVIEWS
Reyrolle Motor Starters, 526, 7[illegible]
Reyrolle Switchboard at the [illegible] Colliery, [illegible]
Reyrolle Switchgear and Accessories, [illegible]
Richards, J. W., Electric Furnace Reduction of Iron Ore, 147, 370
Ritten Electric Railway, The, 11[illegible], 519
Road Repair Problems and the Trackless Trolley, 485
Robb, A., Electric [illegible]
Robinson, S., Tramcar Rolling Stock [illegible], 459
Rogers, J. W., Shop Testing Direct and Alternating Machinery, 72[illegible]
Rogerson, W. M., Electrical Power for [illegible] Tramways, 663
Rolling Mills, Electrically Driven, 31
Rolling Stock Mishaps, Tramcar, S. Robinson, 174
Rome Railway, A Novel, [illegible]
Rotary Condensers and Power Factor, 7[illegible]
Rotaesphere, The, 88[illegible]
Rubber, 218
"Run on Commercial Lines," 679

S

Safety in High Pressure, 326
St. Pancras Tramway Construction, 391
Sales Engineers, 446
Salt Union Works, 635
Sand, Dr., Electro-Analytical Determination of Lead as Peroxide, 811
Sand, Dr., Rapid Electro-Analytical Separation of Metals, 100A
Sanderson, W. M., Recovery of Power from Exhaust Steam, 723
Sartory and Filliadier, Drs., Electric [illegible], 45[illegible]
Sayer, J., & J. Dalziel, Single-phase Electrification of the Heysham, &c., Branch of the Midland Railway, 692
Schafer's Method of Resuscitation, 520
Schniewindt's Lightning Arrester, XIV. No. 4
Schniewindt's Wall Fastening, XIV. No. 1
Scott, E. K., Electricity and Fertilisers, 295
Scott, E. K., Electric Propulsion of Ships, 808
Scott, E. K., Notes on Long Distance Transmission, 415
Scott & Mountain's Mining Electrical Equipments, 821
Scott's Patent Flexible Suspension, 6[illegible]
Seabrook, A. H., Flat Rate System of Charging, 646, 660
Seabrook, A. H., Recommendations for Standardisation of Lighting Tariff, XI. No. 6
Secondary Batteries, see ACCUMULATORS
Secondary, Grounding the, 6[illegible]
Secrets by Radio-telegraphy, 592
Servant, A Good, 619
Seventy Per Cent. Drop, 605
Sewell, W., & [illegible], Electrical Apparatus and Prevention of Accidents, [illegible]
Shaw, [illegible], Equipment and Working [illegible] of the Mersey Railway, 6[illegible]
Sheffield Exhibition, 650
Ships, Electrification, [illegible], 334, 339, 398, 587, [illegible], 72[illegible]
Shock, Recovery from, [illegible]
Shock, [illegible]
Shoreditch Electrical [illegible]
Siemens Battery [illegible]
Siemens Bros.' [illegible], 659
Siemens' Novelties at the [illegible] Association's Belfast Exhibition, [illegible]
Siemens Oil-Cooled Transformer, 65[illegible]
Siemens Selective Call, The, [illegible]
Siemens, A., Tantalum and its Industrial Applications, 123
Siemens X-Ray Outfits, XI. No. 4
Silicon, 526

Silundum, 61, 525
[illegible]

Societies and Institutions:

[illegible]

T.

[illegible]

Technical Problems, &c.:

[illegible]

Technical Problems, &c. (continued):

[illegible] for Dynamos, 351
[illegible] Motor, Effect of Air Gap on, 551
[illegible] Boilers, Water Softening Apparatus for, 41A
[illegible], Electrically Driven, 41A, 69A, 71
[illegible], Rearrangement of, 513
[illegible] Lamps, Cement Jointing [illegible]
[illegible] Wire on 460/230 Volt System, Earthing [illegible]
[illegible] Change Over, 631, 656, 690
[illegible] Steam, [illegible] of Electric Drive for, [illegible]
[illegible] of Magnets, 313
[illegible], The, 791
[illegible] Motors v. Steam Engines [illegible]
[illegible] Converters, Six-Phase v. Three-Phase, [illegible]
[illegible] Three-Phase Rotary Converters, 272
[illegible], 127A
[illegible] Rotary [illegible] to Start, 196
[illegible], 127A
[illegible] Stations, 855
[illegible], 97A, 125A
[illegible] Battery, 823
[illegible], 919
[illegible] for Cage Winding [illegible]
[illegible] Apparatus for Lancashire [illegible]
[illegible] Steam Driven, 314
[illegible]
[illegible] Motors, 511

Telegraphy:

[illegible] 471, [illegible], 516, 555, 636, 796, [illegible]
[illegible] 280
[illegible] and Telephony, 919
[illegible] MEETINGS
[illegible], 97A, 125A
[illegible], 767
[illegible], 1, 47
[illegible] System, 446
[illegible], Chamber of Commerce, 732
[illegible] Cable [illegible], 284
[illegible] District Post Office Staff, 830
[illegible] Report on, 759
[illegible], 101, 128
[illegible] Plate, 639
[illegible] Selective Call, The, 341
[illegible], 831
[illegible] Pictures, 758, 776, 784
[illegible] Photographs by, 758
[illegible], 797
[illegible] Cables, 594
Wireless:
[illegible], 141
[illegible]
[illegible] System, 756
[illegible] Station, 419
[illegible]
in British Columbia, 704
at Buenos Ayres, 249
Cullercoats Demonstration, 366
[illegible] of Acoustic Tuning, 495
Detectors, 469
Determination of Locality by, 865
Development of Radiotelegraphy, Prof. Stroud, 754
Economical, 446
Efficiency, B. Davies, 872
Experiments with, 656
in France, 674
German Africa-America System, 893
in [illegible], 895
and the Government, 416, 431, 486, 496, 566, 807
Lepel System, The, 754
[illegible], 855
Marconi System, The, 1, 18, 416, 486, 496, 566, 701, 720, 754, 7[illegible], 844, 874
for Multiplex Working, 590
in New Zealand, 146
[illegible] Report on, 739
Poulsen System, The, 326, 366, 754
Progress of, 17[illegible], 245
Quantitative Measurements in Radiotelegraphy, Dr. Fleming, 877
Radiotelegraphy, Development of, Prof. Stroud, 754
in Russia, 737
on Ships, 319, 590, 754, 798, 893
in South America, 518
Standish Moors Station, 634, 656
Stations for, 590, 634
Telefunken System, 754
Tesla System, 893, 916
[illegible], Remarks on, 720
Underground Station for, 374
Telephone Cables, Electrolytic Corrosion of, E. [illegible], 193
Telephone Engineers, Apprenticeship Course for, A. D. Cousins, 915

Telephony:

[illegible]
[illegible], 31[illegible], 506, 530, 555, 669, 701, [illegible]
[illegible] Course for Telephone Engineers, [illegible]
[illegible]
[illegible] Exchange, 399
[illegible], 257
[illegible], 318
[illegible] Exhibition, &c., Telephone Equipments, [illegible]

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Telephony (*continued*):
at Buenos Ayres, 318
Cable Pointers, VIII. No. 6
Cable for Telephony and Telegraphy, 919
Cables, Deterioration of Lead, 894
in Canada, 318, 516
Central Battery System, The, 823
in China, 349, 669
Companies' Meetings, see COMPENIAS MEETINGS, AND REPORTS
Contracts for, see ELECTRICAL TENDERS
in Corea, 438, 704
Correspondence, see CORRESPONDENCE
Development of the Telephone Industry, L. E. Wilson, 750
Dry Cells for, 507
Electrolytic Corrosion of Telephone Wires, E. Miller, VIII., 193
Essential Requirements of the Modern Telephone Cable, F. R. Jewett, VIII., Aug. 6
Exchange Fires, 61
in Germany, 798, 893
at Gosport, 437
at Hoddesdon, 131
in Italy, 704, 798
in Japan, 669
Long Distance Transmitter, A, 758
and Magnetic Storm, 446
Majorana System of Wireless Telephony, H. J. Reiff, 494
in Mexico, 555
Moloney's Long Distance Transmitter, 758
on Monte Rosa, 397
in Monte Video, 120
in New Zealand, 758
Night Service of, 430
Overhead Wires in the City (London), 258
P.M.G.'s Report on, 739
Rates for, 101
Receiver, A Novel, 10
Reporting by, 382
in Rio de Janeiro, 279
at the River Plate, 355, 555, 831
in Russia, 195
in Spain, 202
in Switzerland, 831
Telephone Industry, Development of the, L. E. Wilson, 750
Telephone Interference on Transmission Lines, 780
Tests on Overhead Work, 764
Tidd, E. G., Remarks on, 720
and Train Dispatching, 701
Transmission of Photographs by, 758
in the Transvaal, 253
in Turkey, 800
in Venezuela, XII. No. 19
Wireless, 245, 494
Terminology, Electrical, 892
Tesla on Radiotelegraphy, 893, 916
Testing Electrically Driven Mills, C. A. Ablett, 465
Test of Engines using Producer Gas, 496
Textile Factories, The Electrical Operation of, H. W. Wilson, 117, 153
Textile Mill Electrified in North Carolina, 348
Textile Mills, Electric Drive in, 117, 153, 645, 657, 679, 711, 765, 818
Thermal Columns, The Wilkinson, 694
Thermo-Electric Detectors, 702
Thermo-Electric Pyrometer, 798
Therol Electric Water Heater, 342
Thomas, P. H., High-Tension Transmission, 90
Thompson, Prof. S. P., Illuminating Engineering Up to Date, 810
Thomson, Sir J. J., Progress in Electricity, 270, 287
Thorpe Electrolytic Wattmeter, 527
Threads of Sparking Plugs, 618
Three Hundred Kilowatt Sub-Station, Switchgear for, 855
Thullier, G., Report on Accumulators, 336
Thunderstorms, Artificial, 904
Thury Direct Current System and its Development, 367, 779
Thwaite Fund, The, 101
Tidd, E. G., Advance in a Quarter of a Century, 720
Tierney, J. P., Point Controllers for Electric Tramways, 905
Titanium Arc, The, 767
Top Compass, The, 829
Trackless Trolley and Road Repair Problems, 485
Traction Diagram, A Useful, 466
Trade Changes, 152
Trade Openings in Sweden, 822
Trade or Profession, 923
Traffic, London, 807
Training of Engineers, The, 206, 406, 487
Train Resistance, Determination of, E. I. Wenger, 684
Trains, Electric Lighting of, A. Robb, 653
Tramcar Rolling stock Mishaps, S. Robinson, 174, 459
Tramways Income Tax and Depreciation, 872
Tramways Conciliation Board, 30, 47
Tramway Problems in the Future, A. L. C. Fell, 407
Tramway Standards as Stay Poles, 399

Transformers:
Berry, The, 582
Birch, The, 582
British Westinghouse, The, 581
Brown-Boveri, The, 715
Brush, The, 582
Cooling of, by Electric Air Fans, 702
Dimensions of Single-Phase Core and Shell, &c., A. R. Low, 177
for Direct Current, 435
in Ferndale Collieries Power Station, 567
Foster, The, 622, 724
A Grant, 829
G.M.B. Direct Current Rotary, 36
for High-Tension Transmission, 115, 812
Kapp, Dr., Remarks on, 714
Lahmeyer, The, 583
at the Lochgelly Coal Mines, 292
for Mines, 292, 567, 575
for the Nyassa-land Power Scheme, 376
Notes and Calculations, 525, 575, 616, 687
Oil Cooled, 659
Oil for, 680, 712
Siemens, The, 659
Siemens Schuckertwerke, The, 714
Star *v.* Delta Connection on Transmission Lines, 780
Static, 815
for Three Hundred Kilowatt Sub-Station, 855
Westinghouse, The, 828
Transmission, Heat, Prof. Dalby, 578
Transmission Voltage, The Limit of, 778
Transport and Electricity, 807
Transportation, Automatic Electric, 683
Transvaal, Cheap Power in, 160
Trunk Lines, Electrification for, C. L. de Muralt, 426
Tschentscher, R., Electric Power in Steel Plants, 450
Tubification Abroad, 445
Tungsten as Valve Electrode, L. H. Walter, 373
Turkey, Electrical Enterprise in, 17, 380
Turpentine, Distillation of, by Electricity, 299
Twelve Hundred Volt Direct Current Car Equipment, F. E. Case, 686
Two Thousand Seven Hundred and Fifty Volt Direct Current System, A, A. H. Barringer, 908
Tyneside Business Results and Prospects, 921
Tyneside Notes, 303, 349, 398, 433, 472, 514, 553, 593, 634, 667, 699, 732, 764, 795, 826, 861
Typewriter, Telegraph, A, 797

U.
Unbreakable Insulator, An, 790
Undertakings, Electrical, Development of, S. J. Watson, 607
Union Electric Co.'s Multiple Solenoid Switch Starters, XIV. No. 3
Union Insulation Testing Set, 542
Uranium X, The Rays and Product of, F. Soddy, 681
Urban Traffic (1) Tramway (2) Tubes, 445
Useful Traction Diagram, A, 466
Utilisation of Natural Laws, 526

V.
Value of Controllers, The, 923
Valves, Oscillation, 924
Veritys Estimate for Arc Lamp Installations, 918
Vaughan, F. P., High Potential, High Frequency, 781
Victoria Electrical Developments in, H. R. Harper, 389
Victoria, Government's Research Scholarships, 340
Victoria Turbo Pumps, 342
Voltage Transmission, The Limit of, 778
Voltmeters and Ammeters, British Standard Specification for, 490
Voting by Electricity, 743

W.
Walter, L. H., Tungsten as "Valve" Electrodes, 373
Warr, J. W., Electric Ignition of Internal Combustion Engines, 646
Warships, Electrical Propulsion of, Engineer Vice-Admiral H. J. Oram, 723
Waste, Reduction of, 417, 679
Water Cooling and Condensing Plants, E. Lunn, 310
Water Power, A Set-back and Possibilities, 113
Water Power Problems, 297
Water Power Schemes, &c., see POWER SUPPLY, &C.
Water Softening Apparatus for Lancashire Boilers, 15A, 41A
Water *v.* Coal, 446, 485
Watson, E. A., & Dr. Marchant, Long Distance Transmission on Overhead Lines, 777, 812
Watson, S. J., Development of Electrical Undertakings, 607
Watt-hour or Ampere Hour Meters, 430
Wattmeters, Integrating, on Cars, T. W. Hinkle, 368
Wattmeter, The Thorpe Electrolytic, 527
Wave Power for Electric Lighting, 660
Waves and Tides (Italian Tidal Project), 565
Wear and Tear, Assessing, 497
Weather Forecasting, 325
Weddless Chains, Ltd., Chain Adjuster, XIV. No. 2
Wells, G. T., Winding Engine Design, 827
Wenger, E. I., Determination of Train Resistance, 684
West Ham Corporation Tramway Report, 17
West Ham Publicity Department, XI. No. 2
Westinghouse Chain Drives, XI. No. 3
Weston Normal Cell, Cadmium Amalgams and the, F. E. Smith, 618
Whettall, S., Railway Rates and the Electrical Trade, 252
"Whipall" Electric Tyre Pump, VIII. No. 7
White City, Electrical Inventions at the, 33, 122
White, Sir W. H., Hydro-Electric Power in Canada, 291
Wilkinson, G., & R. McCourt, Metallic Filament Lamps, 842
Wilkinson's Thermal Column, 694
Willans & Robinson's Impulse Steam Turbine, 421
Willans-Victoria Turbo Pump, 541
Wilson, L. E., Development of the Telephone Industry, 750
Wilson, Prof. H. A., The Electrical Properties of Flame, 142
Wilson, H. W., The Electrical Operation of Textile Factories, 117
Wimbledon Exhibition, 724
Wind the Generator, 446
Winding Engines, 314, 325, 827
Winding Ropes, Corrosion of Steel, Mr. T. Murray, 651
Winnipeg Water Mains, Electrolysis of, L. A. Herdt, 327
Wire Gauges, 701
Wireless Detectors, 469
Wireless Electricity and Aeronautics, 141
Wireless Signalling for Airships, 430
Wireless System of Telephony, H. J. Reiff, 494
Wireless Telegraphy, G. Marconi, 844, 874; *also see* TELEGRAPHY
Wiring, Stannos System of, 621, 627, 706, 897
Witton-Kramer Transportable Electric Equipments, XI. No. 4
Wood, G. R., Electricity in American Mines, 230
Wooden Poles, A New Method of Preserving, 121
Wood Green Lighting Scheme, Report on, 68
Woodhall, A. R., Locating Fault in Armature, 420
Woodhouse, W. B., Electrical Driving of Textile Machinery, 657, 711
Worm Gearing for Electric Motors, 511
Wraith, H. O., Electrical Energy in Factories, 586
Writing, Electric, 445

Y.
Year Books and Calendars, 884, 918

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THE

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CABLE RATES.

The first subject brought before the Imperial Press Conference was that of cable rates and Press inter-communication. A strong committee was then appointed to go fully into the question, and the report of this committee was presented to the meeting of the conference on Friday last. The committee passed the following resolutions: (1) "That in the opinion of the committee it is urgently necessary that the Governments of the British Empire take steps to increase the means and to reduce the cost of the electric communication between the different parts of the Empire, and the committee recommends the conference to ask the Prime Minister to receive a deputation upon the question." (2) "The committee takes the opportunity to draw attention (1) to the high charges made by the Indian authorities on all cable messages to and from the United Kingdom placed on the Indian wires; and (2) to the present scale between ordinary and Press cable rates, and invites the conference to pass a resolution calling the attention of the India Office and the Colonial Office, and also of the Eastern Telegraph Company, to these matters, with a view to securing some immediate relief in both respects. And that the attention of the Colonial Office and the companies be called to the prohibitive rates at present obtaining in the West Indies." (3) "That this committee urges upon the Governments concerned the desirability of establishing a chain of wireless telegraph stations between all British countries, because these are necessary both for the cheapening of electrical inter-communications and for the safety of the mercantile marine." To pass resolutions is a function freely exercised by all conferences, but too many joint efforts end there. This is not the case with the Imperial Press Conference. As a direct outcome of their representations the Pacific Cable Board have agreed to reduce their charges for Press messages to one-half. At the same meeting it was announced that the New Zealand Government would give the same reduction in their terminal charges, and it was expected that the Commonwealth of Australia would do likewise. The members of the conference are to be heartily congratulated on this practical outcome of their work. The discussion which followed raised once more the competition between cables and wireless telegraphy, and the question of State *versus* private submarine cables. Thus the Pacific cable is owned conjointly by Great Britain and the Governments of the colonies served by it, but all the messages from England to Australia or New Zealand have first to be sent over company-owned cables to America. The proportion of the total rate charged which goes to the companies is fivepence per word for transmission over cables of from 1,800 to 2,000 miles in length. The Pacific Cable Board has received fourpence per word to Australia and fivepence to New Zealand for messages over a cable 7,800 miles long. These latter charges are now to be reduced by one-half for Press messages. It was this disproportionality which led to a resolution advocating State-owned electric communication between the British Isles and Canada. This was so

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worded that the service might be either by cable or through the ether by wireless telegraphy. Mr. Marconi added interest to the discussion by his promise of a limited Press service to Canada at twopence-halfpenny per word, and by his description of large stations which, when completed, would, he hoped, be able to deal with 15,000 to 20,000 words a day. Then for a large amount of Press messages his company would charge twopence per word. This, again, is the result of private enterprise, but the success of wireless telegraphy has led already to State regulations on the subject, and may eventually call for State ownership. The members of the conference looked to State ownership of electric communication to reduce costs, but we think that there is a greater need for the same for Imperial reasons. The Pacific cable is an all-British one, and we should be able in time of war to communicate with all our Colonies without using apparatus placed in any foreign country. This applies equally to cables and to wireless telegraphy, and it is a further advantage that the links which would preserve the Imperial unity in war would serve to draw the Colonies closer to the Mother Country in times of peace.

STEAM-TURBINES.

The most important paper discussed at last week's convention of the Incorporated Municipal Electrical Association was undoubtedly the one on steam-turbines presented by Mr. Alfred S. Blackman. The maintained economy of the steam-turbine is now generally acknowledged, and the superiority of this type of plant over the reciprocating engine as a form of prime mover in electricity works has long since been established. Its advantages, however, have hitherto been presented mainly by the manufacturers, and there has been a curious reticence on the part of users to communicate the results which actual experience with steam-turbines have produced. But Mr. Blackman's paper stands in a somewhat different category from the majority of papers which have dealt with this question; it is the outcome of long practical experience gained in large and important stations, and it deals with the present position of the steam-turbine purely from an electricity works standpoint, so that there is no ground for doubting its impartiality, or its advocacy of any special design. Moreover, the paper is invested with additional importance, inasmuch as it represents the point of view of a user who has studied from all sides the difficult problem as to the relative merits of the impulse and reaction types of the steam-turbine. This, in short, is the question which looms most prominent in the present situation of the steam-turbine industry, for the partisans of each type claim so many advantages which the other does not possess that an impartial statement is necessary. The author's review of the progress of the last two years shows that while trouble with the reaction type has undergone a marked diminution, the impulse type has not made the headway which many people anticipated. It is often a matter of difficulty to decide at what size of unit it becomes advisable to adopt turbines, but Mr. Blackman wisely declined to draw any definite line of demarcation. It is very often stated that for units above 750 kw. turbines should be installed, while reciprocating engines should be used for units below 750 kw. As a general statement this may be acceptable, but the safest plan is to determine the choice by the particular conditions of individual cases. It is interesting to examine the figures given by Mr. Blackman of his experience with the Willans-Parsons turbine at Sunderland. The results show this type of turbine to be absolutely trustworthy. For over sixteen months the bulk of the work has been done by the 2,000-kw. turbine plant of this make, running at 1,500 r.p.m., and during the year ended March 31 last we gather from the author's statement that the total units generated in the works were 9,207,227, of which no less than 8,009,000, or 87 per cent. of the whole output, was generated by the one turbine plant. The opinion of Mr. Blackman that maintenance costs on steam-turbine plant complete should not exceed, say, £100 per annum per 10,000,000 units generated confirms the estimates put forward from the manufacturers' standpoint. As a matter of fact, the maintenance of the 2,000-kw. plant at Sunderland came to less than £35 during the year ended March 31 last. No reference is made in the paper to the important question of the prices of the two types of turbines. The lower price of the reaction type, in many cases, might be the deciding factor, but the Parsons-Willans type might still hold its own if there is no difference in steam consumption. At Manchester they are working with the two types, and the results which Mr. Pearce has promised to publish later should afford a good opportunity for making comparisons between the two types. With the elimination of the defects which the earlier designs have brought to light, and particularly of the blade troubles, together with the increasing size of the units now produced, and the higher speeds at which it is now possible to run turbo-generators, there should be little doubt as to the future of the steam-turbine. And it seems to us that the design of the future will not be controlled so much by what manufacturers think as by what users think, hence the importance of Mr. Blackman's contribution to the discussion of this problem.

THE ELECTRICAL EQUIPMENT OF BIRMINGHAM UNIVERSITY.

BY E. A. ALLCUT, B.SC. (ENG.).

The new university buildings at Birmingham, which are devoted entirely to scientific work, are invested with special interest at the present moment on account of the approaching opening ceremony which is to be performed by his Majesty the King on July 7. This university aims at giving a thorough practical and theoretical training to engineers such as no other institution in England is capable of supplying. Its situation in the metropolis of the Midlands, the centre of a great engineering district, is responsible for its specialisation in this direction, as the essential object of such an institution is to train men to take prominent parts in the industries of the surrounding district.

A brief general description of the buildings may not be out of place. They are situated at a distance of about three miles from the centre of the city, on a plot of ground 25 acres in area, kindly given by Lord Calthorpe. The great hall, itself larger than the Birmingham Town Hall, forms the centre of a semicircular block of buildings, the other blocks radiating out from the semicircle in T form. There will be eventually six of these blocks, three on each side of the hall, but at present only three of these—devoted to mechanical engineering, civil and electrical engineering, and mining and metallurgy respectively—are at present in use. A smaller set of buildings, including the physics, library, and chemistry blocks, forms the diameter of this semicircle, while the tower, 325 ft. in height, is situated in the courtyard between the library and great hall. A smaller group of buildings at some distance from the main block contains the power station, smithy, foundry, smelting laboratory, and battery-house.

The headquarters of the electrical engineering department are situated in block B, which is adjacent to the great hall on the west side. The course taken by a student who wishes to graduate in electrical engineering extends

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over four years. In the first year he takes mathematics, physics, chemistry, machine drawing, workshop, and lectures in general engineering. The second year substitutes metallurgy for chemistry, while the drawing taken is more advanced in character, simple designs being sometimes included. Up to this point mechanical and electrical engineers take the same course, but in third year the electrical student spends more of his time in the electrical laboratories. In the third year lectures in civil, mechanical, and electrical engineering are given; electrical and mechanical designing, together with laboratory work in all three branches of engineering, occupy much of the time. The final year sees more specialisation, electrical design and laboratory work forming a great part of the course. The design work is greatly facilitated by the provision of a large number of prints illustrating the best English and Continental practice in electrical machinery. The more elementary designs in third year are also done with the assistance of numerous small machine details and materials of construction loaned by the makers and accessible at all times in the museum showcases. The upper floor of block B contains the professors' and lecturers' rooms, departmental library, drawing office, photometric and galvanometer rooms, and elementary laboratory.

The library for the department is well provided with all the standard works of reference in connection with electrical engineering, while the drawing office, which accommodates 12 students, is provided with special lighting fittings for drawing work. These lights, consisting of 110-volt carbon-filament lamps, are mounted at the end of a telescope arm, which is suspended from a standard by a ball-and-ring joint. This allows the arm and lamp to be fixed in any position required by the draughtsman at a moment's notice.

The galvanometer rooms are provided with instruments for induction and capacity work, magnetisation and hysteresis curves, and all kinds of experiments involving the use of ballistic galvanometers. A fluxmeter is also included for the purpose of ascertaining the strength of magnetic fields.

A dark-room adjacent to the large laboratory contains a Bunsen photometer for finding the horizontal and mean spherical candle-power of incandescent lamps. A standard lamp and several sub-standards are provided for this work. On a gallery above the library is installed an arc lamp photometer with revolving mirrors to obtain the Rousseau curve for all kinds of arc lamps.

The large laboratory contains all facilities for the performance of tests on magnetic fields, electromagnets, accumulators, heating of wires and coils, electro-deposition of metals, calibration of instruments, insulation and resistance measurements, and all the smaller electrical tests not involving the use of machines. Terminals on the benches provide direct current at 110 and 220 volts, three-phase supply at 220 volts, and heavy currents at 2 to 25 volts. Instruments of every pattern are provided, and are regularly tested by the students.

The ground floor is occupied mainly by the senior laboratory, which contains the machinery for generating current at different voltages for use in the laboratories. The supplies available from the power station are 110 volt direct current and three-phase alternating current at 200 volts and 30 periods per second. This is supplemented by a battery of 112 E P.S. cells which gives a discharge of 200 amperes for three hours. It is situated below the main switchboard, and only the extreme terminals are brought to the board, so that all portions of the battery are equally discharged. The different voltages required are supplied by regulating machinery which forms part of the laboratory equipment.

The various supplies obtainable in the laboratories and lecture-rooms are as follows: A 110-volt direct-current supply with a capacity of 200 amperes is obtained by means of a 30-kw. Brown-Boveri rotary converter by tapping from one main lead and the middle point of a three-phase auto-transformer, which acts as a neutral point. Heavy currents at low voltages (300 to 600 amperes at 2 to 25 volts) are obtained from a six-cell battery through a plug board. Where special regulation is required, a main current booster is included in the circuit. The 220-volt supply has a normal variation of about 30 volts. This is compensated for by taking one of the main leads through a booster, automatic regulation within one volt being performed by a Thury regulator.

The battery is charged from the 110-volt supply by a B.T.H. motor-generator (30 kw.) coupled to a booster transformer. It can also be charged by the alternating-current power station supply through the rotary converter. The pressure during charging is reduced to 220 volts by a 30-kw. Allen motor-generator, regulation being again obtained by the booster. The alternating-current machines include a 30-kw. motor-alternator by Holmes and Co., of Newcastle. The motor is a 220-volt machine, and the frequency of the alternating current obtained is varied from 50 to 20 by reducing its speed from 750 to 300 revolutions. The alternator is specially fitted up for a Behrend test, its field being divided into two parts for this purpose, while the ends of the three phases are brought to a special board for the purpose of making either the mesh or star connection. A Parker set, consisting of two motors mechanically coupled driving two alternators with magnetic clutches, supplies two-phase current. The machines are each of 10 kw. capacity. A three-phase supply of 50 alternations is provided by the Brush 25-kw. set. It consists of a 220-volt motor driving a 200-volt generator of the revolving armature type. The voltage of this machine can, however, be regulated over a wide range. A three-phase supply at 30 frequency is provided by running the rotary converter from the direct-current side, the volts being kept at 200 by a three-phase booster. Each of the sets is provided with a special switchboard connected to the main board, and provided with special terminals for making connections for any kind of test. These machines are nearly all used for experimental purposes in the fourth-year laboratory course, two lamp loads, one of 7 kw. and the other 30 kw., being provided to absorb the power, in addition to the water loads. The testing beds proper are situated at the north end of the laboratory, and are provided with motors of all classes for brake and other tests. The wiring from the test switchboards is done by the students. The machines at this end of the laboratory may be grouped for special tests by means of hand travelling cranes of one and two tons capacity. The motors include direct-current machines by Siemens, Verity, Electromotors, and other prominent makers; alternating-current machines, a Westinghouse rotary converter, and a number of small motor-generators. The special machines are Winter-Eichberg and Déri single-phase commutator motors, Siemens series-wound crane motor with controller and starter, Rosenberg constant-current dynamo for tram lighting, and Brush tramway motor. These small machines are about 30 in number, and are fitted up with friction and eddy-current brakes and all other appliances for testing work. An interesting machine in this part of the laboratory is an Edison Z-type dynamo, made in 1881, exhibited at the Crystal Palace Exhibition in 1882, and in constant use for 20 years. This machine is lent by Messrs. Verity, of Aston. The remainder of the laboratory is devoted to transformer work, insulation and capacity tests, and other advanced experiments not requiring moving machinery. Two very sensitive ballistic galvanometers are provided in this section for cable and other testing. For measuring the capacity of a three-core cable a quarter-mile length is sunk in the ground and its ends brought to a special set of terminals near to the galvanometers. Several Westinghouse and Burnand transformers are also provided for short-circuit and other tests. The smaller apparatus, such as choking coils, small transformers, etc., are made in a special workshop adjacent to this laboratory. It is fitted up with both metal and wood working tools, and a skilled mechanic is kept there for the purpose of making such apparatus and adapting existing electrical machinery for special experiments or research purposes. A feature of this department is the standardising room, in which standards of pressure and resistance and sub-standards for direct-current and alternating-current work are kept, and which contains special facilities for the rapid standardisation of any instrument. The installation is such that instruments can be calibrated in position if required.

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It may be of interest to note that these electrical laboratories were first designed by Dr. D. K. Morris, and the work was taken up and completed by Dr. Gisbert Kapp upon his appointment as first professor of electrical engineering in 1905. The present lecturer in electrical engineering is Dr. J. D. Coales, who also controls the laboratory work. Mr. E. J. Kipps, M Sc., takes charge of the electrical drawing and design, while Dr. W. Lulofs is also a demonstrator in the laboratory.

The power station supplies lighting and power to all the buildings, and also acts as a heat laboratory. The engines and boilers, therefore, are all different, so that the engineering student gains experience with many different kinds of machinery while working in this department.

The pressure originally adopted for lighting purposes was 110 volts direct current. This is supplied by five machines. The Premier 100-h.p. gas-engine is directly coupled to a Westinghouse 55-kw. compound-wound generator and runs at 160 r.p.m. A Westinghouse three-cylinder vertical gas-engine drives a 37½-kw. compound-wound generator at 270 revolutions. The 100-h.p high-speed set by Messrs. Willans and Robinson is coupled to a four-pole Siemens dynamo, while that of Messrs. Belliss and Morcom drives a Bruce Peebles six-pole machine at 500 r.p.m. The 30-h.p. De Laval turbine, running at 20,000 r.p.m., is geared down to 2,000 and drives a compound-wound machine with drum-wound armature and interchangeable field coils.

Upon the erection of the physics, library, and chemistry blocks at some distance from the station, it was found that the extension of this system would involve too great a cost in cables, and so it was resolved to install a 440-volt three-wire system for the outlying buildings. A 50-h.p. cross-compound engine was presented by Messrs. Ruston, Proctor, and Co., of Lincoln, and this was direct coupled to a six-pole Westinghouse compound-wound dynamo giving 440 volts. The middle wire of the set was earthed through a resistance, so that in case of a fault work could be continued with a loss to earth until it was possible to shut down for repairs. As light is required in some of the departments during the night, a battery-house was installed. The charging set is housed in the central chamber, and consists of a Siemens 60-kw. three-phase motor driving two direct-current generators, one for each half of the battery. The two halves of the battery, each consisting of 120 E.P.S. cells, are housed in each end of the building, the connections being burned together. A small milking booster is provided for treating single cells. A balancer is provided in the engine-room, and consists of two mechanically-coupled 6-kw. machines by the Lancashire Dynamo Company. They are compound-wound machines and run at 750 r.p.m. The cables are paper insulated, lead covered, and are laid in Howard troughing. The great hall is illuminated by flame arc lamps from the 440-volt system, and the motor for blowing the organ bellows is also worked from this supply. The new buildings mentioned above are all on the 440-volt system, while blocks A, B, and C are supplied at 110 volts. The switchboards for controlling the last three blocks are placed in a subway which runs entirely along the main buildings, and all the lighting and heating operations for each block are controlled from this point. All the large lecture theatres, except that in the chemistry block, are lighted by arc lamps, and the smaller rooms by either carbon or metallic filament lamps. The latter are generally superseding the former in this connection. The chief difficulty met with in the chemistry block is that of protecting the wiring from fumes. This is done by the use of galvanised, solid-drawn, steel tubing, this having been found superior to the enamelled variety. It may be of interest to note that in the buildings at present erected there are about 65 arc lamps and 3,600 incandescent ones.

The third supply from the power station consists of the 220-volt three-phase system (30 frequency), which is provided by a 75-kw. Westinghouse alternator of the revolving armature type. This is driven by a MacLaren triple-expansion marine engine, and is capable of taking a continuous overload of 50 per cent. and a temporary one of 75 per cent. This supply is used for power purposes, the motors for driving the various workshops being mostly of the three-phase induction type. Alternating current is also supplied for this purpose by a 37½-kw. Westinghouse rotary converter, which is run from the 110-volt system. The installation is completed by three 15-kw. Westinghouse single-phase transformers, which are used in connection with the converter. The large switchboard contains all the necessary instruments for use with these machines, a panel being devoted to each set.

In the metallurgical department special facilities are given for electroplating work. The plating vats are eight in number, and are used for the deposition of gold, silver, nickel, brass, zinc, and acid and alkali copper. A three-phase motor on the 220 volt supply drives an electroplating dynamo which gives eight volts, and is used either for charging the plating accumulator or for direct use with the vats. A small switchboard at each vat contains an ammeter, voltmeter, and controlling resistance. Cleaning baths and polishing bobs are also installed. In the research laboratory a Heraeus electric tube furnace is worked from the 110-volt supply. It is specially designed for the heat treatment of metals and alloys. The smelting section contains a Moissan electric furnace which takes 1,000 amperes at 110 volts. This is used for high temperature work, metal melting, and the preparation of special alloys.

The physics and chemistry departments are also well provided with both alternating and direct current. Each has its own battery and dynamo room, in which the power station supplies are converted into those needed at the moment in the laboratories. Each dynamo-room contains a plug-board, from which the power is distributed to various subsidiary boards throughout the building. The electro-chemical equipment will be exceptionally large, and will be the finest of its kind in the country. Provision is also made for electric furnace work, with special reference to chemical processes. In each department electricity, gas, and water are taken to the flat roof, so that processes which cannot be conveniently carried on indoors may be done in the open air.

The equipment of the whole of the buildings is admirable from every point of view, and the student who has taken a course at this university will have a thorough practical as well as theoretical training which will stand him in good stead when he comes to take his place in the engineering world.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The annual business meeting of this association was held in Manchester last Friday morning. The principal items on the agenda were the annual report and balance-sheet and the election of officers. Very little change took place in the constitution of the committee. Mr. W. W. Lackie, chief electrical engineer of the Glasgow municipal undertaking, succeeds Mr. S. L. Pearce in the presidency. The vacancy in the office of vice-president, created by the elevation of Mr. Lackie, is filled by the election of Mr. G. Wilkinson, while Mr. C. Furness and Bailie Willock take the places of Mr. G. Wilkinson and Alderman Bruce (Sunderland) on the committee. The full list of the executive council for 1909-10 is, therefore, as follows: president—Mr. W. W. Lackie (Glasgow); vice-presidents—Mr. J. Christie (Brighton) and Mr. G. Wilkinson (Harrogate); past-presidents — Mr. S. E. Fedden (Sheffield), Mr. H. Talbot (Nottingham), and Mr. S. L. Pearce (Manchester); council—Messrs. A. C. Cramb (Croydon), A. A. Day (Bolton), C. Furness (Blackpool), Councillor Howarth (Manchester), F. M. Long (Norwich), V. A. H. M'Cowen (Salford), H. Richardson (Dundee), C. E. C. Shawfield (Wolverhampton), Councillor Sinclair (Swansea), Alderman J. P. Smith (Barrow-in-Furness), Alderman C. West (Coventry), Alderman Wilkinson (Luton), T. P. Wilmhurst (Derby), and Bailie Willock (Glasgow); hon. solicitor—Alderman G. Pearson, Bristol; hon. treasurer — J. E. Edgcome (past-president), Kingston-upon-Thames; hon. secretary — H. Faraday Proctor (past-president), Bristol; secretary — Mr. C. McArthur Butler, London.

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STEAM-TURBINES, FROM THE USERS' POINT OF VIEW.*

BY ALFRED S. BLACKMAN, BOROUGH ELECTRICAL ENGINEER AND MANAGER, SUNDERLAND.

In presenting this paper, dealing with the present position of the steam-turbine from an electricity works standpoint, the writer has thought it advisable to set down definite opinions upon several questions open to considerable controversy with the object of promoting discussion. There is such an abundance of literature on the subject of the steam-turbine, giving descriptions of types and systems, that only a passing reference will be made to this point. Briefly, the present situation of the steam-turbine industry is a battle for supremacy between the impulse and reaction types, and while the partisans of each type claim all sorts of wonderful advantages which the other does not possess, yet the following statements are put forward as representing the point of view of a user who has studied the problem from all sides: (1) *All turbines* must fulfil a certain law of combination of blade speed and number of running rows; (2) steam expanding between boiler pressure and condenser must generate a certain velocity, and this velocity must be imparted to the revolving mass in small increments, as in the Parsons machine, entailing many rows of blades, or in larger increments, as in the Zoelly or Curtis machines, or in one increment, as in the Laval; (3) the fewer the rows of running blades the higher must be the speed at which the blades run, and consequently the higher the speed of the steam impinging on the blades; (4) the impulse type turbine runs at a much higher speed at blading than the reaction type and necessitates particular attention being given to the design of the wheels and blades owing to the greater stresses that prevail; (5) the impulse type turbine lends itself to a more mechanical looking construction than the reaction type; (6) the reaction type, as illustrated by the best Parsons type, is more economical than the impulse type; (7) for speeds of 3,000 r.p.m. and below 1,000 kw. the impulse type is better than the reaction; (8) for speeds of 1,500 r.p.m. and up to 3,000 kw. the reaction type has up to the present proved most satisfactory; (9) for speeds of 1,000 r.p.m. and 750 r.p.m. and up to the largest sizes likely to be used there is absolutely no evidence that the impulse type can compete in reliability or economy with the Parsons type.

In making the above statements regarding reliability and economy, isolated cases have not been considered, only an opinion expressed on a general survey; and a very important point which must be considered, both for and against the two types, is that the reaction type has been longest in the field, the uses to which it has been put are of wider application, and the total horse-power in use must very greatly exceed that of the impulse type, and whether the impulse type will come through the many vicissitudes that are supposed to beset all turbines is a matter which has yet to be proved. A review of the progress of the last two years, the writer thinks, shows that while trouble with the reaction type has shown a marked diminution, due to the defects of the earlier designs having had time to come to light, thus showing the necessity of more mechanical construction, and notably of stiffer shafts, the impulse type has not made the headway many people looked for, and may still be said to have its infantile complaints ahead.

Turbine Outputs and Speed.—Too little attention is given nowadays to selecting an efficient combination of power and speed, although the latter is such an important point from every point of view. Take two instances: (1) 750 kw. on 50 cycle; (2) 1,500 kw. on 40 cycle. In Case 1, the periodicity being 50, only two speeds can be considered—viz, 3,000 r.p.m. with a two-pole machine or 1,500 r.p.m. with a four-pole machine. Many engineers have selected the slower speed in putting down their installations, but there is no argument in reason which can be given against the higher speed of 3,000 r.p.m., as the high-speed set will be (1) more economical by about 10 per cent.; (2) take up less floor space; (3) be about 15 per cent. cheaper in first cost. The same remarks apply to Case 2, where of the two speeds of 2,400 r.p.m. and 1,200 r.p.m. it is an uncommercial proceeding to put in the slow-speed set. A very good rule to follow, and one which should be insisted on, is: choose the size of your unit to suit the highest speed that the periodicity will allow, and here the assistance to be obtained from external fan cooling of the generator should not be overlooked, because the higher the speed at which the set is run the greater the benefits which will be obtained from a turbine installation. At Sunderland we have a 1,500-r.p.m. Willans-Dick-Kerr combination, installed to carry a load of 2,000 kw. continuously and 2,500 kw. for two hours, and the economies effected by this plant have been most pronounced, as is very practically exemplified by the fact that with the present normal works day load, amounting to about 2,300 kw. on the turbine, two boilers will easily steam the turbine, but upon changing over to three modern high-speed reciprocating engines, of about 700 kw. capacity each, it is impossible to hold the steam without substantial assistance from a third boiler, and we always hold additional boilers banked against the contingency of a failure of the turbine plant. The question of steam consumption is returned to later on. For direct-current turbo sets the merits of the tandem machine must not be lost sight of. For a given size unit the advantages accruing from tandem machines are many—for instance: (1) by putting in tandem generators the speed of the set can be increased by about 75 per cent., with all the attendant advantages, as already pointed out; (2) the electrical portion being divided into two, there is only 50 per cent. of the machine out of commission should troubles of any sort arise. It would be very interesting to hear the opinion of those engineers who have adopted tandem turbo-generators and can speak from extended experience of them. The writer recently heard the remark of a well-known dynamo designer that if direct current was wanted the best way of providing it was to put down turbo-alternators and use motor-generators for conversion to direct current, but it is to be hoped that the serious commutation difficulties of a few years ago are being surmounted, and in this respect the radial brush gear of the Westinghouse Company looks promising on paper, and it would be interesting to hear of actual experience with it.

Turbines v. Reciprocating Engines.—It is often a subject of some concern to an engineer to decide at what size of unit it becomes advisable to adopt turbines in preference to reciprocating engines; a general statement which has been made very frequently is that above 750 kw. as a unit use turbines, below 750 kw. use engines. It is, however, impossible to draw any definite line of demarcation, as so much depends upon the available conditions and the requirements. For instance, the temperature and quantity of circulating water affects the situation very seriously, and must be taken into consideration as regards both capital and running costs before any decision can be arrived at. Every case calls for a detailed investigation, which it will repay to make thoroughly. There is, however, not the slightest doubt that with the higher speeds at which it is now possible to run turbo-generators the proposition of turbines *versus* engines will soon disappear, and it will be a case of turbines only; in fact, it is even now difficult to prove a case for the reciprocating engine under any ordinary conditions. The Brush Company, who have made a speciality of small turbo-generator sets, give the following typical figures for a 300-kw. plant: Steam consumption in pounds of steam per kilowatt-hour with steam at 16 lb. per square inch: reciprocating engine 26-in. vacuum, 24 lb. dry steam, 20½ lb. with 100 deg. superheat; turbines, 28 in. vacuum, 22 lb. dry stream and 19¾ lb. with 100 deg superheat; while the capital cost of the two plants complete with condensers is practically the same. Granting that capital and steam costs are equal upon so small a unit, and taking into consideration the undeniable advantages the turbine has in cost of oil and general upkeep, it does, indeed, appear that the reciprocating plant has only a small field left, except upon sites where the facilities for obtaining cooling water are exceptionally bad.

Selection of Conditions for Turbine Installation.—This can

* Paper read before the Incorporated Municipal Electrical Association at Manchester on June 24.

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be summed up in few words: (1) 150 lb. per square inch steam pressure—because at pressures above 150 lb per square inch the volume becomes small and leakage percentages are increased, with only a small gain in B.T.U.'s available; (2) 150 deg. superheat—because there is no appreciable gain in plant over-all economy above 150 deg. superheat; (3) highest possible speed—already commented on; (4) best vacuum possible—because it is the strongest feature in turbine working, and it will pay to maintain as high a vacuum as possible.

Condensing Equipment and Vacuum.—As mentioned above, the condensing plant is the most important detail of the plant, and yet how often is it neglected, or, one should say, not paid sufficient attention to. A vacuum should be selected with an equivalent temperature about 25 deg. above the available temperature of circulating water, and this gives a commercially obtainable and maintainable vacuum. Having once obtained this, see that it is always maintained. If a vacuum of 28½ in. can be obtained, never let it drop to 27½ in., which it will easily do with a little inattention and neglect of glands, joints, sluice, and automatic valves, etc, etc. An inch down in vacuum will mean a 5 per cent. rise in the coal bill. Work this out in expenditure per annum, and it will draw its own moral. The writer has found a vacuum recorder kept under lock and key worth considerably more than its weight in gold. The writer is of opinion that the field for improvement in condensing plant is even greater than in turbines. As regards types of condensing plant in use, this again depends on circumstances. There are three main types: (1) surface; (2) low-level jet; (3) barometric. (1) Surface can be sub-divided as follows: (*a*) Ordinary—viz., generally consisting of surface condenser, air pump, and circulating pump. (*b*) Parson's augmentor surface, which is as in (*a*) with the addition of a steam jet and auxiliary condenser, which allows smaller cooling surface, and less circulating water to be employed. Further, the hot-well temperature is higher than with (*a*). This is, in the writer's opinion, undoubtedly the best form of surface-condensing plant. (*c*) Counter-current, an arrangement of (*a*) with compartment drainage. From the point of general works economy, as a rule, the capital cost of surface-condensing plant will be rather higher than either jet or barometric condensers. (2) Jet condensers are made in many highly successful ways, and require, if anything, rather more power than surface plants. Upon account of air entrained with the circulating water, very complete air-extracting apparatus is necessary. (3) Barometric condensers are a very satisfactory form of plant, provided every precaution is taken to prevent air leakage and ample passage-way given to steam and water. The power taken for pumping is, however, slightly in excess of other types of condensing plant, but from the writer's experience it makes a very satisfactory installation. A great point is the uniformity of the vacuum which can be maintained, owing to the absence of cooling surfaces, which become dirty and, therefore, inefficient. In some cases no air-pump is installed, but where a high vacuum is essential a really powerful dry air-pump is necessary. It is probable that this type of condensing plant has been kept back, owing to the fact that when used with reciprocating engines the presence of oil in the exhaust steam put difficulties in the way of using the hot-well water for boiler feed purposes. With turbines this difficulty has, of course, disappeared, and it is possible that barometric condensing plants will be more heard of in future; they are certainly more easy to maintain at their best than surface condensers.

Reliability of Turbines as Prime Movers.—Sunderland experience has shown the Willans-Parsons turbine to be absolutely trustworthy. For over 16 months the bulk of the work has been done by the 2,000-kw. turbine plant of this make, running at 1,500 r.p.m., and during the year ending March 31 last the total units generated in the works were 9,207,227, of which no less than 8,009,000, or 87 per cent. of the whole output, was generated by the one turbine plant. This turbine has, with very few exceptions, been put on load every Sunday at noon, and has run through without any stop until the following Sunday at about 1 a.m. During the night the load drops, as a rule, to about 400 kw., and the day peaks have been about 2,300 kw. When this has been exceeded, one or more 700-kw. reciprocating sets have been paralleled. Throughout the day the work has consisted of about three-quarters shipyard and one-quarter tramway load, and it is of a very fluctuating character. During the whole of this time any sudden mishap to the turbine would have shut the whole system down, because in no case has there been sufficient plant in parallel with the turbine to take the load up temporarily, but in no instance has there been a hitch in any way attributable to the turbine. It runs through week after week with an entire absence of incident. It will be realised that these are severe and exacting conditions, and such dependence upon a single unit calls for the utmost reliability, and after fairly lengthy experience of both high-speed piston-valve and slow-speed Corliss-valve reciprocating engines, the writer trusts the turbine with equal confidence to either of these alternatives.

Maintenance of Turbine Plant.—The writer is of the opinion that maintenance costs on steam-turbine plant (consisting of turbine, alternator, and condensing plant) complete should not exceed, say, £100 per annum per 10,000,000 units generated, and if careful record were taken in some of the larger turbine works, and fair maintenance debits were allocated against units generated, it would be found in many cases less than this amount. As a matter of fact, the maintenance of the Sunderland 2,000-kw. plant for the year ending March 31 last, including opening the turbine twice to measure clearances, came to less that £35, and while it is true that the set was under the contractor's maintenance, a detailed and careful check was taken of all that was done to the plant, including the renewal of exciter brushes, etc., and the figure given is a liberal allowance of what it would cost the Corporation to do the same work, although the contractors will have expended more than this, by reason of men's travelling expenses and out-money. The Sunderland turbine exhausts into a barometric condenser, and it *is* probable that the maintenance costs would be greater upon a surface-condensing plant. As regards wear upon the turbine itself, it appears to be negligible, and most careful examination has failed to reveal any signs of blade erosion.

Exhaust Steam Turbines.—The advantages of the application of the exhaust steam-turbine do not appear to be fully appreciated even at the present time. As compared with a high-pressure turbine, an exhaust steam set requires about double the steam, and the gain due to high vacua is more than twice as great. The machine can be of robust construction owing to there being no necessity for fine clearances, and, moreover, the temperature distortions are small. The impulse type can be of very simple construction for exhaust steam working, but does not, upon the other hand, lend itself so well to economical working as the reaction type, as it works with higher steam velocities, and if the steam is wet, as is usual, the friction losses due to this cause are high. Many present-day condensing-engine plants, with a good supply of cold water for circulating, could be increased in output by 25 per cent. without any appreciable extra expense, save the capital cost of the exhaust turbine installation; it is, however, the exception to find such plants in electricity works, but their installation seems such an absolutely sound scheme that it is a wonder the development has not been more rapid.

Economies to be Obtained from Turbines.—Sunderland experience shows the cost of working with turbine plant to be much lower than with reciprocating engines. The writer has already dealt with maintenance costs, and, as regards steam consumption, it has been argued against the steam-turbine that it does not maintain its economy, but the following experience of the writer's shows that good results can be maintained after the hardest work. The 2,000-kw. Willans-Parsons set installed at Hylton-road was tested on setting to work, and again on the expiration of one year and two months' work, during which time the plant ran over 9,000 hours and generated over nine million units. The steam consumption on a 27½-in. vacuum was 17·07 lb. of steam per unit on one test and 17·1 lb. of steam per unit on the other. As regards oil, which was logged separately from the other

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plant, the total cost for the year ending March last was—for the turbine £13. 8s. and for the turbine auxiliaries £18. 8s. 6d., a total of £31. 16s. 6d., equivalent to ·000953 of a penny per unit generated. It would be difficult to claim such a record of maintained economy for any prime mover other than the steam-turbine.

A METHOD OF COMPOUNDING ALTERNATORS BY MEANS OF CONDENSERS.

The effect of leading currents on the terminal voltage of alternators has long been known, but owing to the difficulty of obtaining the large capacities required in connection with large alternators the practical application of the effect has not hitherto been carried out. Herr W. Linke in the *Elektrotechnische Zeitschrift* for May 13 describes some interesting tests on a small machine in this direction. In order to reduce the capacity to a minimum

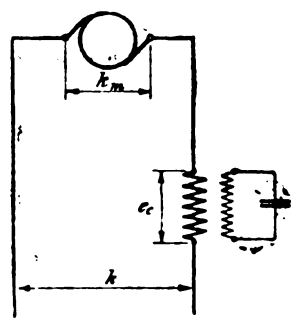

FIG. 1

it is advisable to connect it to the circuit through a current transformer giving a high voltage at the condenser terminals, as shown in Fig. 1, the voltage, in fact, being raised to the maximum value which the condenser insulation will stand.

The voltage drop of an alternator is due to four effects—viz., the ohmic drop, $i\,\omega$, the drop due to armature back ampere-turns, the drop due to armature leakage flux, and the drop due to field distortion by armature reaction. For practical purposes it is, however, permissible to consider the drop as made up simply of an ohmic drop, $i\,\omega$, in phase with the armature current, i, and an inductive drop, $L\,\omega\,i$, displaced 90 deg. in phase from i.

If E is the induced voltage of the machine, e_ω = ohmic

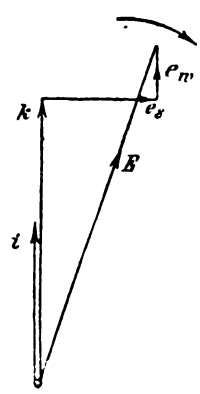

FIG. 2.

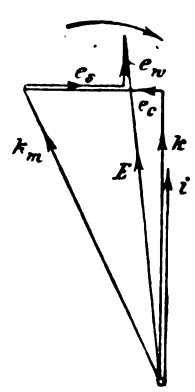

FIG. 3.

drop = armature current i × armature resistance ω; e_s = inductive drop = $L\,\omega\,i$, where $\omega = 2\,\pi \sim$; e_c = the voltage across the condenser reduced to the primary side = $\frac{i}{C \times \omega}$, where C = the capacity of the condenser; K_m = terminal voltage of the alternator; K = the voltage across alternator + condenser.

Then the vector diagram for non-inductive load and without the use of a condenser is as shown in Fig. 2, whilst with the condenser connected the diagram becomes as in Fig. 3. e_c has been chosen as somewhat greater than e_s, and the magnetising current of the condenser transformer has been neglected. Fig. 3 shows that according to the value of e_c the current lies more or less ahead of the machine terminal volts, K_m, in phase. The voltage, K_m, is, therefore, dependent on e_c and becomes greater as e_c increases. For non-inductive load K is smaller than K_m, but K_m itself is greater than it was at no load. Whether an actual compounding on non-inductive load can be obtained depends, therefore, on the relation between terminal volts and power factor for the particular alternator.

Figs. 4 and 5 show the conditions for inductive and capacity loads respectively.

It will be seen that with inductive load the effect of the capacity: is (1) the terminal voltage is brought more into

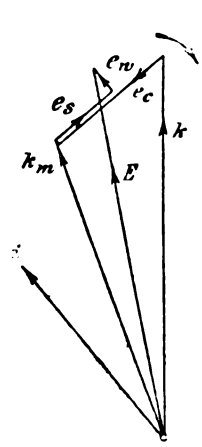

FIG. 4.

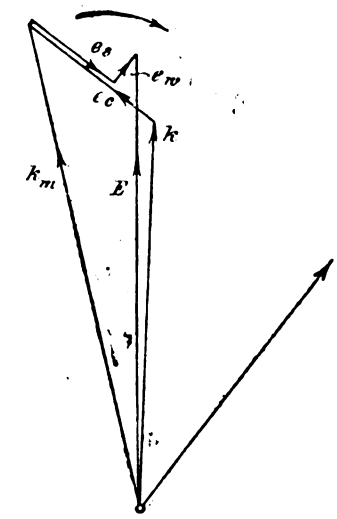

FIG. 5.

phase with the current, so that the phase displacement in the generator is less than in the circuit; (2) the condenser voltage, e_c, becomes added to K_m at a steeper and steeper angle as the phase difference increases—*i e*, the vector K becomes greater than K_m. The increase of K becomes greater the greater the phase difference in the circuit is, and by suitably choosing e_c it is possible to obtain effective compounding with power factors of ·8 or ·9.

With a leading current in the circuit (Fig. 5), e_c causes the generator current to be still more displaced from the terminal voltage, K_m, so that K_m increases further. The condenser voltage, e_c, however, is subtracted from this

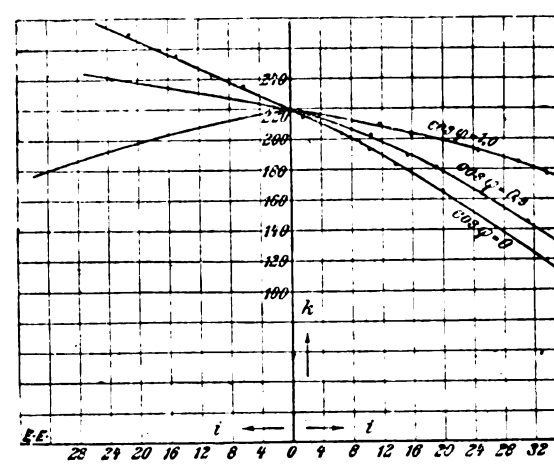

FIG. 6.

terminal voltage more and more nearly in line as the angle of load increases. By suitable choice of e_c it is, therefore again possible to obtain a compounding effect.

Some tests were carried out by the writer on a small single-phase A.E.G. alternator for 8 k.v.a., 220 volts, 50 ~. The condenser used consisted of a battery of 20 Leyden jars of a total capacity of about ·2 microfarad. A 6-k.v.a. transformer of variable ratio was used in connection with the condenser. Fig. 6 shows the normal load characteristics of the machine without the condenser with loads of 1, 8, and 0 power factors and constant excitation. From that it is seen that, with fair approximation, the inductive voltage drop, e_w, may be taken as equal to $2{\cdot}8 \times i$. The resistance of the winding is ·45 ohm, so that $e_\omega = {\cdot}45\,i$. By experiment

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it was found that an average compounding effect was obtained if e_c was made equal to 3·35 i. With this capacity the test shown at a in Fig. 7 was made, whilst curve b was made without the condenser. The armature current throughout was kept constant at 20 amperes (normal full load is 28 amperes).

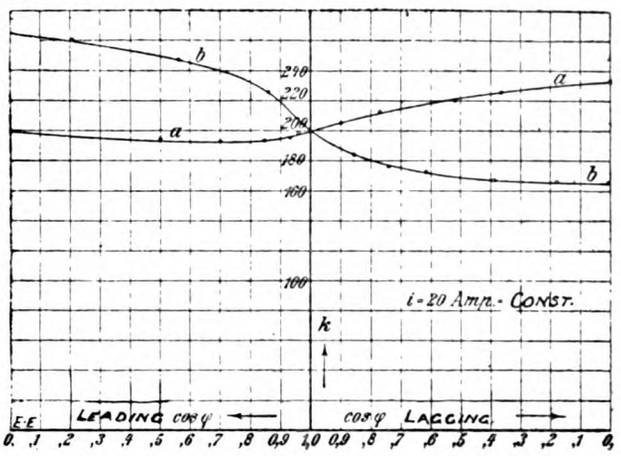

FIG. 7.

Fig. 8 gives the voltage drop curves with the condenser at ·6 and ·8 power factors (lagging), and without condenser at ·8 power factor (lagging); whilst Fig. 9 shows the relation between the volts and the current for cos $\phi = 8$ both leading and lagging. Curve a is with the condenser

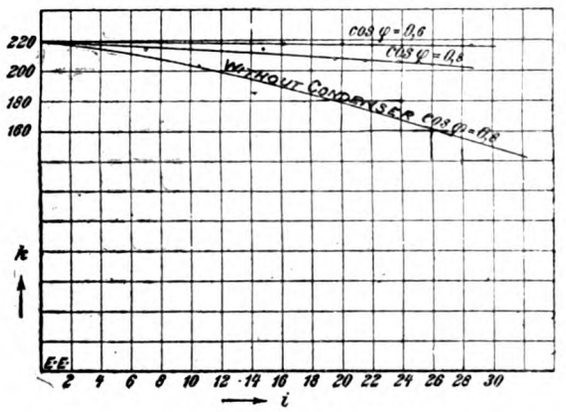

FIG. 8.

connected, and curve b without it. It will be seen that the condenser chosen ($e_c = 3·35\ i$) is not quite sufficient for a lagging power factor of ·8, whilst it over-compounds with a leading power factor of ·8. Fig. 9 also shows that the condenser takes about 33 per cent. of the kilovolt-amperes of the alternator.

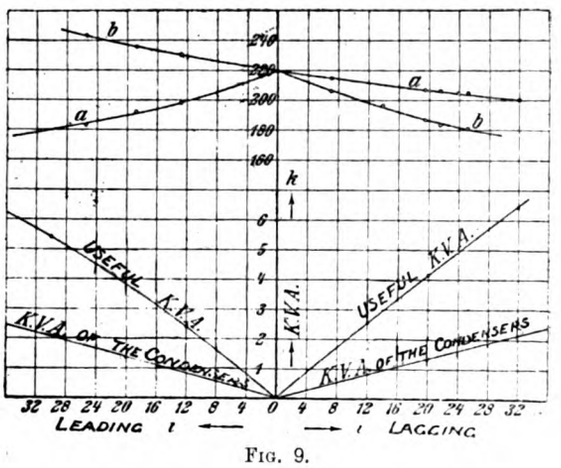

FIG. 9.

This method of compounding has the advantage over most others of responding instantly to variation of load, and, therefore, although a given condenser only compounds accurately for a particular power factor, it is well fitted for traction or power transmission work.

MODERN CABLE SYSTEMS.

Mr. E. M. Hollingsworth's paper on the above subject, read before the Incorporated Municipal Electrical Association last week, gave a valuable *résumé* of up-to-date cable practice. His experience at St. Helens has been unique, as in that town the conditions are as unfavourable to underground cables as it is possible to have them. It is a colliery district, which means that the ground in places will subside from time to time, and one of the principal industries is the manufacture of chemicals, in connection with which there are eight large works. It will be realised from this that the ground in the neighbourhood of these works cannot fail to be impregnated with acids and alkalis. For this reason, armoured cables laid direct in the ground have given more trouble than all the rest of the network. The armouring has been eaten away almost entirely. Again, the subsidences in the streets reduce the advantages to be derived from a draw-in system. The author's description of the subways at St. Helens is of special interest, as they provide space for gas, water, and other services as well for the electric mains. There is in St. Helens down the two principal thoroughfares a subway, 6 ft. 6 in. high and 5 ft. 6 in. wide, nearly half a mile in length, with an entrance at each end

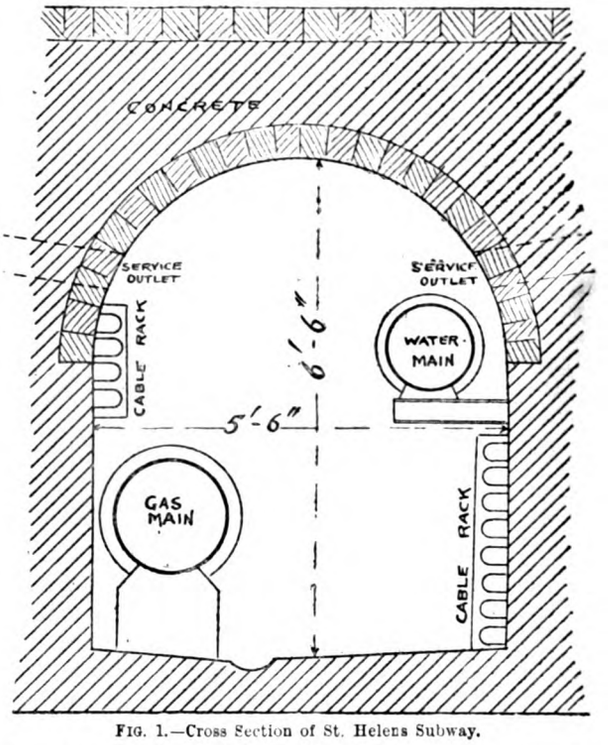

FIG. 1.—Cross Section of St. Helens Subway.

and one midway, and with lateral ways at the intersections of the other streets. With the exception of a 4½-in. ring of blue bricks forming the inner arch it is constructed entirely of concrete, and the form of construction and arrangements of the gas and water mains and electric cables are as shown (Fig. 1). For the gas, water, and electric service connections, 6-in. earthenware pipes are laid at frequent intervals from the subway to the footpath. It is ventilated by means of open gratings placed about 30 yards apart, and is, of course, lighted by electricity. The work was completed in 1899, and the cost including the lateral ways was £7 per lineal yard, and the electricity department's share of the capital and maintenance charges is £90 per annum. At the present time, exclusive of service connections, there are four miles of cables ranging from ·1 sq. in. to 1 sq. in. single and multi-core. The cables are supported on strong racks, and the average cost including the racks and the placing of the cables is about 1½d. per yard of cable. The feeders and distributors are connected to distribution boards placed in a chamber at the centre entrance to the subway. About 100 consumers are supplied through services connected to the mains of the subway. Large three-wire consumers are in each case connected direct, but in the case of small consumers three or four are supplied from one set of service cables.

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The close proximity of the cables to each other and to the gas-mains has been advanced as an objection to such a system, but so far the author has not experienced any trouble, and he considers that if ordinary care be taken this risk should be very remote. A subway for electric cables offers that accessibility and freedom from mechanical damage which is not obtained in any other system.

The author also gives a brief description of the overhead system of conductors that has been in use in connection with the St. Helens Corporation scheme since 1902. By means of overhead conductors a supply of energy at 500 volts direct current, with one side earthed, is given to several glassworks and collieries situated within a radius of two miles from the power station, but separated by rough ground impregnated in places with chemical waste. For this reason it was quite out of the question to lay cables underground, and the Board of Trade being convinced of this consented to the conductors being placed overhead. The total length of the pole line is just over 1½ miles, and the poles are placed about 40 yards apart. The dimensions of the poles and cross-arms and the arrangement of insulators and conductors are shown by Fig. 2. The poles are of red fir, well creosoted, and are to the specification issued by the General Post Office in connection with the supply of telegraph poles. They are planted to a depth of 8 ft. with a packing of concrete, and about every two years the base of each pole is exposed to a depth of about 2 ft. and coated with oil of creosote. Apparently, so far, there is little or no deterioration, which undoubtedly is due to the process of creosoting these poles, for by some misunderstanding one or two poles that had not been treated were erected, but after six years' use they had to be replaced. The cross-arms are of creosoted oak with stays of wrought iron and the insulators are the Post Office heavy telegraph type. The conductors are 4/0 S.W.G. solid-drawn copper, staggered in order to comply with the Board of Trade regulations. Three pairs of conductors are in use for a portion of the distance, and there is room for another pair, or four pairs in all. The cost of the work, exclusive of the conductors, was £220 per mile, and for each pair of conductors erected must be added £170 per mile. If copper conductors were replaced by aluminium at present prices, the cost would be for each pair of conductors £120 per mile. For comparison, the cost for the equivalent underground mains—that is, two ·15 sq. in. cables laid solid in earthenware troughs—would be £800 per mile.

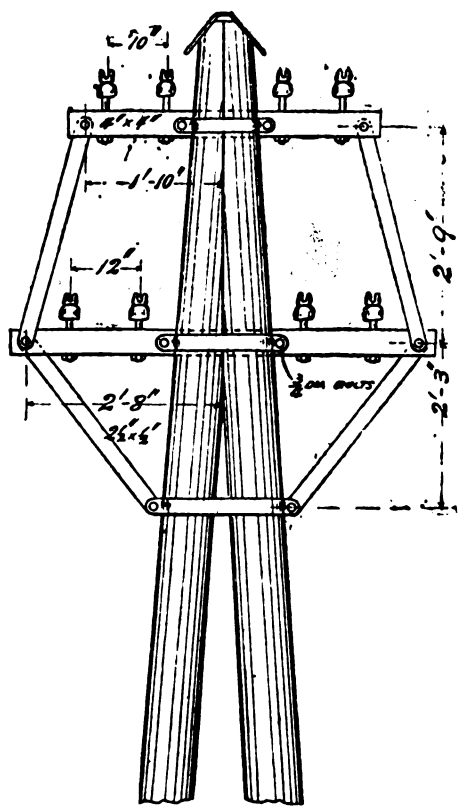

FIG. 2.—Arrangement of Cross Arms.

From these figures it will be seen that the installation of overhead conductors is considerably less expensive than in the case of underground cables, and, in addition, the cost of maintenance is less, and such a system offers more flexibility and less risk of breakdown.

AN IMPROVED FORM OF HIGH-TENSION INSULATOR.

The weight, size, and cost of the ordinary high-tension porcelain insulator increase rapidly with increasing voltage. The increase, in fact, is approximately as the square of the working voltage, as is shown in Fig. 1, in which the full line gives the relation between working voltage and weight of insulator for the standard type made by the Porzellanfabrik Hermsdorf. In Fig. 2 the relative cost of these insulators for the various voltages is shown by the full line. This rapid increase is accounted for by the difficulty of manufacturing large porcelain pieces, and also by the fact that the dimensions have to increase much more rapidly than the voltage in order to avoid the surface leakage which precedes the breakdown.

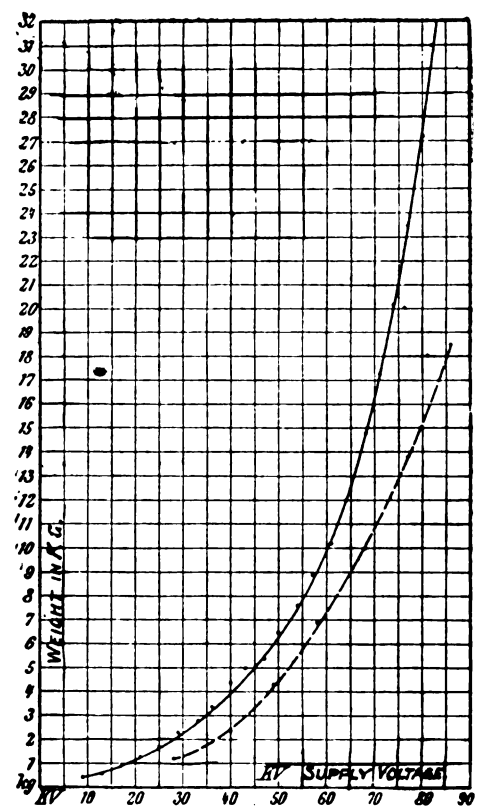

FIG. 1.

Experiments carried out at the Hermsdorf Porzellanfabrik have shown that the difficulties met with in these large insulators can be removed to a great extent if the upper porcelain plate is replaced by a metal one. This may seem a strange way of improving the insulation, but it, nevertheless, has this effect. In the first place, the upper porcelain plate of any insulator is of little value as insulation, for its outer surface soon becomes covered with water in rainy weather, and its chief purpose is to protect the remainder of the insulator from the wet. This purpose is equally well carried out by a much thinner and lighter metal plate, especially as the latter can be easily and cheaply made of larger diameter. The metal cover is also, of course, much less liable to damage by stone-throwing, etc. But besides these mechanical advantages the metal cover has a further purely electrical advantage, for the rain-drops, as they drip off the edge of the cover, are electrostatically repelled much more effectually than in the case of the insulation cover. This action is well brought out in Fig. 3, which shows a metal-cover insulator under high tension, with the drops being thrown outwards and quite clear of the lower part of the insulator. The effect can be enhanced by adding a metal ring beneath and just inside the metal

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cover. The action is not appreciably interfered with if the metal cover is painted or enamelled to protect it against atmospheric corrosion.

The reduced weight and price of insulators designed in this way, especially for the higher voltages, is shown by the dotted curves in Fig. 1 and Fig. 2. Thus, an ordinary porcelain insulator for 80,000 volts weighs 27 2 kg., whilst an equally effective metal-cover insulator for the same

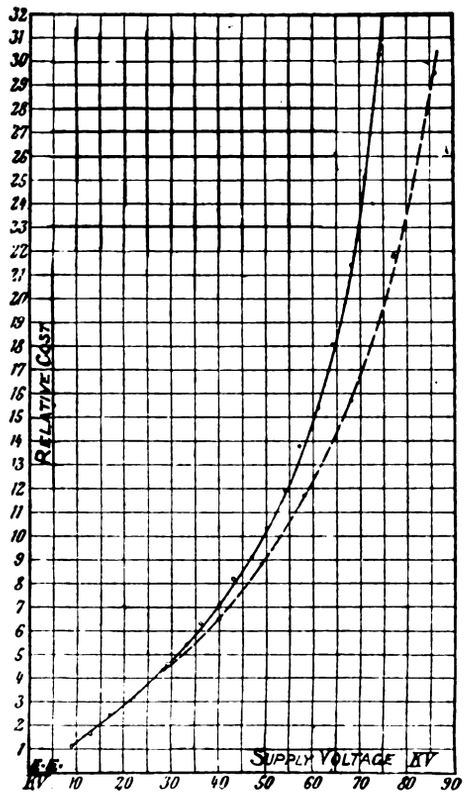

FIG 2.

voltage weighs only about 15 kg. The cost is also considerably reduced in the latter case.

It might be expected that the metal-cover insulators would show a greater loss when under pressure, but experiment has shown that this is not the case. Thus a number of similar insulators were tested at 100,000 volts, half being ordinary porcelain ones and the other half having the upper porcelain plate replaced by a metal cover,

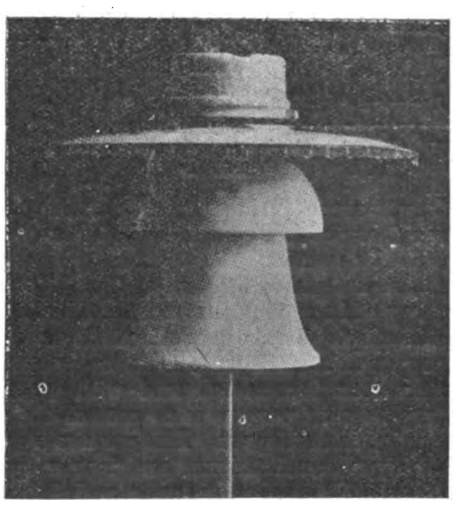

FIG. 3.

as shown in Fig. 4, A and B. Both types showed the same loss, which amounted to about 50 watts per insulator. Certain experiments also show that the metal cover has the effect of improving the electrostatic pressure distribution within the insulator.

It is found that whilst with ordinary porcelain insulators tested under rain or spray the breakdown is always preceded by surface discharges, this is not the case with the metal-cover insulators. In these the breakdown occurs without previous warning, although not until a higher voltage is reached than with the normal insulator. Thus, in Fig. 5 a test of an ordinary and a metal-cover insulator in parallel at 140,000 volts under spray is shown. These

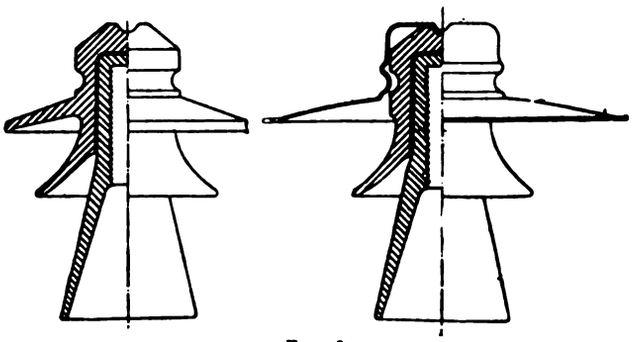

FIG. 4

insulators are for a working voltage of 80,000, the porcelain one being 39 cm. in outer diameter and 49 cm. in height and weighing 19 kg., whilst the metal-cover one is 50 cm. in outside diameter, 39 cm. in

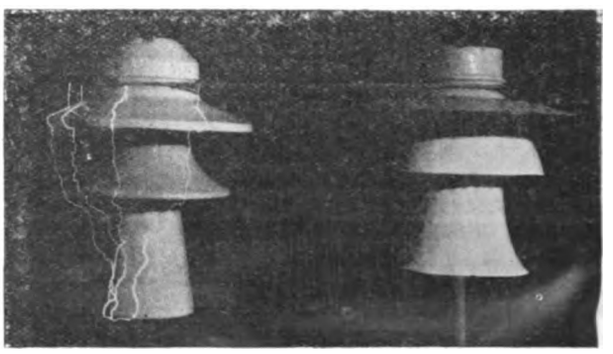

FIG. 5.

height, and weighs 13·8 kg. A heavy surface discharge is seen to be passing over the porcelain insulator whilst the metal-cover insulator is unaffected. From these experiments it is clear that the addition of a metal cover to many existing porcelain insulators would add considerably to their safe working voltage, and would make many simple indoor insulators of the ribbed type fit for outdoor use.—*Elektrische Kraftbetriebe und Bahnen.*

A NOVEL TELEPHONE RECEIVER.

Some experiments by Prof. Penkert on the use of iron-cored apparatus—such as electromagnets, dynamo arma-

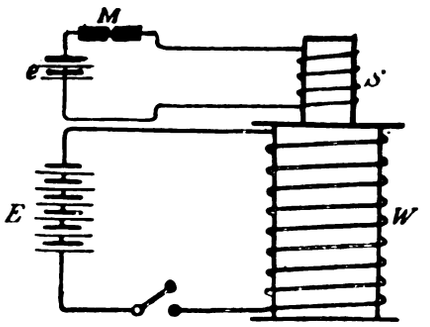

FIG. 1.

tures, or transformers—as loud-speaking telephone receivers were described in these columns recently. Some further experiments in this direction are described by Herr E. Kosach in the *Elektrotechnische Zeitschrift* for June 17, 1909. Not only closed iron circuits, but straight-core open-circuit electromagnets, such as are shown in Fig. 1, were found to give good speech reproduction. The soft-iron core, K, was initially magnetised by the winding, W, connected to the steady supply, E, whilst a second coil, S, also wound round

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the core, K, was connected in circuit with the microphone, M, and the cells, *e*. The reproduction is still audible when the magnetising coil, W, is omitted, although the effect is weaker. The effect can, however, be very decidedly improved if one end of the iron core is brought into contact with a fairly large plate, P (Fig. 2), of iron or other metal, or even wood. The best results were obtained with an iron-wire core, but solid iron or steel cores also acted.

It was also found that without any iron core the coil connected in the microphone circuit itself was capable of reproducing musical pieces, etc., with great purity, although

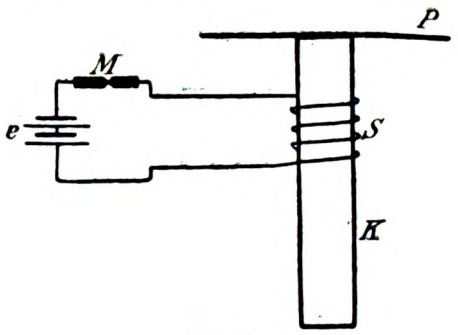

FIG. 2.

only weakly, so that the coil had to be held close to the ear to become audible. A coil of iron wire gave somewhat better results than one of copper. Satisfactory results, for instance, were obtained with a coil of 30 or more turns of insulated wire about 1 mm. in diameter, and wound on a diameter of 5 cm. to 10 cm. The effect is doubtless chiefly due to the electrodynamic action of the turns of the coil on one another, but it seems probable that molecular action within the wire also helps. It was found, for instance, that a coil embedded in a pitch-like mass, so as to be practically a solid block, acted no worse than an ordinary unembedded coil. The action could again be decidedly improved by adding a plate, P (Fig. 3), at one end of the

FIG. 3.

coil. That the action of this plate is not of the same kind as that of the membrane of a Bell telephone is shown by the fact that quite thick plates can be used, and that the plate can be of any non-magnetic material just as well as of iron. The plate appears rather to act through the increased volume of air set in motion.

As a new form of receiver, the writer suggests the use of a brass bobbin wound with the microphone coil and provided with a metal plate at one end (Fig. 4), which might, perhaps, with advantage be shaped as a funnel. Such a receiver used with an ordinary granule microphone and connected to a few volts gives clear reproduction which is audible at considerable distances, whilst if the receiver is

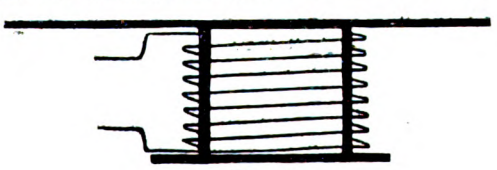

FIG. 4.

held to the ear the slightest whisper into the microphone is heard. The introduction of the usual induction coil between the microphone and the receiver does not interfere with the result. If the former on which the coil is wound is made of iron, very little improvement results. If the iron former is magnetised by a separate coil carrying a steady current, the result is again a little improved, and this improvement is found to occur even when no iron is present—*i.e.*, when the copper-wire coil connected to the microphone is surrounded by a second copper coil carrying a steady current in the same direction as the microphone current.

FITTINGS FOR HOLOPHANE GLASS.

If additional evidence were needed to justify the movement which is endeavouring to rescue illuminating engineering from empiricism, and to bring about a wider recognition of the fact that this distinct branch of engineering has a broad and scientific basis, none more convincing could be adduced than the modern design of electric light fittings and glassware for same. Till within comparatively recent times, the design of this class of goods followed strictly conventional lines; the bulk of the goods were often incongruous and defective, and many installations that we have inspected have so lacked a balance between artistic merit and efficiency of illumination that they seemed to denote a curious paralysis of the designer's mind, almost to be compared with that paralysis of Hamlet's will which followed when the evidence of two worlds hung in equipoise before him. Whether the movement recently noticeable in this country, which aims at placing illuminating engineering on a more scientific basis, is the direct or indirect result of those forces which have brought about the change just mentioned, or, on the other hand, whether it is that movement which is influencing

FIG. 1.—Holophane Reflector Bowl Fitting.

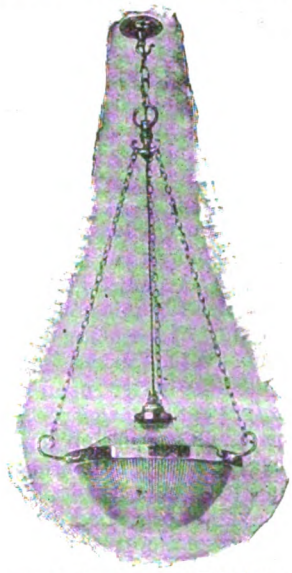

FIG. 3.—Pendant with Holophane Reflector Bowl.

FIG. 2.—Holophane Reflector Bowl Ceiling Fitting.

and determining this change, is a question we will leave undiscussed. Here we are concerned merely to point out the distinct improvement in the design and construction of modern electric lighting accessories.

The advent of the metallic-filament lamp has completely revolutionised electric lighting, but owing to the intensely brilliant filament many objections have been raised to its use. We believe it is generally agreed that an ideal illumination requires absence of glare, which must be secured without loss of light. A metal-filament lamp in a Holophane reflector bowl is, without doubt, the nearest approach to this ideal on a commercial basis. It seems sometimes to be forgotten that the style of fittings and type of glassware used are almost as important a factor in the efficiency of the result as the current consumption of the lamps themselves. In fact, a lamp with a relatively large consumption of current, used in combination with Holophane glass, will give a higher efficiency of illumination than a lamp giving more candle-power with the same current consumption when used under an obscured or heavily etched shade; and it is to the property of giving perfect diffusion with the least possible loss of light that the increasing popularity of Holophane glassware is primarily due. The advantages of the latter are at

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once apparent on entering rooms where it is in use. At the showrooms of Messrs. Julius Sax and Co., 100, Charing Cross-road, London, W.C., there is a wide range of fittings for Holophane glass, and their numerous applications are of interest. We can only illustrate two or three examples of the fittings to be seen in these showrooms, the styles of which are such as to harmonise with the style of various buildings and schemes of decoration, while the light obtained from tungsten light sources used in combination with Holophane glass compares very favourably with the illumination obtained from an enclosed arc lamp as regards quality, and closely approximates it for efficiency. The accompanying designs require no explanation. Their artistic merit is obvious, and this, we are pleased to note, has been secured without sacrificing efficiency of illumination.

CANVASSING NOTES.

BY P. O. W.

Central-station engineers in the past have, to a large extent, believed that the securing of new business was dependent merely upon the struggle between the rival costs for the consumption in the case of electricity and gas. It is only in recent times that they have realised the value, importance, and necessity for something to be done in the way of systematic publicity. The recent scientific methods introduced into the subject of illuminating engineering, with the comparatively recent Press articles dealing with the expansion movement, are in large measure responsible for the adoption of progressive policy by a few of the larger undertakings. The adoption of this policy has been very keenly felt by the gas suppliers, in such a way as to bring about, as a result, a general "waking up" even in districts where electricity is not yet available.

In view of the amount that has been written in the past dealing with the various publicity schemes, it is not intended to enter upon details of any particular set of arrangements in the present article, but it is perhaps not superfluous to mention that in the case of any undertaking either large or small, probably the most important matter in connection with its commercial management is the employment of a good canvasser. One of the chief reasons why systematic canvassing has fallen into such evil repute is that it has often in the past been left to the mercy of the tallyman type of individual, or has been reserved as a spare-time employment for the unassisted intelligence of certain of the office staff. Experience shows that if suitable canvassers seek the right sort of load, the desired results are effected. Successful canvassing is an art, and to be properly conducted should be in the hands of a tactful engineer of some experience, or at any rate of a man capable of advising as to the planning of, probable initial cost, and yearly bill involved in the installation of either light, heat, or power. He should be a sentient being who uses his brains and experience in evolving and improving methods of dealing with the individual public, and dispelling the absurd illusions brought about by the one-sided statements made by the gas suppliers which constantly recur to unsettle the mind of the public as to the immense advantages of electricity.

It has been the experience of the writer to find that, although the vast majority appreciate cheap electricity and a straightforward tariff, a considerable number of new connections are obtainable by persistent personal educating, irrespective of the prices charged for the current. It is this class of consumer who, once properly shown the error of his ways in clinging to gas and its evils, is willing in most cases to pay twice over for the wisdom and pleasure of an electric installation; he is certain to remain a satisfied and remunerative source of income to the supply undertaking. The reason why people do not wire their premises is mainly on account of their doubt as to whether the advantages to be derived really justify the expenditure incurred thereby, and not merely, as some tell us, that "electricity is expensive."

Notwithstanding the fact that the usual forms of advertisement have reached a high state of excellence, it cannot be claimed that they have in many cases "clinched the bargain." It is usually the pleasure of the canvasser—who obtains the man's support by taking him out of the crowd and talking to him privately—to bring about the actual signing of the application form. Although the cost of personal canvassing may be far in excess of other forms of publicity, there is no doubt that more good work is done in this manner than would be the case were everyone addressed without direct reference to their individuality.

An important point which will often predestine the result of a call is the time of calling. For instance, it is almost hopeless to interview a busy doctor during his consultation hours or a draper on, say, a Monday afternoon. In canvassing shop premises it is, of course, a good practice to first attack places frequented by the public, such as hairdressers, public-houses, and the larger establishments. It is also important that such public buildings as the town hall, public library, and baths when secured, should be, if anything, overlighted, as these are places where the public congregate and are likely to adopt the excellence of the light as a topic of conversation. Were preferential treatment permissible it would in most cases pay the electricity supply authorities to make specially low charges for the lighting of public buildings, in consideration of their immense value as advertising mediums.

It is within the province of the canvasser to arrange for the distribution of publicity literature; quantities of this can be effectively distributed by means of its being available at the public library and on the counters of some of the larger establishments and shops in the district. When dealing with shopkeepers, special propositions, in the form of schemes embodying the "you switch on and we do the rest" principle, drawn up in attractive style command attention from the very fact that they are special.

The writer, on whose experience the above suggestions are based, hopes that the foregoing will serve to emphasise the absolute necessity of the publicity man as an adjunct to every electricity undertaking.

THE INFLUENCE OF METALLIC-FILAMENT LAMPS ON THE ELECTRICAL INDUSTRY AND ON STREET-LIGHTING.

Mr. Hoadley, in his paper read before the recent meeting of the Incorporated Municipal Electrical Association, stated that the above title embraced a great many divisions of the subject, and on looking closely into the matter it was astonishing how far reaching and on how many widely differing branches of the great electrical industry was the influence of the metallic-filament lamp felt. He proceeded to consider the effect of the lamp, first, on the manufacturer and selling agent, and, secondly, on the supply station. To the manufacturer of plant the new lamps have been anything but a blessing. Orders for extensions have been hung up indefinitely. Cablemakers are somewhat less affected, as new consumers have to be connected off the lines of existing mains. The makers of the lamps have had a rich harvest, and the accessory suppliers also have gained. The author puts the wiring contractor also amongst those benefited by the new lamps.

The station engineer is affected to an extent depending on the class of consumer catered for. The alternating-current station supplying a residential district feels the change hardest, as practically all the circumstances are against them. "Speaking of them generally, the class of property they supply is of the better class, houses whose owners will face the outlay demanded by a transformer and metal lamps with equanimity. Not having a large late-closing shop demand, the raising of the standard of illumination will not help them very much, as it is not so much increased light for the same amount of money that the consumer will go in for, as in most cases the houses supplied are sufficiently well lighted already, but the same amount of light for a greatly reduced amount of money. In the generality of the towns in question gas is not particularly cheap, so that a large proportion of the available houses already take a supply, so purely from the lighting supply it is doubtful if new consumers will come along fast enough to take all the units that existing consumers will save;

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even if they do, it means that the capital charges per unit sold will be increased, as although the generating plant will not need addition, yet new mains and services must be provided, and in these residential towns these are generally an expensive item per consumer, and with the poor load factor generally prevalent capital outlay should be kept as low as possible." Even here Mr. Hoadley is rather adverse to the raising of the price per unit. He believes that the cost of the new lamps will soon be reduced, just as the carbon lamps were. To get the full benefit of this reduction, it is, in the opinion of the author, a necessity that municipal bodies generally should have the power to raise money for the purposes of wiring houses and other premises, for letting out cooking and heating apparatus as well as motors on hire and hire-purchase. Forty-four towns now possess these powers, and he considers it to be stupid to insist on special Acts before granting the powers to other authorities.

On the wiring question Mr. Hoadley says: "Whatever be the system or systems of cheap wiring that will survive and become standard, in the sense that conduit and casing have become standard, the author can state from his own experience that the Continental system of flexibles on special insulators requires a lot of beating—among other places, he has tried it in the damp warm atmosphere of a conservatory for 18 months without the slightest trouble. With cheap wiring, the necessary powers to hire out cooking and heating apparatus, wiring and fittings, and the improvements in cooking and heating apparatus which are bound to come with extended experience, most central stations should be able to look on the metal lamp as an ally and not as an enemy."

The cost of the lamps must be reduced, as to a workingman 4s. 9d. for a new lamp would decide him at once against electric lighting.

"Provided that it can be arranged that central stations can obtain the advantages set out above—viz., extended powers, cheaper wiring, and cheaper lamps—it is the author's opinion that a new era of prosperity for the greater part of the electrical industry will begin, and in the meantime supply engineers should do their utmost to counteract any disadvantage there may be in a falling revenue from purely lighting consumers, by pushing into prominence the many other uses of electrical energy, some of which have up to the present been seriously neglected. That there will be a diminution in revenue from lighting consumers cannot, the author thinks, be denied, as although the standard of lighting demanded will undoubtedly be increased, yet it will be in very few cases that the standard of illumination will be raised some three and a half times, which is roughly the ratio of efficiency between tungsten and carbon lamps at present, and some makers of tungsten lamps are already considering the question of raising the efficiency of the lamp, as the average life obtained in a large number of cases points to a large sale of lamps for renewal purposes a great deal less than was estimated."

For street-lighting the lamps have a wide field: "Up to the present the generality of streets lighted by incandescent gas at ordinary pressures in towns where electric light mains are laid, are so lighted on the score chiefly of cheapness, the supporters of gas lighting claiming that electric light was beaten in the competition, as the light given by carbon or other lamps available up till recently was not equal to the light of an ordinary gas mantle, while for many streets the cost of arc lighting even with the lamps spaced as far apart as possible was prohibitive. Whatever truth there was in these statements then has considerably altered now, for an ordinary 60-watt metal lamp without any reflector will, from the point of view of the ordinary public, produce the same results as a good gas mantle in the heyday of its youth, while with reflectors the effect can be considerably increased. The other advantages, from an electrical point of view, are that no special mains are necessary; with the same fitting, different candle-power lamps, graded according to the importance of the streets can be employed, lamps that fail can be renewed at any time without trouble, the candle-power of the lamp does not appreciably diminish with age, and last, but not least, the average life of the lamps is a revelation. In the author's own experience, some 18 months has given an average life of very nearly 1,100 hours, individual lamps lasting 6,750, 5,450, and 5,044 hours on a circuit at 230 volts where a large and fluctuating power demand does not make for a particularly steady volt chart, however admirable may be the intentions of the switchboard men. In conclusion, the author would urge all station engineers to unite in trying to obtain what he considers the necessary powers to enable them to utilise to the full the immense power put into their hands by this epoch marking invention, and by themselves getting into personal contact with their consumers, putting before them the great advantages of more light for the same money instead of the same light for the less money."

CHEAP UNITS.

Mr. A. M. Taylor (Birmingham) has kindly furnished us with some notes of his contribution to the discussion on the paper which was presented under the above title by Councillor H. Sinclair before the annual convention of the Incorporated Municipal Electrical Association last week. From the report of the paper, which appeared in our issue of June 25, it will be recollected that Councillor Sinclair dealt with three classes of power load: (1) those consumers who keep off the peak altogether; (2) those who keep on right through the peak; (3) those who employ a time switch and are charged at high rates during the peak. With regard to the first class, Councillor Sinclair suggested charging nothing beyond works cost at 0·5d. per unit (unless special mains extensions are involved), but later he seemed to retreat from his figure. Mr. Taylor, however, maintained that not only would he be safe in selling at 0·5d. per unit to this class of consumer, but (with a large station) he would make the best part of 100 per cent. profit. Mr. Taylor's remarks may be summed up as follows:

"It cannot be too often emphasised that the annual costs on account of fixed charges consist almost equally of charges to pay interest and sinking fund on extra plant and charges which depend on the employment of the said extra plant at the generating station. Such latter charges are wages, management, repairs, rates, taxes, stand-by coal, and depreciation, and they frequently represent in large stations £4 per kilowatt of maximum demand per annum. Some or all of these costs are included in Councillor Sinclair's Table A and, therefore, in his 0·5d. per unit.

"My proposal is that a consumer who keeps entirely off the peak should be charged his *actual* cost to the station, plus, say, 25 to 50 per cent. for profit, but no fixed charges of any sort in addition. Consider the case of the group of consumers depicted in the darkly-shaded area on the diagram. They total 4,000 kw.; they come on at dead of night and they cost the station practically nothing in the way of fixed charges beyond coal handling, an extra clerk, and a meter inspector, say £300 per annum (= 0·01 per unit). Load factor = 17 per cent. Another group of consumers, also representing 4,000 kw., come on for the whole 24 hours. They cost the station £32,000 per annum in the way of fixed charges, £16,000 of this being for interest and sinking fund on plant and mains. Their load factor is 100 per cent. (for the day). If diversity factors were ignored, the second class would need to have, roughly, *100 times* the load factor to pay off the £32,000 at the same rate per unit. But it has only six times the load factor, so the diversity factor must evidently be introduced—in this case it is infinity—and the capital charges and those dependent on new generating plant then disappear.

"Next consider—and this is a very important point—how far we could carry the night load consumers into the day without extra plant or mains being involved in order to cope with this load. Referring to the diagram, it will be seen that it would be safe to allow the load to continue up till, say, 3.30 p.m. and come on again at 6.30 p.m., if only we could be sure that we would not create spurious peaks at other portions of the day. The way in which I would

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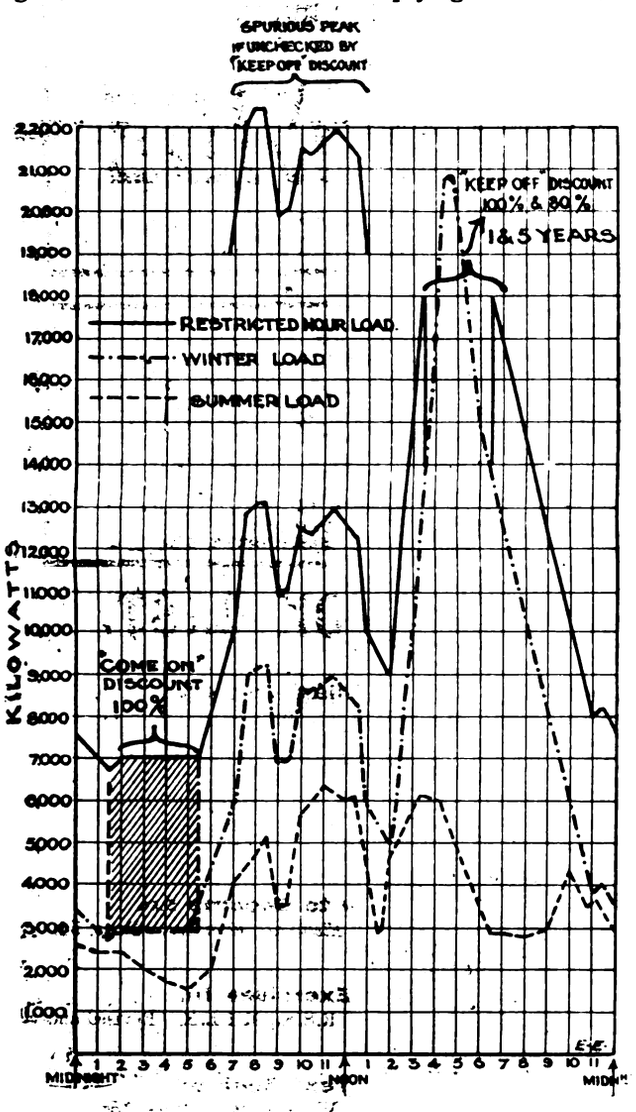
suggest that the station engineer should protect himself against these spurious peaks is to offer a 'keep off' discount of, say, 100 per cent. (off fixed charges) to consumers who were willing to have the keep-off period revised—*i.e.*, to have their time-switches reset—*every year*, and to offer, say, 80 per cent., or even 60 per cent., to those who preferred a five-yearly revision. The consumer would, of course, pay all *true* running costs as an extra, plus the £300 allowed to above, plus 50 per cent. for profit.

"There is no injustice whatever to existing consumers in the scheme I have indicated, because they will reap the benefit of the 25 to 50 per cent. 'net profit' which the new consumers bring in; and because if the restricted-hour consumers did not come on (which they won't do without sufficient inducement) the existing consumers would have to go along on existing rates, without this benefit; and, again, because additional 'interest-paying' consumers, on



the ordinary terms, would be attracted by the general increase of business done in the town, and the better terms that could be offered to ordinary consumers consequent on profit made off the "restricted-hour" consumers (0·01d. per unit would bring in £6,000 per annum of net profit). It is grossly unjust that a potential consumer who would only cost the station some £300 per annum on fixed charges, should be forced to pay £30,000 per annum just because existing consumers, who are unwilling to suffer the inconvenience of being cut off during the peak, are obliged to pay this figure.

IRON AND STEEL INSTITUTE.

The autumn meeting of the Iron and Steel Institute will be held in London on Monday, Tuesday, Wednesday, and Thursday, Sept. 27, 28, 29, 30, and Oct. 1. An influential reception committee is in process of formation, and arrangements are in progress for the entertainment of the members taking part in the meeting. On Monday, the 27th, the offices of the institute will be open for registration of names and distribution of programmes and badges. The mornings of Tuesday and Wednesday will be devoted to the reading and discussion of papers at the Institution of Civil Engineers, the council of which have kindly placed at the disposal of the members their hall of meeting, Great George-street, Westminster. The afternoons of Tuesday and Wednesday will be devoted to visits to works and to places of interest in and around the Metropolis. These visits will include the Royal Arsenal, Woolwich; the works of Messrs. Siemens Bros., Woolwich: the generating station of the London County Council at Greenwich; the works of Messrs. Fraser and Chalmers, Limited, Erith; the Lambeth Potteries of Messrs. Doulton and Co., Limited; and the motor carriage works of Messrs. Napier and Son, Limited, Acton. A visit will also be arranged to the Royal Small-Arms Factory at Enfield and to the National Physical Laboratory, Teddington. On Thursday afternoon the Lord Mayor (the Right Hon. Sir George Truscott, Bart.) and the Lady Mayoress have invited the members and their ladies to a reception at the Mansion House. The evening entertainments will consist of a theatrical performance on one night and a banquet and musical entertainment on another night. In both these functions ladies can participate. There will also be visits to the Mint, to the halls of several of the City companies, and to the places of interest in the City. On Friday, Oct. 1, it is hoped to arrange an excursion to Portsmouth, and, by permission of the Admiralty, to visit any men-of-war which may be there on that day. Negotiations are in progress with a view to securing from the various railway companies the privilege of obtaining return tickets to London at a single fare and a quarter, available from Sept. 25 to Oct. 2, to be issued at provincial centres to members on production of a voucher signed by the secretary.

BRUSSELS INTERNATIONAL EXHIBITION.

We are enabled to publish the tariff of charges for space at the international exhibition to be held next year in Brussels. These are as follows: including the use of an isolated show-case, or part of a case having more than one frontage, 6s. per square foot; including the use of a wall case, 4s.; including the use of a platform and ornamental façade without glass, 4s.; including the use of a platform only, 2s. 6d.; on wall or screen, 2s. 6d.; in the Machinery Hall, including the use of platform and hand railing where required, 2s. 6d.

For motive power the charges are unusually low. The Royal Commission will defray half the charges made for it by the Belgian administration on all machinery driven to illustrate processes of manufacture. Thus exhibitors will pay: for steam (133 lb. pressure), ½ centime per kilogramme; for gas, 1s. 3d. per 1,000 ft.; electricity (2 × 220 volts continuous), 1½d. per kilowatt-hour.

Water will be supplied free for pumps or condensers. The charge for purer water in the Machinery Hall will be 1s. 10½d. per 1,000 gallons (50 lb. pressure), and in the Industrial Hall 1s. 8d. per 1,000 gallons for domestic and 10d. for industrial purposes. Not only will there be crane power, but the laying of foundations by Belgian contractors will be superintended by a competent engineer employed by the Royal Commission. With the above particulars, the railway and shipping freights, and the contractor's tender, an exhibitor of machinery can make his calculations with a degree of confidence not hitherto possible.

The special catalogue for the British section, published in English and French, will give a free insertion of 12 lines; the general catalogue a free insertion of four shorter lines. Another provision made by the Royal Commission is that of a suite of rooms for exhibitors' agents. This is a new thing in exhibition practice. There will be a reference library and a staff of high-class interpreters attached to the establishment, and it will be furnished with all the necessary equipment for transaction of business, correspondence, and so forth.

The Belgian State Railways, charging full rates on the outward journey, will return exhibits to their termini free of charge. The British railway companies will make a reduction of 50 per cent. on returned exhibits not sold and travelling by the same route to the station from which they were sent out. Twelve shipping companies have also agreed to this 50 per cent. reduction.

It will be understood that all preparations begun so far in advance by the Exhibitions Department are part of the reform which has been described, and that a prompt response to the campaign now being carried on throughout the country is advisable in the interests of exhibitors as well as of the general scheme.

An inquest was held last week on two men who were killed in the Clifton Pit, Nottingham. It was stated that the men were working with electric coal cutters, the current being supplied by cables from the generating station at the pit mouth. The current was suddenly switched on, and the men in charge of the machine killed.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

1,194. A mining fan for ventilating the colliery workings is driven by two 160-kw. 500-volt motors directly coupled at each end of the fan shaft. Each motor was originally large enough to drive the fan by itself, but owing to the distance of the workings one motor is now insufficient to drive the fan, and the other motor has to be coupled in. Please give the method of determining the efficiency of the motors, fan, and the combined efficiency. Water-gauge to register 3 in., and the best method of making the test.—DOUBLE CROSS.

1,195. In a certain station a rotary converter combined with a transformer is used to step down from high-tension alternating current to direct current. The rotary is wound for six-phase current. Explain why a six-phase arrangement is more efficient than a three-phase one.—O. L.

ANSWERS.

Answer to No. 1,186 (awarded 7s. 6d.).—Before proceeding to reply in detail to the points raised in the query, it may be pointed out that the decision which has apparently been arrived at, not to install a flywheel storage system, is very unusual, and one the wisdom of which is open to the gravest doubts. In accordance with the well-known principles of flywheel storage sets, the use of the latter much reduces the strain on the supply generators, and though such sets may be dispensed with in cases where a very large miscellaneous load is supplied in addition to the winding plant, the percentage effect of the winding peak loads then being slight, the number of cases where such conditions exist is very limited. The maximum demand of a single winding engine may easily rise to between 1,000 h.p. and 2,000 h.p., and there are few supply systems where the effects of such a load suddenly applied are negligible. The nature of the load curve of a winding engine is shown in Fig. 1, and in a supply system dealing solely with one or two such engines these variations of demand could not be tolerated. In such a case a flywheel storage system is essential if any reasonable efficiency of working is to be attained. Without it steam winding is far preferable.

The use of storage batteries to equalise the demand on the supply mains has been suggested and attempted, but this system is, of course, only applicable if a direct-current winding motor be employed, and even then the excessive currents (1,000-2,000 amperes) required at the moderate voltages for which direct-current machines are built necessitate very cumbersome and costly secondary batteries. Not only is the capital cost of such cells exorbitant, but their repair cost and depreciation are found to be very heavy. The sudden application, stopping, and reversal of more than 1,000 amperes through the battery is found to be ruinous in its effects.

With regard to the type of motor, the three-phase induction type has here been decided on. The only practicable alternative to this is the separately excited direct-current motor, and this is considered by some authorities to be essential to successful electrical winding. Alternating current is still necessary if power has to be transmitted any considerable distance from the generator, and hence a motor-generator is required. This being installed a flywheel can be added at little extra expense. Since the latter is decided against in this case there is little doubt that the induction motor is preferable, particularly as low capital cost seems to be the main requisite. The direct-current motor system has the disadvantage of involving the capital cost and operating losses of a motor-generator set, and massive switchgear to deal with heavy direct currents at low voltages—in some cases 2,000-2,500 amperes at 400 volts has to be handled—but the very important advantage of improved speed control is obtained. By varying the field strength of the main motor or, preferably, varying the excitation, and so the volts of the generator of the converter set supplying it, a very wide range of accurate speed control can be attained. "Inching"—*i.e.*, running dead slow at 60 ft. to 120 ft. per minute for shaft inspection, etc.—is more easily obtained with direct-current than with alternating-current winding motors. Further notes on speed regulation are given later.

Another point needing discussion is the advisability of the gearing and link coupling proposed. Such a coupling between the motor and drum presents no apparent advantages, and will involve considerable frictional losses in operation—an important point since the whole economy of electric winding lies in its low running costs, an economy which is seriously discounted if undue gearing and coupling links, etc., be interposed between the motor and its work. It is far preferable to connect the motor directly to the drum, full advantage being thus taken of the higher working efficiency of the electric drive and of the uniform starting torque. If the motor be coupled through cranks and drag links, much of the disadvantage of the uneven turning moment of the steam-engine is retained.

Pulley.—The 8-ft. cylindrical drum at present installed will be quite suitable for electric driving, though in laying down a complete electric installation a large diameter Koepe pulley would usually be preferred at present.

Speed Regulation and Safety Devices.—The speed regulation of asynchronous motors must be effected by varying the total resistance of the rotor circuits. The resistance of the rotor winding being fixed once for all, speed control can only be obtained by varying the external resistance between the slip-rings. This resistance is almost invariably liquid, soda solution being generally employed. The arrangement of this starting and speed varying resistance is shown in Fig. 2. Three plates, 1, 2, and 3, are connected to the rotor slip-rings and fixed in a tank, E, through which soda solution is circulated from the reservoir, T, by the centrifugal pump, N (driven by the low-tension three-phase motor, M). The height of liquid in E, and hence the rotor resistance, and so the motor speed, is controlled by the valve, *p*, this being opened and shut by links

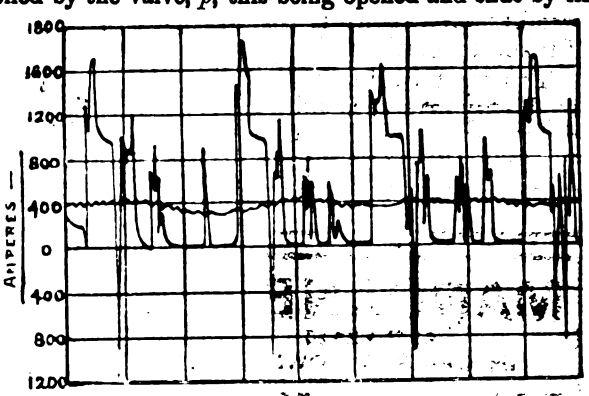

FIG. 1.

connected to the control lever, *a*. The latter first closes the switch, D, for either forward or backward running and then cuts out the resistance, E; the valve rods are coupled to *a* through slotted links, so that they are not "picked up" till D is definitely closed one way or the other. Though retardation is not to be regularly effected by frictional braking, on account of the energy loss this would involve, it must, of course, be possible to stop the whole moving system thus in the case of emergency. The normal means of retardation is the insertion of rotor resistances by means of *a* and *p*. The motor tends to slow down, but is driven at a higher speed than corresponds to the new electrical conditions by the inertia of the moving system; as a result energy is returned to the mains, and rapid and efficient retardation ensues. The mechanical brakes must be ultimately applied to hold the stationary cage unless some "prop" system be employed (as is usual). The safety devices provided must cover the following contingencies: (*a*) in case of overwinding the main motor switch must be opened, and the compressed-air or steam brake automatically applied; (*b*) excessive winding speed must be made impossible, or else made to operate the brakes directly it occurs; (*c*) should the current supply be interrupted an electromagnetic release must apply the brakes and open the main circuit; (*d*) the failure of the compressed-air or steam supply must be safeguarded against by the use of a weight-operated brake, *c* (Fig. 2).

These emergencies are placed in the probable order of their frequency of occurrence. (*a*) Overwinding may be guarded against by a depth indicator, G (Fig. 2). This is shown belt driven from the winding shaft, but a gear drive is usually employed to ensure reliability. Should the lever,

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a, not be moved to "stop" soon enough, G will, at the end of its travel, operate the release trigger, C, by the rods, *g*, *h*, *i*, *k*. Any operation of the release lever, *e*, however effected, must be accompanied by the automatic opening of the switch, F, cutting off the power supply from the main motor, A. (*b*) Excessive winding speed is usually prevented by cams on the shaft of G, so arranged that *a* cannot be moved too quickly, but can be moved as slowly as may be desired. The cams must compel instantaneous operation of the braking gear at each end of the wind. (*c*) Failure of the current supply demagnetises H (Fig. 2), and so releases W, which at once opens the switch, F, and applies the brake lever, C, by the linkwork shown. (*d*) The brake blocks are usually applied by the brake cylinder, B (lever *b*), being air or steam operated (with air there are no condensation losses, but an air-compressor has to be installed if not already existent). Should the air or steam supply fail, C can be released by the foot lever, *c*. All contingencies are thus thoroughly guarded against, and the plant can be stopped in any emergency without risk of damage to the winding motor. Retardation may be practically completed electrically before the application of the mechanical brakes. The arrangement of the motor volt and ampere meters so as to be always visible to the driver is as shown. O O′ are high-tension and low-tension fuses respectively; P, L, R forms the fuse, transformer, and switchgear for the pump motor, M

Sufficient data are not given to enable the estimation of the horse power of motor required, and so on, and apparently these points have already been settled by "R G. M." In determining the winding-engine horse-power, strength of rope and winding drum, accelerating power required, and

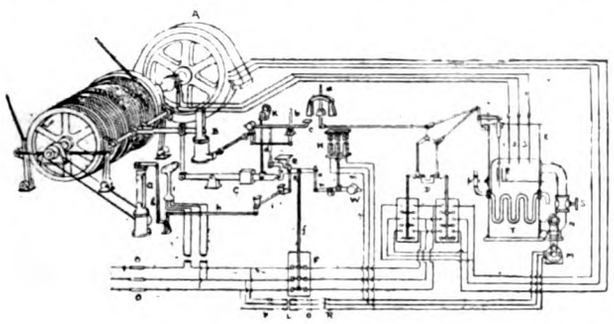

FIG. 2.

so on, there must always be considered the inertia of the cage and its load, the momentum of the winding gear, the varying weights, the balanced and unbalanced loads, the static and dynamic rope stresses, shaft friction, and accelerating and retarding forces. For depths up to 3,000 ft. or 4,000 ft. the rope pull may equal twice the dead load; for greater depths a higher factor of safety is required. As being of use for comparative purposes, the following particulars of an installation at the Preussen II. pits, Dortmund, may be cited: A slip-ring induction motor is used without flywheel storage, as here suggested; the motor is direct coupled to a 19 ft. 8 in. Koepe pulley, and is operated from 2,000-volt three-phase mains; 300 volts is induced in the rotor. Two compressed-air brake slippers are fitted, and bear one on each flank edge of the pulley rim. The rope used is stranded steel 1·77 in. diameter. The total load, including men, tubs, cage, and rope, is 12 tons 6 cwt. Winding cycle, 78 seconds (45 winds per hour), being made up of 16 seconds acceleration, 27 seconds full speed, 18 seconds retardation, 17 seconds decking. Full speed = 3,120 ft. per minute when winding coal; 100 tons wound per hour from 765 yards depth. Power demand, 650 h.p. during full-speed run, 1,380 h.p. during maximum acceleration period.

In conclusion, a brief review may be given of the advantages and economies likely to accrue from the substitution of electric for steam winding. Dogmatic assertions on this point are impossible—everything depends on local conditions; but the general statements below are justified, and the figures quoted are authenticated in the particular cases to which they apply. The over-all efficiency of an electric winding plant may be 50 to 60 per cent., whereas that for steam winding seldom exceeds 20 to 30 per cent., hence, though the capital cost of the complete electric plant (assuming it to be laid down solely for winding, which is very unlikely, since electric haulage underground is very efficient and economical, and is even more widely practised than electric winding) is about four times that of the corresponding steam plant, yet the 50 per cent. saving in boiler equipment and the one-half or one-third working costs more than repay the interest on the increased capital outlay. It must be pointed out that it is not a serious matter if the cost of winding per ton of coal or ore is slightly increased by the use of electric drive. The capital sunk in a mine is so great that *rapid* output is essential, and slightly increased cost per ton wound is of secondary importance if the output per shaft be thereby increased. Electric winders have been shown to operate with steam consumptions at their engines of 26 lb. per shaft horse-power hour, whereas steam winding engines require 50 lb. to 100 lb. per horse-power hour (30 lb. per horse-power hour being phenomenally low in such cases).

Again, the even torque of electric motors, particularly on starting, as compared with steam winding engines, in which, as a rule, only one cylinder is operative on starting—owing to inconvenient crank and valve positions on the second cylinder—is invaluable. The jerky action of steam-engines on starting is not greatly minimised by the inertia of the drum, etc., till the latter attains a fair speed. The ropes used in electric winding may, owing to this steadier action, have a lower factor of safety than would be permissible with steam winding. The use of a rope with a factor of safety of 6 and electric drive enables single-stage winding from depths which would otherwise need double-stage operation. Owing to the inconvenience and cost of two-stage winding, this advantage alone is decisive in many cases. Direct coupling of the motor to the winding drum obviates many of the balancing difficulties so common with steam plant, while the lighter construction of all moving parts, owing to the less strains and less necessity for inertia, enables more rapid acceleration and involves less power expenditure. Where flywheel storage sets are not employed the fluctuations of demand on the supply station may be efficiently reduced by increasing the inertia of the moving system coupled to the motor, and, by sacrificing a certain degree of efficiency, by increasing the motor slip for a given load (by increasing the rotor resistance). These methods should be combined to a certain extent.

With electric winding regenerative braking is possible, whereas none but wasteful frictional braking is applicable to steam drive. The friction loss with electric winding is less than with steam operation, particularly on starting, when the "suction" horse-power of a steam set may be 20 per cent. of the full-load horse-power. The windage loss of the storage flywheel would be avoided in the present case, and, in any case, may be much reduced by enclosing the wheel. Whereas steam winding is strictly limited by the possibilities of engine design, electric winding is, as yet, limited only by the rope strength conveniently obtainable and by the concentration of a sufficient supply of cheap electrical energy at the pit head. The life of a steam winding set is 30 to 40 years, but obsolescence, rather than depreciation, would suggest that 20 years should be taken as the life of an electric plant when allowing depreciation and redemption grants. If this exceeds the probable "life" of the mine, the latter period should be assumed as the life of the whole plant. Electric motors have a superior overload capacity to steam-engines, so that a less powerful motor will deal with a given maximum load than would be required were steam-engines installed. It is frequently argued that a flywheel storage system, having to run throughout the shift, loses by its "light" losses what it saves during winding periods. This assumption is erroneous. The condensation losses in a steam plant are very high, as much as five tons of coal being required to keep the jackets of the winding engine hot for 24 hours in a certain Welsh colliery.

The data of Table I. are self-explanatory and emphasise the economy of electric power for use in mining:

TABLE I.—Cost of Steam and Electric Power.*

P. C. Greaves: Weekly cost £15. 6s. 3d., including capital charges—0·83d. per unit. Weekly cost £9. 8s. 5d., excluding capital charges, coal 3s. 6d. per ton—0·51d. per unit.

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A. J. Tonge, Silesian Colliery: 10-hour day—steam 0·50d., electric 0·33d. per brake horse-power hour.
J. F. Lee: Three-phase plant, coal 4s. per ton—0·365d. per brake horse-power hour.
M. H. Habershon: Coal 6s. 8d. per ton, steam generation—0·418 l. per brake horse-power hour; anthracite 25s. per ton, suction gas generation—0·350d. per brake horse-power hour; 3,000 hours per year. A Westphalian company paid ⅜d. per unit and collected it from the collieries.
Isaac Hodges, Whitwood Collieries: Haighmoor smudge, 3s. 6d. per ton; interest, 4 per cent.; depreciation, 5 per cent.; steam power—0·31d. per brake horse-power hour.
R. Holiday: Cost, including repairs, etc., 0·75d. per unit.
J. Gill, Normanton: Coal, 3s. 5d. per ton; from five years' running actual working cost—0·26d. per unit; or, including capital charges—0·49d. per unit.
W. B. Shaw, Hulton: Interest, 5 per cent.; depreciation, 10 per cent; coal, 5s. 6d. per ton—1904, 0·568d. per unit; 1905, 0·579d.; 1906, 0·425d.

* *Proceedings*, Institution of Civil Engineers, Preece, 1907.

—WREN.

Question No. 1,187.—What size of water-softening apparatus is most suitable in the case of a battery of five Lancashire boilers, 28 ft. by 7 ft. 6 in., three of which will be constantly working on maximum (winter) loading, say between 500 kw. and 600 kw.? State disinterestedly, considering all circumstances, whether the apparatus will pay for itself in a plant of the above capacity, at present using canal water (small annual charge) chemically treated in feed tank.

Answer to No. 1,187 (awarded 10s.).—From the wording of the query it would appear that a rough water-softening plant is already installed, and the point at issue is the advisability of replacing the present rough process by an automatic softening plant. The first

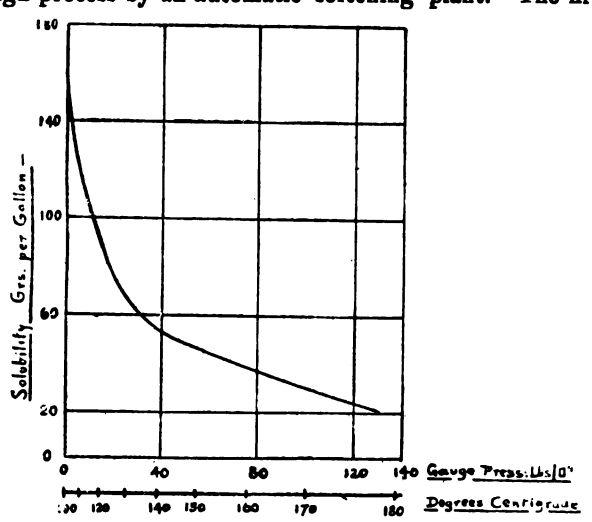

FIG. 1.

point to be considered is the amount of water dealt with per annum. Though "Economist" probably possesses more or less accurate information regarding this quantity no indication is given thereof in the query, and, as the nature of the load is not stated, considerable assumptions must be made. The load apparently includes a considerable proportion of lighting or heating duty, since the winter load is discriminated from the summer load, whereas in a purely power supply little difference would exist between these demands. It is assumed, therefore, that during the six winter months the demand on the boilers, allowing for auxiliaries, "banking" periods, etc., is equivalent to a continuous load of 90 per cent. of a maximum load of 550 kw. for 12 hours daily. This load $= \left(\frac{365}{2} \times 12 \times 0{\cdot}9 \times 550 \times \frac{4}{3}\right)$ $= 1{\cdot}45 \times 10^6$ horse-power hours. During the summer months half this load is assumed, though this figure must, of course, depend on the nature of the load, and hence the value $0\,725 \times 10^6$ horse-power hours is attained, making a total annual load on three boilers of $2{\cdot}176 \times 10^6$ horse power hours. It may be fairly assumed that the two spare boilers will be worked to one-third the extent to which the remaining three are employed, hence the load on the two spare boilers $= \frac{2}{3} \times \frac{1}{3} \times 2{\cdot}175 \times 10^6 = 0{\cdot}483 \times 10^6$ horse-power hours per annum. The total output of the whole battery on the above assumptions must supply a demand of $2{\cdot}658 \times 10^6$ horse-power hours. The next stage in the estimate depends on what class of engine is employed. Using steam-turbines of 500 to 600 kw. capacity, the steam consumption varies from 22 lb. to 27 lb. per kilowatt-hour = 16 lb. to 20 lb. per horse-power hour, but to cover all condensation losses, and to allow for the possible use of less efficient prime movers and to supply the steam consumption of auxiliaries, it is not safe to assume less than 30 lb. per horse-power hour in this case. On this basis the total water to be evaporated per year amounts to $79\,74 \times 10^6$ lb.—*i.e.*, $7\,974 \times 10^6$ gallons per year.

To determine (*a*) the deleterious effects probable if the water be used without softening and (*b*) the cost of softening the water, it is necessary to have a representative analysis of the water used. Though this differs in various cases, a fairly representative analysis of canal water is given in Table I., from which the equivalent degrees of hardness, reduced to calcium carbonate as a common basis, can be determined by aid of Table II.

TABLE I.—Analysis of Canal Water.

Constituent.	Grains per gallon.	Degs. of hardness (Clarke).
Calcium carbonate	10·99	15·20
Magnesium ,,	2·76	4·49
Calcium sulphate	2·99	3·06
Magnesium ,,	12·41	14·20
Sodium ,,	18·96	18·60
,, nitrate	nil	—
,, chloride	5·28	6·30
Silica	0·31	—
Total	53·70	—
Total CaO	7·39	—
Total MgO	5·48	—
Actual hardness calculated to $CaCo_3$	29·22	—

TABLE II.—Quantities produce 1 per cent. of hardness (Clarke scale).

Material.	Grains per gall.	Material.	Grains per gall.
Lime (CaO)	0·399	$MgCl_2$	0·630
$CaCl_2$	0·798	$MgCO_3$	0·616
$CaCO_3$	0·721	$MgSO_4$	0·875
$CaSO_4$	0·980	NaCl	0·840
MgO	0·249	$NaSO_4$	1·02

The second column of Table I. shows the degree of hardness due to each hardening constituent (see Table II.), but the total hardness is not the arithmetical sum of these figures, since 1·36 grains of sulphates can be "softened" simultaneously with one grain of carbonates by the amount of material required for the carbonates alone: nothing extra has to be added for this quantity of sulphates. The equivalent CaO and MgO in the water is shown in Table I., and the material to be separated, reduced to equivalent $CaCO_3$, are (Table II.):

$$7{\cdot}39 \text{ grains CaO} = 7{\cdot}39 \times \frac{{\cdot}721}{{\cdot}399} = 13{\cdot}36 \text{ grains } CaCO_3.$$

$$5{\cdot}48 \text{ grains MgO} = 5{\cdot}48 \times \frac{{\cdot}721}{{\cdot}249} = 15\,86 \text{ grains } CaOC_3.$$

$= 29{\cdot}22$ total.

i.e., the equivalent hardness of the water is 29·22 deg. Clarke (whence the "measures" of standard soap solution required to produce a lather will be about 50: a "measure" being 10 grains and the weight of water operated on being 1,000 grains). Water is usually considered "hard' if it contains more than seven grains of dissolved mineral matter per gallon, but this amount should be reduced to five grains per gallon before the water is used in the boiler. Most softening processes reduce the amount to two to three grains per gallon, the smaller this amount the better the plant, always providing the high degree of purification is not obtained at unduly increased cost. The importance of sulphates from the "scaling" point of view depends largely on the boiler pressure: thus the solubility of calcium sulphate varies with temperatures, as in Fig. 1.

The total solid matter in the canal water analysed above = 53·7 grains per gallon, and the maximum rate of evaporation per boiler being $\frac{30 \times {\cdot}9 \times 550 \times 4}{3 \times 10 \times 3} \times 84 = 55{,}300$ gallons per week, the weight of solids precipitated per week = 424 lb. per boiler—*i.e.*, 60 lb. per day. If allowed to accumulate this would produce a scale 0 09 in. thick in a week, or 0 36 in. in a month (assuming the scale to be uniform over the whole lower half of the boiler surface—actually it would be thicker on the flue tops and at the bottom of the boiler and thinner elsewhere). This scale would increase the fuel consumption necessary 8 per cent. in a week, or 80 per cent. in a month (see Fig. 2), which, assuming a coal consumption of 1 lb. per 8 lb. water evaporated, results in

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an increase of $\frac{8}{100} \times \frac{550,000}{8} = 5,500$ lb. of coal per week (scaling being done weekly). Hence, as exemplified later, the increased cost of fuel and labour for boiler cleaning, not to mention boiler deterioration and heat wasted by the continual blowing off and shutting down, and the general inconvenience involved, would make feed purification of some description essential. If the water be not softened, "blowing off" will have to be practised to an extravagant extent. This will to a certain extent reduce the above incrustation losses, but is itself a costly remedy. In boilers of the present size at least 500 cubic feet water would be "blown off" daily, which would require the consumption of about half a ton of coal per day above that required were blowing off not necessary.

The usual allowance of softening materials for boiler feed purification is 1 lb. lime for every 8·4 deg. Clarke, and 1 lb. sodium carbonate for every 1·3 deg. Clarke. Hence in this case, per 1,000 gallons of water, there is required in an automatic softening plant about 3·48 lb. and 4·63 lb. of lime and carbonate respectively, which at £1 and £4 per ton respectively totals 2 364d. per 1,000 gallons treated. This estimate, being on the high side, may be taken to cover the very slight labour costs attributable to automatic systems. If simple tank softening be employed, the cost

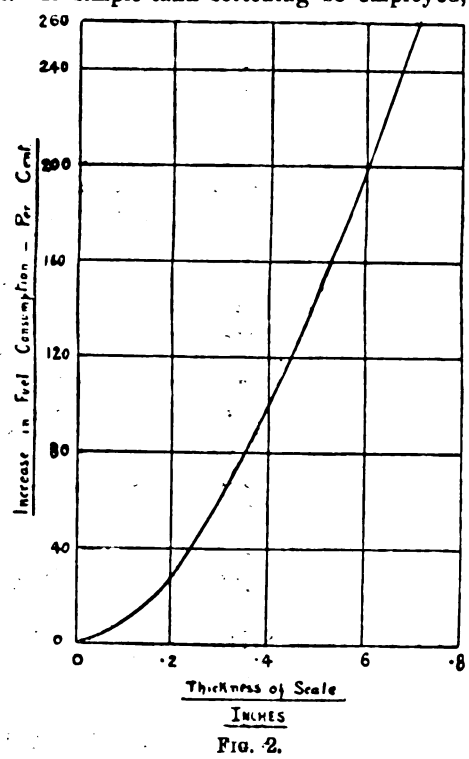

Fig. 2.

for chemicals will be higher than the above. The above figure is not absolute, depending as it does on the water analysis. Even for such an analysis as the present one some makers claim results about half as costly, but, however that may be, the relative charges here made are correct. The higher cost for chemicals in the simple tank is mainly due to less efficient use of a given weight of reagents. Imperfect mixing results in considerable waste of unused materials. For these reasons and on the present basis 3·5d. per 1,000 gallons would not be an excessive chemical charge for the simpler apparatus. The labour involved for stirring, cleaning, etc, would be at least three hours a day, against one hour per diem for setting the automatic plant in operation. This labour is reckoned at 8d. per hour in Table III. It will, no doubt, have been already remarked that the assumptions regarding water evaporation involve very heavy working of the boilers, but this is immaterial for the purposes of the present comparison. The same quantity is assumed throughout, and the softening plant cannot safely be of less capacity than that taken here.

The following notes justify the figures of Table III, which summarises the results of the above considerations.

Case 1.—Non-Softened Feed.—As the result of various practical data, it appears that the cost of scaling the present battery of boilers running with non-softened feed will total £200 per year at least. The fuel waste by scale formation has been shown = 5,500 lb. per boiler per week during the winter, and three-quarters of this figure may be assumed for three boilers all the year round, and one-third the resulting allowance for the two spares. The total fuel loss on this score then $= \frac{5,500}{2,240}(\frac{3}{4} = 3 + \frac{1}{3} \times 2)\ 52 = 373$ tons per annum, which at 14s. per ton = £261. The loss by "blowing off" = half a ton of coal per day for each of three boilers during the winter, and on the above assumptions totals $[\frac{1}{2}(\frac{3}{4} \times 3 + \frac{1}{3} \times 2)\ 300] = 437$ tons = £306 per annum. Assuming a capital cost for the boiler battery of £4,000 and taking the increased depreciation to be allowed in consequence of the pitting and overheating due to scale formation as at least 1¼ per cent. this charge amounts to £50 per year. Total cost per annum £817, due to non-softened feed only.

Case 2.—Tank Softened Feed.—Treating $7{\cdot}974 \times 10^6$ gallons per year at 3½d. per 1,000 gallons as above, the total charge for chemicals amounts to £116 per annum, while $£\frac{365 \times 3 \times 8}{240}$ = £36 10s. covers the operating labour charges. The repair charges, general handling and storing of material and incidental inconvenience, etc, of this method of working may fairly be debited with £50 per annum. The total cost of water treatment by this method then = £202. 10s. per annum.

Case 3.—Automatic Plant.—The capital cost of an automatic plant capable of dealing with the present demand would be about £500, and allowing 5 per cent. interest and 5 per cent. depreciation, the capital charges total £50 per annum. The charge for chemicals and labour has been estimated at 2 364d. per 1,000 gallons, which totals £78 10s. per year. Repairs are very low, and a continuous allowance of 2 per cent. on the capital cost should amply cover them for many years (= £10 per year). Total cost of "automatic" treatment, £138. 10s. per annum.

Table III.—Annual Costs Attributable to Mineral Matter in Feed Water.

I. Non-softened.			
Scaling	£200	0	0
Fuel loss by scale	261	0	0
,, blowing off	306	0	0
Increased depreciation	50	0	0
Total	£817	0	0
II. Simple tank, softened.			
Chemicals	116	0	0
Labour	36	10	0
Incidental	50	0	0
Total	£202	10	0
III. Automatic plant.			
Chemicals and labour	78	10	0
Capital charges	50	0	0
Repairs, etc.	10	0	0
Total	£138	10	0

Conclusions.—From the summarised results of Table III. there can be no doubt as to the economy of water softening over running with untreated feed, but the economic advantage of installing an automatic plant apparently rests on the exact values taken by "general" charges and costs depending purely on local circumstances. Under the conditions assumed there is a substantial advantage in installing an automatic softener, the saving over tank treatment being £64 per year—*i.e.*, 31½ per cent. on the probable present cost of treatment. The saving effected by installing an automatic plant where softening has not previously been practised is about £650 per annum—*i.e.*, 130 per cent. on the capital cost of the automatic plant—while the saving over the simple tank process here equals 12·8 per cent. on the capital cost of the new apparatus. From this, and from the general advantages resulting from the installation of an automatic plant, it may fairly be concluded that *the latter is fully justified in the present case.*

General Advantages of Automatic over Hand Operated Softening Plants.—(1) Less labour costs; (2) greater accuracy and permanence of accuracy of chemical treatment; (3) thorough mixture of reagents with water, ensuring complete and uniform treatment of water and full use of reagents; (4) accelerated chemical action; (5) rapid sedimentation and perfect clarification.—L. C.

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CONTENTS.

Cable Rates	1, 17	Institution of Mining Electrical Engineers	16
Steam-Turbines	2	Researches on the Relative Rates of Migration of Ions in Aqueous Solutions	16
The Electrical Equipment of Birmingham University	2	The Electrical Engineers (Territorial Force)	17
Incorporated Municipal Electrical Association	4	Personal	17
Steam-Turbines, from the Users' Point of View	5	Wind Turbines for Generating Electricity	17
A Method of Compounding Alternators by Means of Condensers	7	West Ham Corporation Tramways	17
Modern Cable Systems	8	Electrical Enterprise in Turkey	17
An Improved Form of High-Tension Insulator	9	Companies' Meetings and Reports	18
A Novel Telephone Receiver	10	New Companies Registered	19
Fittings for Holophane Glass	11	Liens Registered, etc.	19
Canvassing Notes	12	Lighting Notes	20
The Influence of Metallic-Filament Lamps on the Electrical Industry and on Street-Lighting	12	Traction Notes	21
Cheap Units	13	Forthcoming Events	21
Technical Problems, with Solutions by Practical Men	13A	Appointments Vacant	21
Iron and Steel Institute	14	Contracts for Electrical Supplies	22
Brussels International Exhibition	14	Provisional Patents, 1909	25
Annual Report of the Incorporated Municipal Electrical Association	15	Specifications Accepted	26
		Companies' Stock and Share List	26
		Traffic Returns	28

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

ANNUAL REPORT OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The annual report of the council for the year from July, 1908, to July, 1909, presented at the meeting last Friday morning, states that the membership of the association now stood at 390, made up as follows: committees (members), 167; chief electrical engineers (members), 176; honorary members, 3; chief assistants (associate members), 8; assistants (associates), 36. Mr. J. F. C. Snell, a past-president, has accepted honorary membership of the association. A sub-committee, consisting of Messrs. J. Christie, H. Faraday Proctor, J. E. Edgcome, G. Wilkinson, and A. C. Cramb, was appointed to inquire further into the question of economic wiring. The committee reports having circularised all the members of the association with a view to gauging their general opinion on the subject. The replies received were unanimously in favour of doing everything possible to bring about a set of satisfactory regulations which would allow of installation work, where the conditions were suitable, being carried out in a less costly manner than under the present methods of casing or conduits. An interview was arranged with a special sub-committee of the Cablemakers' Association. The matter was discussed at great length, chiefly from the point of view as to what class of cable would be most suitable. The Cablemakers' Association has promised at an early date to go most fully into the whole matter with its members, and, if possible, draft a specification for a suitable standard class of material and fittings which, whilst being moderate in first cost, will comply with all reasonable restrictions which would tend to safety and durability.

The Electric Lighting Acts (Amendment) Bill as promoted contains some suggestions made to the Board of Trade by the association at interviews which the Board of Trade granted, those especially noteworthy being: Clause 5 (now Clause 6), enabling the Board of Trade to authorise undertakers to supply premises outside their area of supply under certain conditions. Clause 15 (now Clause 16) gives power to local authorities to provide and hire out fittings, etc. In consequence of the amendment to the clause proposed by Lord Avebury, and passed by the House of Lords, a circular letter was issued to members of Parliament, as well as to the whole of the members of the association, asking that they should use their influence to get the clause passed in the form in which it was drafted, so that local authorities might be left with a free hand and not be compelled to have such works carried out by contractors, who, it was feared, might form a ring and thus increase prices. The circular also advocated the insertion of a new clause as follows: "Where in any area a local authority, company, or person is authorised to supply electricity under Act of Parliament or under licence or provisional order granted under the Electric Lighting Acts, it shall not, after the passing of this Act, be lawful without the consent of such local authority, company, or person for any other local authority, company, or person to supply, distribute, or transmit electricity within the same area unless such supply, distribution, or transmission is authorised by Act of Parliament, or by licence or provisional order granted in terms of the Electric Lighting Acts." As it was felt desirable that the Bill should be passed this session, it was decided not to oppose on the second reading in the House of Commons, but get it referred to a committee, when the various points could be more conveniently discussed than in the House.

The council has been engaged in conjunction with the Municipal Tramways Association in considering the action which is being taken by the Institute of Municipal Treasurers and Accountants (Incorporated) and a Departmental Committee in relation to the accounts of local authorities. The Municipal Tramways Association is taking the lead in this matter, but the council of the Incorporated Municipal Electrical Association is actively co-operating with them. Most serious attention is directed to the proposals which are being made, and which strike at the existing arrangements for the management and carrying out of all municipal work, but more especially affect the trading departments, whether electrical or otherwise. A *résumé* of the draft regulations have already appeared in these columns. Commenting upon the same, the report states: "These regulations have apparently been drawn up without consultation with the heads of any municipal trading departments, and an attempt is being made by the Institute of Municipal Treasurers and Accountants to get them approved and adopted, or recommended by the Local Government Board. If the matter is allowed to go through on the proposed lines, the control of every department, whether trading or non-trading, will centre in the Finance Committee and the financial comptroller, who will over-ride the powers now exercised by the other committees and chief officers of the various departments. Having regard to these draft regulations as put forward by representatives of the Institute of Municipal Treasurers and Accountants, and also to the report of the Departmental Committee, which tends in the direction of taking away the accountancy and stores work of all trading departments from such trading departments, and putting it under the control of a central accountant, it is evident that some accountants at any rate are endeavouring to get supreme control of all work carried out by local authorities. Needless to say, this would be most disastrous, more especially to all the great trading departments carried on by municipalities, such as docks, water, tramways, electricity supply, gas undertakers, etc., where it is essential that for the proper and economical working of the department the same should be self-contained and each under one head. The Departmental Committee issued its report after receiving evidence from 28 witnesses, including a few Government officers, the remainder being almost entirely accountants and auditors; the witnesses did not include a single engineer manager of any trading department. It is, therefore, imperative that pressure should be brought to bear, so that this matter may not be settled until such representatives of the municipal trading departments have had an opportunity of expressing their opinions and the same have been fully considered. It has been suggested that the proposals are too obviously unworkable and ridiculous to be worthy of serious attention. Since, however, the Departmental Committee has considered a section of the scheme after hearing one side of the question only, it is imperative that the matter be at once taken in hand. That the Municipal Treasurers' Committee can solemnly put forward the above and other similar proposals is in itself sufficient evidence of its ignorance of the requirements of departments which have to trade and compete with other traders, whilst even in non-trading departments the adoption of the same would result in most serious delays and the loss of interest to the various committees and chief officers—indeed, it is inconceivable that any strong committee or body of officers could be found to work harmoniously under such conditions."

The council has had its attention drawn to the fact that the Institute of Municipal Treasurers and Accountants has approached the Chief Inspector of Taxes and the Board of Inland Revenue with a view to getting standard rates of allowances for wear and tear. It feels that in questions of wear and tear of machinery and other works the technical managers should be consulted, and it has, therefore, taken up the matter with the above-named institution, which, however, in this matter also has apparently endeavoured to evade co-operation, although the matters dealt with are essentially questions

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involving engineering experience. Mr. H. Faraday Proctor, the hon. secretary, had an interview with the superintendent inspector of taxes, Mr. E. S. London, at Somerset House, and he stated that the matter had gone too far to be reopened. With this the council do not agree, and they point out that it is incumbent on every municipality to appeal against the proposals as at present drafted, and where possible to withhold the payment of income tax until the matter is arranged upon a satisfactory basis. The following are some extracts from the agreed terms to which exception are taken: Cables.—"In addition to repairs, allowance for depreciation shall be granted at the rate of 3 per cent. per annum *on the written down value.*" Plant and machinery.—"On all other plant, exclusive of loose tools, meters, and office furniture, depreciation shall be allowed at the rate of 5 per cent. per annum *on the written down value*, in addition to the cost of repairs." Conduits, meters, loose tools, and office furniture.—"No allowance shall be made for depreciation, but annual expenditure on repairs *and renewals* shall be charged as working expenses as and when incurred." The council at its meeting held on May 26 resolved: "That, having considered the proposed allowances for depreciation for the purposes of income tax as set forth in the draft handed to the hon. secretary, Mr. H. Faraday Proctor, by the superintending inspector of taxes, Mr. E. S. London, on May 25, 1909, the same are considered inadequate and should not be accepted by local authorities; that, in arranging allowances for depreciation for the purpose of income tax full, regard should be given to the periods allowed by the Local Government Board for the repayment of loans in respect of similar assets."

TABLE A.

Item.	Local Government Board allowances.			Inland Revenue and Treasurers' agreed terms.	
	Period of loan. Years.	Percentage per annum on original sum.	Percentage per annum on written down value.	Percentage per annum on written down value.	Equivalent life. Years.
Buildings	30	3	7	Not mentioned.	
Cables (laid solid)	25	3½	9	No allowance for conduits until renewed.	
Switchboards	25	3½	9	5	45
Dynamos	20	4½	11	5	45
Steam generators	17	5½	12½	5	45
Engines, Motor transformers, Instruments	15	6	14	5	45
Cables (in ground)	15	6	14	3	75
Lamp pillars, etc.	10	9	21	—	—
Receivers piping	10	9	21	5	45
Accumulators	7	13	28	5	45
Arc lamps	5	18	37	5	45

Table A shows the periods usually allowed by the Local Government Board—the corresponding annual depreciation allowance first as a percentage of the principal sum and second as a percentage of the written down value and the percentage of the written down value and equivalent period as agreed by the Municipal Treasurers' Association. The figures indicate the allowances or periods required to reduce to 10 per cent. of the original sum approximately. The table shows that the two Government departments go to extremes, the one department allowing for the life of a cable being five times as great as that allowed by the other department; the extremes in each case operating to the disadvantage of the municipalities of course. The same inconsistency is noticeable throughout. The Board of Inland Revenue, with the concurrence of the Institute of Municipal Treasurers and Accountants, allow for the life of switchboards being twice as great, machinery generally three times, and arc lamps nine times that allowed by the Local Government Board.

The report concludes with a reference to the draft regulations for the generation, transformation, distribution, and use of electrical energy under the Factory and Workshop Act, and a *résumé* of the honorary treasurer's statement, which this year shows a surplus of £42. 4s. 9d. and a total surplus of £391. 8s. 10d., of which £269. 6s. 1d. is on deposit, as compared with last year's amounts of £39. 4s. 10d., £349. 4s. 1d., and £266. 4s. 3d. respectively.

INSTITUTION OF MINING ELECTRICAL ENGINEERS.

The formation of a branch of the new institution is projected in Scotland, and a meeting for this purpose will take place on Saturday, July 3, at 7 p.m., at the offices of the Institution of Engineers and Shipbuilders in Scotland, Elmbank-street, Glasgow, when local officers will be proposed and elected for the Scottish districts.

RESEARCHES ON THE RELATIVE RATES OF MIGRATION OF IONS IN AQUEOUS SOLUTION.*

BY ROBERT BECKETT DENISON, D.SC., PH.D.

Following up his investigations regarding the measurement of transport numbers and ionic velocities, the author deals in the present paper with the transport numbers of the halide salts of the alkali metals and alkaline earths determined by the direct method in moderately dilute solution. It is a somewhat curious fact that there are but very few transport numbers published for bromides and iodides, although almost every worker in this branch of science has investigated chlorides, presumably on account of the ease with which chlorides are estimated. Yet the quantitative determination of bromides and iodides is just as easy as that of chlorides. The neglect of bromides and iodides may be due to the difficulties encountered with them by Hittorf. The earlier transport number determinations resulted in the same number being assigned to chloride, bromide, and iodide of potassium, and afterwards it seems to have been very often taken as correct that the chlorine, bromine, and iodine ions have the same mobility. Subsequently Kohlrausch and Maltby from a very exact study of the electrical conductivity of the halide salts of monovalent metals showed that at infinite dilution the order of decreasing mobility is bromine, iodine, chlorine, the latter ion thus wandering most slowly. The same order was found by Denison and Steele in 0·1 and 0·02 normal solutions by direct transport number determination. The present paper is really a continuation of this work.

Since the object of the research was the determination of transport numbers and not the accurate measurement of ionic mobilities, there is no claim made for any great degree of accuracy of the figures for the mobilities, although the majority of the transport numbers should not have an error of more than ½ per cent. In some cases the accuracy is greater than this. The figures for the mobilities are given because they form a good check upon the transport number determinations. If the experiment has been a normal one, the molecular conductivity (μ) of the solution can be easily calculated from the experimentally determined mobilities, since

$$\mu = 96{,}500\,[U + V].$$

But the molecular conductivity is the specific conductivity divided by the concentration, both of which are measured for the solution in question. Hence in a normal experiment the molecular conductivity of the solution as determined from specific conductivity and concentration, should agree with the value calculated from U and V. If from any cause whatever the experiment has not proceeded normally, this agreement between calculated and measured molecular conductivity will be wanting. Further, if one boundary, say that between the anions, is moving normally, but at the cation margin some disturbance has taken place, thus rendering the observed value of the transport number incorrect, this error will be perceived when the calculated and measured values for the molecular conductivity are compared, because there will now be a much greater difference than usual between the two. Moreover, in any three similar salts of the same concentration containing a common ion, say the chlorides of barium, strontium, and calcium, or the chloride, bromide, and iodide of potassium, we have no reason to suppose that the mobility of the common ion is not very much the same in the three cases. If, however, any error has been made in the transport number determination—that is, an error of much greater magnitude than the average experimental error (and this can easily happen if the experiment be not carefully performed)—then the fact that one or both boundaries have been moving abnormally will be rendered evident by the want of agreement between observed and calculated molecular conductivity. Also the very calculation of the mobilities generally shows in a faulty experiment at which boundary the disturbing element is operating.

Since these experiments were performed there has appeared a very interesting paper by Washburn, who finds that in fairly concentrated solutions the degree of hydration of ions can be calculated from a knowledge of the transport numbers determined by both direct and indirect method, the former giving the true transport number of the hydrated ion, whereas the latter method gives false results owing to the transported water affecting the concentration round the electrodes. In view of this it seems desirable that as many determinations as possible should be carried out by both methods.

* Abstract of a paper read before the Faraday Society, June 29.

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CABLE RATES.

Deputation to the Prime Minister.

A deputation appointed by the International Press Conference, consisting of members of the standing committee appointed in connection with the effort to cheapen and promote the facilities of electric communication between the different parts of the Empire, waited upon the Prime Minister on Monday afternoon to lay before him the views of the conference on the subject. Replying to the deputation, Mr. Asquith said that towards the general object of the deputation—the reduction of cable rates, and especially of the rates for Press messages—the attitude of the Government was entirely sympathetic, as was proved by the fact that the Pacific Cable had, with the full concurrence of the Government, reduced its rates for Press messages by one half. As regards Atlantic cable rates, if no definite arrangement had yet been arrived at, it was not the fault of the Government. He hoped the matter might be regarded as still open. The influence of the Government would be used toward the reduction of rates, but they must recognise that the cable companies had provided a world-wide system of enormous value, and that they were commercial companies. He was glad that the conference had left the Government an absolutely free hand in regard to methods, because the development of wireless telegraphy was a matter they could not leave out of sight. He said that in the view of the Government wireless telegraphy ought to be taken into account in considering the question of communication as a very important factor, and especially in connection with the discussion of the question of laying fresh State-owned cables, and it had also to be borne in mind that the progress of invention in other ways might considerably alter the carrying capacity of cables, and so somewhat change the position.

THE ELECTRICAL ENGINEERS (TERRITORIAL FORCE).

Fifteen members of the corps competed at the Stadium, Shepherd's Bush, on June 26 for the Territorial Force championships, and eight of them succeeded in reaching the finals of six events, winning no less than nine prizes, and just missed winning the £200 challenge trophy for best aggregate by the bare margin of one point, beating the London Scottish by one point. The following is the prize list: (all the events were championships): High jump — Sapper G. C. R. Stewart, D Company, second prize. Quarter-mile cycling—Sapper W. E. Cox, B Company, third prize; Second Corporal J. Roden, A Company, sixth prize. Five-mile cycling—Sapper W. E. Cox, B Company, third prize; Sapper A. E. Argent, C Company, fifth prize. 120 yards hurdles—Corporal F. G. Engholm, D Company, fourth prize. 110 yards swimming—Sapper A. J. Monk, C Company, third prize; Sapper A. R. Fraser, A Company, sixth prize. 440 yards swimming—Sapper A. J. C. Williams, D Company, third prize.

PERSONAL.

The Leek Urban District Council have decided to increase the salary of Mr. R. M. Carr, electrical engineer, from £175 to £200 per annum.

The Tramways Committee of the Aberdeen Town Council have unanimously decided to recommend that the salary of Mr. Pilcher, tramway manager, be increased by £100 in three annual increments.

Among the birthday honours, the order of C.I.E. has been bestowed upon John Newlands, Esq., officer on special duty in connection with the reorganisation of the Telegraph Department, and Henry Alexander Kirk, Esq., India Office, late India Telegraph Department, director-in-chief, Indo-European Telegraph Department.

Mr. A. H. Seabrook, electrical engineer and manager of the St. Marylebone electricity undertaking, has recommended the appointment of Mr. H. H. Holmes, at present sales manager to the West Ham electricity undertaking, at a salary of £400 per annum, to assist him in the reorganisation of the commercial department. The St. Marylebone Electricity Committee have adopted the proposal.

On Saturday last at the Victoria Hotel, Manchester, a meeting was held of the district managers of the Edison and Swan United Electric Light Co. for the purpose of presenting a testimonial to Mr. O. H. Bishop, sales manager to the company, who has resigned after 18 years' service in order to take up other duties. The presentation took the form of an illuminated address and a service of silver, subscribed for by the whole of the district managers and the heads of departments of the northern works of the company. During the same week Mr. Bishop was presented with a gold cigarette case and an address by the sales department staff, and with a gold-fitted dispatch case and a gold-mounted letter-case by the heads of departments at the Ponder's End works.

WIND TURBINES FOR GENERATING ELECTRICITY.

Among the exhibits at the Royal Agricultural Show at Gloucester this week is a plant for generating electricity from wind power, which Messrs. J. G. Childs and Co., Limited, Hawthorn-road, Willesden Green, London, N.W., are showing. The plant is 24 ft. diameter, and consists of one of the firm's special turbines upon a steel tower 60 ft. high with vertical shaft driving a Morris-Hawkins variable-speed generator placed vertically at 50 volts, and charging a 28 cell Pritchett and Gold battery having a discharge capacity of 450 ampere-hours. The plant follows the firm's usual practice in most particulars, but there are several special features of interest in this exhibit. For instance, the show cottage of the Country Gentleman's Association, 200 yards distant, is lighted from this plant, which is also supplying current for working an electric grill by means of the wind turbine at Messrs. Child's own stand.

Another point of interest is that the storage battery is divided into two parts, and by means of a special arrangement 50 volts can be used for working the cooking apparatus and other machines on exhibition, and have 25 volts for the lighting, thus making use of metallic-filament lamps. There is also an electric oven in which special attention has been given to insulation. It differs from all other ovens in that it has a polished marble top and oak sides, and looks more like a piece of dining-room furniture than the conventional oven. There is absolutely no external heat, and it works on less than half the current consumption of other ovens. The plant is also supplying the energy for running two electric grills, saucepan and steamers, radiator, kettles, fans, irons, etc., all by the Phœnix Electric Heating Company, and also a deep-well pump by Messrs. Le Grand and Sutcliffe, a butter churn and cream separator by the Dairy Outfit Company, and a circular saw of special design suited for turbine driving by Messrs. Childs and Co. The generator has a special switch by means of which it can be run as a variable-speed motor for driving any of the above machines when there is no wind, taking current from the battery. This plant in localities where the wind averages about eight miles an hour will produce about 3,000 units per annum.

WEST HAM CORPORATION TRAMWAYS.

A notable feature of the West Ham municipal tramway accounts for the year ended March 31, 1969 (a brief extract of which appeared under the heading of "Traction" notes in our issue of June 25), is the maintenance of the reduction in the works cost. For 1904-5 these costs were 7·343d. per car mile, and this item has undergone a steady reduction during the intervening years till 1908-9, when it stood at 6·65d. per car mile. The gross receipts for the year in the borough treasurer's statement amount to £115,351, but rentals of leased lines and bank interest bring up the total gross receipts to £115,813. The working expenses amount to £77,582, or 6·65d. per car mile for the 2,797,817 car miles run, leaving a gross profit of £38,231, which is equivalent to 7·47 per cent. upon the average expenditure for the year. Interest and sinking fund contributions, etc., absorb £30,138, and this sum, together with a net payment made to adjoining authorities in connection with through running of £2,169, leaves a net profit for the year of £5,923. The total expenditure is 9·24d. per car mile run as against 9·41d. the previous year, and 9·48d. in 1906-7. The net profit has been apportioned as follows: reserve and renewals fund, £3,767; construction of 20 top covers for tramcars, £1,539; construction of 12 top covers for tramcars (preliminary expenditure), £24; bonus payments to traffic staff, £593.

There has been a decrease in the number of passengers carried, but the total number of units used has increased, owing to the greater number of car miles run during the year; the number of units used per car mile was 1·64, as against 1·54 during the preceding year. The decrease in the number of passengers carried is attributed by Mr. H. E. Blain, the able tramways manager, in his report, to the competition from motor omnibuses and of the failure of the London County Council to connect up its tramway routes with those of the eastern district. The Corporation have given the tramways manager full power to vary the fares upon any route upon which undue competition is taking place, and despite the exemption of the motor-omnibus traffic from road maintenance and from rating, no doubts are felt as to the ultimate result. The through-running arrangements between West Ham, East Ham, and Leyton have been continued and extended during the past year, and are working satisfactorily.

ELECTRICAL ENTERPRISE IN TURKEY.

The *Industrie Electrique* gives the names of the various parties of the Franco-German group of financiers which has been formed for the purpose of obtaining electrical concessions in the Orient. The German section comprises the Continental

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Bank for Electrical Enterprises (Nuremberg), the Kommerz und Disconto Bank (Berlin), Warburg and Co. (Hamburg), the Tramways Company of Constantinople, the banks of the Siemens-Schuckert group and Société Générale Allemande, and the Bank for Electrical Enterprises (Zurich). In the French section of the group we find the names of the Société Générale de Paris, the Bank of Paris and of the Pays-Bas, the Imperial Ottoman Bank, A. Spitzer et Cie. (Paris), and J. Allard (Brussels). A branch is about to be formed at Zurich under the auspices of the Swiss Credit Bank to take control of the Société des Tramways de Constantinople. The whole syndicate is under the direction of the Bank of Germany.

COMPANIES' MEETINGS AND REPORTS.

J. G. WHITE AND CO.

The tenth ordinary general meeting of J. G. White and Co. was held on June 28 at the offices of the Company, 9, Cloak-lane, Cannon-street, London, E.C., Lord Arthur Butler in the chair.

In moving the adoption of the report, the CHAIRMAN expressed regret at the absence of Mr. J. G. White, who had been detained in New York, and could not arrive until July. The generally adverse business conditions and the very severe competition existing in the construction business had made the Company's work difficult, but the figures in the balance sheet indicated that those difficulties had been satisfactorily met, the profits for the year showing an increase over those at Feb. 28, 1908. Dealing with the items in the balance-sheet, he said that the cash assets of the Company were practically equivalent to the whole preference capital. This was well in so far as it proved that the assets were liquid, but unsatisfactory in so far as it indicated a reduced turnover. The profit and loss account, however, showed that the Company's resources and credit were being employed in a manner which earned satisfactory returns, though not quite what they should do with better general business conditions. The actual cash and call loans of the Company were equal to twice the whole indebtedness at the date of the balance-sheet. That indebtedness was entirely in connection with ordinary open accounts, the Company having no moneys borrowed. The item of investments now standing at £109,429. 15s. 5d. was considerably lower than the corresponding amount in last year's balance sheet, certain securities having been disposed of in the meantime. He mentioned that, without exception, the securities sold had realised more than the amount at which they were taken in last year's accounts, thus showing that they had been conservatively valued. The directors believed that the present valuation of securities was equally conservative. The valuation of plant, material in hand, etc., was nominal, having been taken at practically a scrap value basis, and not at its value to the Company in carrying on its ordinary business. The item of goodwill stood at the same figure as last year, but the reserve fund of the Company would be more than double the amount of that item. The debit side of the balance-sheet required no comment beyond saying that the item of sundry creditors, etc., consisted of ordinary trade accounts in connection with the carrying on of the Company's business, and the necessary provisions for contingencies. Regarding the future prospects of the Company, he said that the business now in hand ensured satisfactory profits for the current year, and negotiations were progressing favourably for the securing of a considerable amount of new work. After deducting the dividends recommended in the report, amounting to 8 per cent. on all classes of shares for the year, the Company's reserve fund would stand at £100,000, and the profits carried forward amount to £15,460. 6s., making a total accumulated profit now in the business of £115,460. The directors believed that a conservative policy was in the interests of the shareholders, and that the accumulation of substantial reserves greatly added to the value of their investment. Finally, the chairman moved: "(*a*) That the report and accounts for year to Feb. 28, 1909, be adopted; (*b*) that a dividend be declared, free of tax, at the rate of 6 per cent. per annum on the cumulative preferred shares for the half-year to Feb. 28, 1909; (*c*) that a dividend be declared, free of tax, at the rate of 6 per cent. per annum on the ordinary shares for the year to Feb. 28, 1909; (*d*) that an additional 2 per cent. be declared on the preferred and ordinary share capital of the Company, making a total of 8 per cent. on all shares for year."

The motions were seconded and unanimously agreed to.

MARCONI'S WIRELESS TELEGRAPH.

The ordinary general meeting of this Company was held on Monday last, Mr. G. Marconi (chairman and managing director) presiding.

In moving the adoption of the report and balance-sheet, and after alluding to the retirement through ill-health of the late chairman, Sir Charles Euan-Smith, Mr. MARCONI said that new important orders for stations and plant had been received since the report was posted to shareholders from the Portuguese and Greek Governments, and the value of orders in hand at this date amounted to over £100,000, with every prospect of a very substantial increase in the immediate future The Transatlantic station at Clifden had been completed. The directors very greatly regretted that the completion of this station was seriously delayed by the failure of certain manufacturers to deliver the necessary plant at the dates promised, the delivery of certain essential machines having been retarded for nearly six months. It was, however, a matter of satisfaction to himself to be able now to state that the plant had in every way come up to his expectations in regard to efficiency. As to the corresponding station at Glace Bay, in Canada, the machinery had already been completed and was now nearly all delivered. He did not expect that more than a month would be required for its efficient erection. If his colleagues on the Board had not considered it necessary for him to remain in England so as to be present at that meeting, he would now have been in Canada atending to the final completion of the station on that side. The limited service across the Atlantic, which had now been established for over 18 months, had continued to give satisfaction to its principal users, but that service, although exceedingly useful to the Company, had been very difficult to efficiently maintain whilst additions and alterations were being constantly carried out at the terminal stations. He had no doubt that a very great extension of the Transatlantic service might be anticipated as soon as the complete duplication of the station in Canada had taken place, which would enable the Company to accept from 15,000 to 20,000 words per day for transmission across the Atlantic, between the stations at Clifden and Glace Bay. The Board expected about the end of August to be in a position to invite the Post Office to give effect to the agreement with the Postmaster-General relative to the acceptance and delivery of the Company's Transatlantic messages at Government telegraph offices throughout the United Kingdom. The Board had had to face and overcome arduous tasks and numerous difficulties. A thorough reorganisation of the administration of the Company and of some of the associated companies was not only desirable, but imperative. This, in his opinion, had been so far as possible carried out, and although some of the changes involved a certain expenditure, nevertheless the result had been a considerable saving in current expenses. The Board was glad to state that the fear it had once entertained in regard to the ratification of the Berlin Convention by his Majesty's Government being detrimental to the maritime business controlled by the Company had so far not been realised, and a considerable addition had been made to the number of ships carrying the Marconi system. He felt that that was an eloquent proof that, even under what certain foreign Governments called conditions of open competition, the system controlled by the Company had proved able to more than hold its own against other systems, even although these were powerfully assisted by Governments which considered their development a question of national and political importance. The assistance rendered by the Company's organisation of wireless telegraphy to the steamship "Slavonia" was still fresh in the memories of all. The two assisting ships, the "Princess Irene," of the North German Lloyd, and the "Batavia," of the Hamburg-American Line, were among the ships fitted with this Company's system shortly after the accident which resulted in the sinking of the White Star liner "Republic" in the North Atlantic on Jan 23 last, on which occasion also the efficiency of wireless telegraphy as worked by the Company was so fully and unquestionably demonstrated. It should be gratifying to the shareholders to know that wireless telegraphy was beginning to be considered every day more and more by the Press and the general public as likely to afford the most efficient and economical method for satisfactory telegraphic communication between the distant parts of the British Empire. He announced that since the issue of the report three influential gentlemen had consented to join the Board—Mr. Hammersley Heenan, of Messrs. Heenan and Froude, engineers, Manchester and Worcester; Mr. Frederick Whowell, managing director of the Bleachers' Association, Manchester; and Captain Henry Rial Sankey, R.E. (late of Messrs. Willans and Robinson), Palace-chambers, 9, Bridge street, Westminster, S.W. Mr. Hammersley Heenan, in company with Mr. Whowell, visited the Clifden station some time ago, and were able to investigate thoroughly the present state of the station and the efficiency of the Transatlantic transmission.

The report was adopted.

"Z" ELECTRIC LAMP MANUFACTURING.

The annual general meeting of the shareholders was held on Monday, Mr. J. G. B. Stone presiding.

In his opening remarks the CHAIRMAN called particular attention to the item of money spent on patents which figured in the balance-sheet. The capital assets of the Company included certain works and their equipment, but consisted mainly of a number of patents in this country and a number of others which they had acquired, and which protected them in the manufacture of "Z" lamps in 17 British colonies and dependencies. These patent rights from time to time required certain expenditure to maintain their validity, and the expenditure was consequently part and parcel of the cost of the patents; therefore, it was a matter of consideration how to deal with this item. With regard to the general position of the business, the directors were disappointed that substantial results had not already accrued to the shareholders from the manufacture and sale of their lamps. They had had many difficulties to overcome. It might seem a comparatively easy matter to make, first, good filaments, and then good lamps, but experience had shown that there were difficulties which arose when manufactured in quantities. The directors had always felt that this business should be developed on a large scale, and they had always aimed at a considerable output. This had, of course, increased their standing charges during the year and the troubles of training the staff, but the output had now grown to a point where they were feeling the benefit of this liberal policy. In considering the operations of this Company he asked them also to bear in mind the real progress that had taken place during the past year. When they first started manufacturing the 100-volt lamp the lowest candle-power they could make for this voltage was 30 to 40; now they had on the market lamps of 16 c.p. for 100 volts, and of 30 c.p. for 200 volts. Throughout the year the candle-power had been steadily brought down. First, 30-c.p. lamps were standardised, then 25-c.p., then 20 c.p., and now 16-c.p. Each of these steps had entailed an immense amount of work in training the hands to manufacture and handle the finer filaments. The size of the bulb had also been reduced, and the form of support modified to suit the finer filaments. All this took time, as the results had to be tested at each stage, and when

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it was remembered that a life test of a lamp occupied 1,000 hours, which meant six weeks' continuous burning, it would, perhaps, be understood why progress had not been more rapid. In many of the operations, too, they were to a certain extent dependent on outside suppliers. In the past the supplies had nearly all to be obtained from foreign firms, but more and more was now being procured in this country. They had now reached the stage when they could put a thoroughly satisfactory metallic-filament lamp on the market at reasonable prices, they had mastered the difficulties connected with the manufacture, and must now increase their output to meet an ever-increasing demand. He thought the best proof that he was stating facts, and not merely giving opinions, was that last month they sold the whole of their stock to the trade for forward dates at satisfactory prices. The efficiency of the factories was steadily improving, the output of lamps increasing, and the cost of manufacture was steadily decreasing. They had made most important improvements in the filaments themselves, and, again, in the finished lamps. It was a matter of importance and congratulation that both filament and lamp were made entirely in this country, unlike most of the other metallic-filament lamps. On the basis of what they were doing now they were earning a good profit, and the Board would be very disappointed if the results of the current year did not produce a return satisfactory to the shareholders. With regard to the patent position, they had already successfully maintained their position against infringement, and the Board would continue to take all precautions to protect their interest in these matters.

In conclusion, the Chairman moved the adoption of the report and accounts, which was unanimously adopted.

BRITISH ELECTRIC TRACTION.

The report of the British Electric Traction Co. for the year ended March 31 last, to be presented to the meeting on the 8th inst., as on former occasions, contains various schedules giving particulars of the items appearing in the balance-sheet and profit and loss account, and also schedules showing the business done and dividends paid by the associated companies. The report states that the amount standing at credit of reserve account is £602,420. In addition, reserves amounting to £59,162 have been made out of profits against loss or depreciation of specific assets. The various associated companies have created depreciation and reserve funds of their own, which amounted at Dec. 31, 1908 (including balances carried forward), to £1,015,340. The total amount outstanding in respect of creditors at March 31, 1909, was £65,227, and of this £46,623 was in respect of debenture interest accrued at March 31, 1909, which has since been paid. Investments and undertakings stand at £5,037,095, and consists of shares and debentures in associated tramway, electricity supply, manufacturing and other companies, consols, and sundry securities and undertakings. Investments standing in the books at £2 883,086 were revenue earning during the past year, and produced an average return of 4·18 per cent. Investments standing in the books at £2,012,441 did not earn any revenue during the past year. The amount of sundry debtors and debit balances stands at £473,680, and shows a reduction on the amount at March 31, 1908. The expenditure on and in connection with the new office building which has been erected for the British Electrical Federation amounts to £36,188. There is a further sum of £3,274 in respect of other buildings and land. The item expenditure on Acts of Parliament, etc., stands at £19,640, and represents expenditure on promotion of Acts of Parliament, light railway orders, and other rights and powers, surveys, negotiations, etc., in connection with various schemes, some of which may not be proceeded with. The amount is being written down annually by 20 per cent. Stock stands at £9,876 and represents the stock of cars on hire to associated companies, electrical equipments, paving setts, and general stores. Provision has been made for depreciation. Goodwill stands at £1,000, and is the balance of a larger amount. Furniture stands at £4,119. The net profit, after reserving £12,500 against depreciation of undertakings worked by the Company, buildings and freehold land, stock, doubtful debts, and expenditure on undertakings not proceeded with is £130,725, to which must be added the sum of £35,393 brought forward from last account, making a total of £166,119. After deducting interest on the 5 per cent. debenture stock and the 4½ per cent. debenture stock for the year, amounting to £97,484, there remains a balance of £68,634, out of which a dividend has been paid on the preference shares at the rate of 3 per cent. for the year, amounting to £48 431, leaving a net balance of £20,203, which the directors propose should be carried forward. The full dividend on the 6 per cent. cumulative preference shares of the Company has been paid to March 31, 1908. Dividends and interest received from the associated companies during the past year show a diminution of £33,332. The decline in profits has been general throughout the country, and is attributed by many of the companies to the severe depression in trade which has prevailed. A few of the undertakings in England and those at Bombay and Auckland, however, show increased takings per route mile, which are sufficient to increase the average over the whole of the systems. The total number of passengers carried shows a small increase, the route mileage of lines worked having slightly increased during the year, but the number of passengers carried per route mile of line has fallen from 662,726 to 654,770, which was 1·23d. as against 1·21d. for the previous year. It has been pointed out in previous reports that the average fare per passenger had steadily fallen from 1·38d. in 1901 to 1·21d. in 1907, in which year the directors announced their intention of making every effort to improve the position by increasing fares, shortening fare stages, and eliminating unremunerative services. Their efforts have succeeded in arresting the decline, and the present year's figure shows a small increase. The general depression in trade has been severely felt by the electrical manufacturing companies. The general charges and expenses of administration again show a material reduction, being £16 868 as compared with £24 185, the reduction on this occasion being mainly the outcome of the formation of the British Electrical Federation. In the last annual report it was stated that the directors were giving consideration to some of the proposals for electrical enterprise submitted to them from countries where the conditions for the investment of capital are more favourable than in this country, and they are glad to say that the prospects of securing such business are encouraging. The Company has already secured a substantial participation in a powerful syndicate, which has been formed in association with German and other Continental banks, for the purpose of negotiating with the municipality of St. Petersburg for a concession of tramways in that city. Other negotiations are pending in regard to various enterprises abroad. The Poole undertaking in which the Company was largely interested was purchased by the Bournemouth Corporation under an agreement which provided that the purchase price should be settled by arbitration, on the basis of fair market value as a going concern, and that in addition to such price the Corporation should pay certain liabilities of the Company. In regard to the latter items litigation arose and, although the Court of Appeal had given an unanimous decision in favour of the Company, the Corporation appealed to the House of Lords. The litigation had recently been concluded by the decision of the House of Lords in favour of the Company on all points, and in the result the shareholders of the Poole Company will have received a return of their capital in full, together with a premium. While it is not possible to draw from this a general conclusion applicable to the undertakings of the associated companies, the directors consider that this result affords some indication of the value of a successful tramway undertaking when sold upon an equitable basis. Deep regret is expressed through the loss by death of the Right Hon. H. O. Arnold-Forster, M.P. The Hon. Arthur Stanley, M.P., accepted the invitation of the directors to fill the vacancy, but immediately afterwards resigned his seat at the Board, pending the determination of a business in which he has conflicting interests. The directors who retire this year are Mr. J. S. Raworth and Mr. P. Debell Tuckett, who, being eligible, offer themselves for re-election.

ELECTRIC AND GENERAL INVESTMENT.

The report for the year ended May 31 last, to be submitted to the meeting on the 7th inst., states that the gross profit on the transactions of the year was £11,565. After deducting all general charges and the interim dividend already paid on the preference shares and providing for the proportion of the final dividend accrued on the preference shares to May 31, 1909, there remains a balance of £4,095. As a further reserve to meet the depreciation in the investment and loan securities, the directors propose to carry this amount to the contingencies fund, thereby raising the amount to credit thereof to £71,651 as at May 31, 1919. The trustee for the ordinary shares reserve fund proposes to distribute the sum of 6d. per share out of the dividends received on the trust investments. The trustee for the founders' shares reserve fund proposes to distribute the sum of £8 per share out of the dividends received on the trust investments.

NEW COMPANIES REGISTERED.

Lechlade Electric Light and Power Co., Limited.—Registered May 22. Capital, £400 in £1 shares. Objects: to carry on the business of electricians, mechanical engineers, manufacturers and workers of electricity for power and light, etc. Private company. Registered office: High-street, Lechlade, Glos.

Kukub Rubber Estates, Limited.—Registered June 11. Capital, £250,000 in £1 shares (100,000 cumulative preference). Objects: to acquire, work, and develop certain rubber estates in Johore, Straits Settlements, known as the Kukub Estates, to adopt an agreement with the Kurub Syndicate, and to carry on the business of planters of and dealers in rubber, guttapercha, and gums of all kinds. Registered office: 16, Finsbury-circus, E.C.

Havana Exploration Co., Limited. — Registered June 21. Capital, £500,000 in £1 shares. Objects: to acquire asphalt, bitumen, oil, and coal bearing lands and farms, mines, mining rights, and other properties in Cuba or elsewhere, to adopt an agreement with Havana Investment Syndicate, and to carry on the business of miners, explorers, prospectors, preparers for market of and dealers in coal, iron, asphalt, bitumen, oil and metal and mineral substances of all kinds, etc. Registered office : 56, Cannon-street, E.C.

Jamaica Estates and Rubber Plantations, Limited.—Registered June 16. Capital, £300,000 in 299,900 preference shares of £1 each and 2,000 deferred shares of 1s. each. Objects: to acquire estates, lands, and hereditaments in Jamaica or elsewhere, to develop the resources thereof by building, reclaiming, clearing, fencing, draining, pasturing, farming, and planting, to adopt an agreement with the Caribean Trading Association, and to carry on the business of rum distillers, planters and manufacturers of and dealers in sugar, rubber, logwood, fustic, mahogany, bananas, pimento, cocoa, cassava, cocoanuts, copra, guttapercha, flax, fibres, cotton, tobacco, guinea and Para grass, oranges, and other produce, etc. Shares divisible. Registered office : 20, Copthall-avenue, E.C.

Liens Registered, etc.

Derby Boiler Co., Limited.—Particulars of £3,000 debentures, created June 4, 1909, filed pursuant to Section 93 (3) of the Companies (Consolidation) Act, 1908, the whole amount being now issued. Property charged: the company's undertaking and property, present and future, including uncalled capital. No trustees.

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BUSINESS NOTES.

LIGHTING AND GENERAL.

Brighton.—The Education Committee have decided to install a four-light electric radiator in the headmaster's room at Finsbury-road School.

Buenos Ayres.—The Municipality of Loberia, province of Buenos Ayres, are studying the tenders received for establishing electric light in that town.

Barnstaple.—The Board of Guardians have decided to install electricity for lighting purposes at the workhouse, and have empowered the Visiting Committee to invite tenders and to report further to the Board.

Salford.—The Royal Technical Institute Departmental Sub-Committee have decided that the whole of the remaining portion of the re wiring at the institute is to be proceeded with during the present financial year.

Farnham.—The Farnham Gas Co. have given notice to the Rural District Council of their intention to apply for parliamentary powers to supply electricity for public and private purposes within the urban and rural district of Farnham.

Swansea.—The Executive Committee of the Harbour Trust received at their last meeting tenders for portions of the plant, and appointed a sub-committee to report upon the same. It is estimated that the plant will cost nearly £20,000.

Watford.—At the last meeting of the Electric Lighting Committee the electrical engineer reported that 18 consumers had been connected to the system since the previous meeting, making a total of 773 connected to date, equivalent to 51,823 32-watt lamps.

Wrexham.—The Electricity Supply Committee reported at the last meeting of the Council that during May 32,497 units of electricity were sold, against 33,172 a year ago, and 41,252 last month. Two new consumers had been connected, bringing up the total to 312, against 279 last year.

Morecambe – At the last Town Council meeting the Electricity Committee announced that a report would be forthcoming as to the best means of working the electricity works, whether by oil or gas, as a substitute for steam, and that inquiries had been made in various places as to the best means to adopt.

Stirling.—At the last Council meeting the engineer's monthly report showed that for the four weeks ending May 8, 22,784 units of electricity were generated at the power station, as compared with 22,230 for the corresponding period of last year. The total number of 8-c.p. lamp connections was 25,984, as against 24,176 last year at the same date.

Llanelly.—The Llanelly Traction and Electric Lighting Co. have arranged with the Harbour Trust for a site at the docks on which to erect a generating station on a 99 years' lease at £80 per annum. The rapid development of the districts, and the anxiety of trade-people to have electric light, should induce the traction company to proceed with the scheme immediately.

Grassington.—The first directors' meeting of the Grassington Electric Supply Co. was held at the Wilson Arms Hotel, Grassington, on the 23rd ult., Mr. J. S. Fielden in the chair. A report of the company's progress was submitted by Mr. Chas. Pullan, and the general officers, etc., were appointed. The company hope to obtain their final certificate next week, when they will commence business.

Blackpool.—At the Corporation electricity works the output for May showed an increase of 9,889 units upon the corresponding period of 1908. Private lighting actually showed a decrease of 2,655 units, due to the greater use of the metallic-filament lamps, but the Corporation's trams used nearly 11,000 units more. During April and May the falling off in the demand for private lighting was 4,102 units, but the Corporation trams used over 16,000 units more as compared with 1908.

Market Harborough.—The Urban District Council at their last meeting decided to make application to the Board of Trade for an extension of time in connection with the electric lighting provisional order, inquiries recently made by the Council having proved that the local demand for electric light was extremely small at present. The original period of the order has long since passed, but an extension of time was allowed. The Board of Trade have now granted a further extension of 12 months.

D.P. Batteries.—Exception has at times been taken to the use of storage batteries in hot climates, but there is good proof that the D.P. Battery Co., of Bakewell, have managed to produce plates that will work satisfactorily under these conditions. Cells supplied to the Indian Government some six years ago by this company are still working well and giving no trouble. No renewals of either positive or negative plates have been required, nor are there signs of deterioration, according to the latest accounts.

Rugby.—The Town Council have decided to seek sanction from the Local Government Board to the borrowing of £5,500 for the following—viz: one 150-kw. alternator, £1,316; switchboard, etc., £144; feeder and distributing mains, £2,492 10s.; transformers, £214; transformer chambers, £109; consumers' connections and meters, £880; contingencies, £344. 10s. In moving the adoption of the report, the chairman stated that the amount to be spent this year would not exceed £2,000 probably, and the remainder would be used next year and the year afterwards.

Exeter.—Mr. Hodson, moving the adoption of the report of the Electric Lighting Committee at the City Council meeting, spoke of the successful working of the undertaking during the past year, despite the reduction in the charges made to the consumers involving £1,000. The economical working was shown by the fact that although there was a greatly increased consumption, there had been no increased cost in working. Their best thanks were due to the electrical engineer and his staff for the able manner in which they had managed the undertaking. The report was adopted.

Coventry.—The Electric Light Committee of the City Council have considered the annual accounts, which show a net profit for the year of £3,765. 5s. It was decided to recommend that £1,000 of this be paid to the general district fund in aid of the rates; that £2,598 be paid to the reserve fund and transferred from that fund to capital account to meet certain capital expenses so as to obviate the necessity of raising loans; and that the balance of £167. 5s. be carried forward to the next account. Last year a profit was made of £5,647. 4s. 6d. The sum of £1,000 was paid to the general district fund, £831 to the reserve fund, and £3,806 was paid to reserve fund and transferred to capital.

Oldham.—The mayor presided at the fortnightly meeting of the Corporation Electricity Committee last week, when the engineer (Mr. Newington) reported that the number of units sold during the fortnight was as follows: lighting and power, 53,285, against 44,034 during the same period last year; traction, 136,555 against 160,400—total, 208,840 against 204,434. The number of lamps connected during the fortnight were: incandescent 68, equivalent to 145 lamps of 8 c.p., bringing the total connected to date to—arc 748, incandescent 30,051, and motors 483, equivalent to 148,152 lamps of 8 c.p. The mayor said that the net profit on the electrical undertaking for the 12 months ended March 25 was £3,451. He thought that was very satisfactory.

Athy.—Arising out of a reference in the minutes of the previous meeting to guarantee promised in connection with the proposed telephone installation, Mr. Deegan, at the last meeting of the Urban District Council, asked what was the amount of the guarantee to be given to the Post Office authorities? The Chairman said the guarantee would amount to £30 extended over three years, but the Council would be only liable for one-third of that amount. The Town Clerk said the Council would only be liable for £11. It was mentioned that there was a likelihood, in the event of the system paying, of the Council having to pay nothing. The Chairman said that the matter was gone into very closely at the previous meeting, when the members present calculated that the cost would be practically nil.

Southampton.—The Corporation having applied for sanction to borrow £3,000 for the purposes of their electricity undertaking, the Local Government Board inquiry was held last week at the municipal offices. The proceedings were conducted by Mr. A. W. Brightmore, those present including the town clerk (Mr. R. R. Linthorne), the electrical engineer (Mr. Street), the borough engineer (Mr. J. P. Crowther), and the assistant borough treasurer (Mr. Wiltshire). The proceedings were of a purely formal character, no opposition being forthcoming. The town clerk tendered formal evidence on behalf of the Corporation in support of the application, and explained that the loan was necessitated by the natural growth of the borough's electrical system. The electrical engineer supplemented the town clerk's statement with some additional details relating to the projected work, and the inspector having intimated that he would report in due course, the inquiry terminated.

Shrewsbury.—At the last meeting of the Town Council a report was received from the Lighting Committee, in which they stated that it was necessary for the development and economical working of the electricity undertaking that an application should be made to the Local Government Board for sanction to a loan, and the committee suggested that the present was an opportune time for such an application to be made, in order to defray the following capital expenditure—viz.: extension of mains (including Abbey Foregate and additional feeder mains when required), £2,700; services to consumers, £900; meters and accessories, £450; mechanical stokers for boilers, £900; machinery, boiler, pump, steam-pipes, etc., £800; street-lighting, £500; contingencies, £78; for repayment of amount overspent on capital account, £3,672—total, £10,000. The proposed works were absolutely necessary for the efficient working of the undertaking, and it might be stated that the provision of mechanical stokers would effect a large saving in fuel, besides other advantages. After a discussion it was decided to apply to the Local Government Board for sanction to the borrowing of the sum of £10,000.

Wigtownshire.—At a meeting of the Wigtownshire County Council at Stranraer on Saturday the clerk read a communication from the secretary, Post Office, Edinburgh, stating that engineering estimates of the cost of extending the trunk telephone system to Wigtownshire had been obtained. The capital expenditure would be very heavy, and would only be justified if a larger number of subscribers were forthcoming than, he was afraid, were likely to be obtained. To test the matter, however, arrangements were being made to have the town of Stranraer thoroughly canvassed for subscribers as soon as possible, and the Postmaster-General would be glad to have any assistance towards the success of the canvass which the County Council might be able to afford. Mr. Ross, an official of the Post Office, was called in, and said the idea was to extend the system from Girvan to Stranraer provided the support was forthcoming. He did not think, however, it would stop at Stranraer if the county gave a sufficient guarantee. After some discussion it was remitted to the clerk to continue his negotiations with the Post Office and to ascertain the amount of the guarantee required.

Birmingham.—Mr. H. R. Hooper has held an inquiry into an application made by the City Council to the Local Government Board for sanction to borrow £149,350 for purposes of the electric supply undertaking. Mr. Prideaux, in making the application on behalf of the Corporation, said that £100,000 of that amount was required for an extension of the underground mains, rendered necessary by the rapid increase in the demand for electrical current in the city. That demand was evidenced by the fact that there was an increase in the

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sale in the year terminating March 31 last, as compared with the previous year of about 4,400,000 units of current supplied, and for the first time in the history of the undertaking the Electric Supply Committee were able to recommend the Council to pay £10 000 in relief of the rates on the last year's working. Of the £100,000 about £20,000 had already been expended owing to the rapid extension and urgent necessity to lay down the mains; £15,000 was needed for high-tension switchgear, which was necessitated in connection with supplies of current to consumers' premises at a high voltage; £2,000 was required to supply transformers to consumers' premises in cases where consumers desired low-tension current in districts where there were only at present high-tension mains available; and the balance of the loan was wanted for the installation of new plant at Dale End and Summerlane stations. Mr. Prideaux asked that the loan might be extended over the greatest possible period, having regard to the permanent nature of many of the proposed works.

Aberdeen.—The various works in connection with the introduction of a supply of electric current into the Woodside and Bucksburn districts, included in the extended electric lighting area, are now nearing completion, and in a brief period the inhabitants of these localities will have electricity available for lighting, heating, and power purposes. Six motors are to be fitted up at Woodside, four being ready for coiling up, and from the transforming sub station, which, with the necessary apparatus for reducing the pressure from 6,600 volts to the required quantity, has been constructed near the Adamant Paving Co.'s works at Bucksburn, a high-tension cable has been laid to Stoneywood to supply the Admiralty wireless telegraphy station. Low-tension cables have also been carried to the tramway terminus at Bankhead and the Fountain at Woodside. The high-tension cables, to supply at 6,000 volts, have been carried from the electric works at Dee Village along the subway to its termination at the junction of Justice Mill-lane with Holburn-street, and there it has been taken along Alford-lane, across Albyn-place, along Victoria-street, Albert-street, Craigie Loanings, Westfield-road, Argyll-place, and then, by wayleave arrangement, across the Cornhill property, and by Back Hilton-road to the Inverurie turnpike. The storm in January and February resulted in a total suspension of the cable-laying operations, but with the exception of those two months the work, giving employment to 150 men, has progressed steadily and satisfactorily until finishing point has almost been reached. Mr. J. A. Bell, city electrical engineer, has personally supervised the carrying out of the scheme.

Stock Exchange.—Applications have been made to the committee to appoint a special settling day in and to grant a quotation to the Bombay Electric Supply and Tramways Co.'s £150,000 5 per cent. second mortgage debentures of £100 each, Nos. 1 to 1,500; and the Southern Electric Tramways Co. of Buenos Ayres (Compania de Tramways Electricos del Sud), £100,000 5 per cent. first mortgage debentures, Nos. 1 to 800 of £100 and 801 to 1,800 of £20 each. The committee has also been asked to appoint a special settling day in the following: Consolidated Malay Rubber Estates' 62,007 shares of £1 each, fully paid, Nos. 1 to 62,007; Cordoba Copper Co.'s further issue of 43 550 shares of 5s. each, fully paid, Nos. 270,367 to 287,116 and 661,747 to 688,546; London Asiatic Rubber and Produce Co.'s further issue of 11,000 shares of £1 each, fully paid, Nos. 107,001 to 118,000; Yam Seng Rubber Co.'s 8,000 ordinary shares of £1 each, 12s. paid, Nos. 12,001 to 20,000, 26,900 ordinary shares of £1 each, fully paid, Nos. 1 to 12 000 and 20,001 to 34,900, and 100 5 per cent. preference shares of £1 each, fully paid, Nos. 12,535 to 12 634; Zinc Corporation's further issue of 18,000 preference shares of £1 each, fully paid, Nos. 646,027 to 649,026 and 664,027 to 679,026. The committee has further been asked to allow the Bukit Rajah Rubber Co.'s 66,700 shares of £1 each, fully paid, to be quoted in the official list. The committee has appointed July 13 as a special settling day in the East Rand Mining Estates' further issue of 50,000 shares of £1 each, fully paid, Nos. 400.001 to 450,000; and the Sapong Rubber and Tobacco Estates' 30,000 vendors' shares of £1 each, fully paid, Nos. 70,001 to 100,000, and a further issue of 10,000 shares of £1 each, fully paid, Nos. 31,379 to 41,378; and ordered the undermentioned securities to be quoted in the official list: Central Electric Supply Co.'s further issue of £63,124 4 per cent. guaranteed debenture stock, and the Highlands and Lowlands Para Rubber Co.'s 123,546 shares of £1 each, 15s. paid, Nos. 1 to 7 and 181,462 to 305,000, and 182,952 shares of £1 each, fully paid, Nos. 8 to 181,461 and 305,001 to 306,498.

York.—In view of the construction of the light railways in the city, the Electricity Committee requested the city electrical engineer to report to them upon the carrying out of any necessary extensions of mains along the routes of the railways, so that advantage could be taken of laying down the requisite cables in the trenches which would be made in the streets for the tramway cables, and so save the cost of again opening out the pavements for the electric cables at a future time. With this object power has been reserved in the contract with the contractors for the light railway to make use of their trenches for the cables. The city electrical engineer has accordingly laid before the committee his scheme for the extension of mains, a brief description of which is as follows: (1) a middle-wire feeder to be laid from the electricity works to the junction of Holgate-road and Blossom-street to enable a balance of pressure to be maintained in the Mount district; (2) the feeder cable which at present terminates at the corner of Spurriergate to be extended to the corner of Railway-street, a distance of 310 yards, and terminate in a new feeder pillar; (3) the Micklegate feeder cable to be extended from Micklegate Bar to the junction of Holgate-road and Blossom-street and be also provided with a feeder pillar; (4) the distributor now terminating at a point opposite the Fox Inn to be continued as far as the boundary on Acomb-road; (5) Lendal Bridge to the Railway-street distributor. The estimated cost of these extensions is approximately £2,510. The committee recommend the Council to authorise these extensions to be made and to apply to the Local Government Board for sanction to the borrowing of the above-named sum as the cost thereof. The return for the month of May of the electricity department shows that the units generated were 96,735, as against 94,767 for May, 1908; approximate units sold 81,688, as against 78,698 for May last year. Horse-power of motors connected during the month, 21¾ (10¾ in May, 1908); total horse-power of motors connected to 1,138 (1,031); 8-c.p. lamps connected during the month, 413 (194); total 8-c.p. lamps connected to 65,421 (60,959); equivalent 8 c.p. connected—total, 93.871 (86 734). Total cost for May, £450. 15s. 4d.; cost per unit, 1·32; May, 1908—total cost, £451. 8s.; cost per unit, 1·38.

TRACTION.

Hobart Electric Tramway Co.—The directors have declared a dividend of 5 per cent., free of income tax.

Enfield.—The Middlesex County Council's tramway extension from Winchmore Hill to Enfield Town has been inspected by Major Pringle, of the Board of Trade.

River Plate.—The Santa Fe City Council have rejected all the tenders received for the electrification of the city tramlines. New tenders are to be called for.

Hornsey.—The Town Council have decided to consent to the purchase by the Middlesex County Council from the London County Council of that portion of the Highgate-hill tramways within the borough of Hornsey.

Bradford.—The report of the manager of the Bradford city tramways (Mr. C. J. Spencer) for the week ending June 19 states that the total receipts amounted to £5,020, the average per car mile being 11·37, as compared with total receipts £4,537 and car mile average 10·30 for the corresponding period of last year.

Pittsburg.—The electric railways in and around Pittsburg are completely at a standstill in consequence of the strike of drivers and conductors. Only the cars used to convey the mails ran on Sunday. The president of the tramway company has notified the mayor that traffic will be resumed at once, and that the company expect protection.

Hammersmith.—A letter has been received by the Borough Council from the Board of Trade stating they had appointed Colonel Yorke to inquire into the application of the London United Tramways for permission to increase the speed of their tramcars along Uxbridge-road, King street, and other places. The company desire to have the speed increased in some instances to 16 miles an hour.

South Shields.—The electric tramcars of the Corporation last week carried 158,518 passengers, and the takings amounted to £633. 6s. 3½d., an average of 9·33d. per car mile, as compared with £767. 17s. in receipts and 189 029 passengers, an average of 8 51d. per mile in the corresponding week of last year. The Jarrow cars, on the South Shields Corporation lines, whose receipts are included in the above figures, carried 18,403 passengers, and collected £73. 3s. 4d. in fares, this working out at 11·08d. per car mile.

Fife.—The promoters of the tramway scheme to link up Kirkcaldy and Dunfermline, *via* the coastside, touching at Kinghorn, Burntisland, Aberdour, Inverkeithing, and Rosyth, are now engaged "sounding" the various local authorities interested. On Thursday week they were in Dunfermline, and met a special committee of the Town Council. The principal point discussed was the route which would be taken by the company to enter Dunfermline from the south. The company propose to use the nearest road from Inverkeithing—viz., *via* Backmarsh—but it is believed they were given clearly to understand that such a route, if persisted in, would meet with the Council's opposition. Municipally, the road by which it is desired the city should be connected with Rosyth is the Grange-road, which is further west than the Inverkeithing road, and runs in almost direct line with what will be the naval base into Dunfermline.

FORTHCOMING EVENTS.

FRIDAY, JULY 2.

Junior Institution of Engineers.—At 8 p.m., visit to the engineering workshops and laboratories, East London College, Mile End.

SATURDAY, JULY 3.

Institution of Mining Electrical Engineers.—At 7 p.m., meeting at the offices of the Institution of Engineers and Shipbuilders in Scotland, Elmbank-street, Glasgow.

APPOINTMENTS VACANT.

Pupil. Vacancy at the works of the Kilmalcom Electric Lighting Co., Kilmacolm, Renfrewshire. See advertisement.

Motor Inspector to undertake duties of motor instructor, Bournemouth Corporation Tramways. Wages, 36s. per week. Applications to the General Manager.

Switchboard Attendant, Stockton-on-Tees Corporation. Wages, 27s. 6d. per week. Applications to Mr. J. J. Smith, borough electrical engineer. See advertisement.

Postmasters. Vacancies at Birkenhead, salary £500 a year; Abingdon, salary £260 a year; Ellesmere, salary £170 a year; salaried sub-postmastership of Beeston, Nottingham, salary £160 a year. Applications to the office of the Postmaster-General.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

Acton.—The Urban District Council invite tenders for the annual supply of lead-covered, paper-insulated cables. Particulars from Mr. M. Martin Blair, electrical engineer, 130, Churchfield-road, Acton, W. Tenders by July 12.

Lisburn (Ireland).—The Urban District Council invite tenders for the lighting of the town of Lisburn from Aug. 7, 1909, to May 7, 1910. Tenders must be sent to Mr. T. M. Wilson, town clerk, Town Hall, Lisburn, by July 5.

St. Pancras.—The Borough Council invite tenders for the supply of arc lamp carbons. Particulars can be obtained upon application at the Electricity Department Offices, 57, Pratt-street, Camden Town, N.W. Tenders by July 10.

Lauder (Scotland).—Tenders are invited for the installation of electric light and heating apparatus at the Lauder Technical School extension. Tenders must be sent to Mr. D. Gorrie, clerk to the School Board, 104, High-street, Dunfermline, by July 10.

Wallasey.—The Urban District Council invite tenders for the supply of a battery of accumulators, reversible booster, and switchboard. Specification from Mr. J. A. Crowther, electrical engineer, Offices, Sea View-road, Liscard. Tenders by July 12.

Barnstaple.—Tenders are invited for supplying and fixing a new boiler at the soup kitchen, Boutport-street. Particulars obtainable at the office of Mr. E. Y. Saunders, P.A.S.I., borough surveyor, The Strand, Barnstaple, where tenders must be sent by July 3.

Gravesend.—Tenders are invited for the supply of an automatic stoker and fitting same to the Council's water-tube boiler. Particulars from Mr. C. McInnes, borough electrical engineer. Tenders to the Town Clerk, 147, Windmill-street, Gravesend, by July 3.

London, S.W.—The Directors of the South Indian Railway Co. invite tenders for the supply of 94 carriage underframes with bogies and vacuum brake complete. Specifications can be obtained from the Secretary, 91, York-street, Westminster, on payment of £1. Tenders by July 6.

Devonport.—The Corporation Electricity Committee invite tenders for the supply of the following for a period of 12 months ended June 30: (Contract No. 1) direct-current meters; (2) paper-insulated cables, rubber-covered wires, flexibles, and cut-outs; (3) lubricating oils. Particulars from the Borough Electrical Engineer.

Ealing.—The Corporation invite tenders for the supply of cylinder oil, crank-chamber oil, bearing oil, paraffin, best rope waste, stoneware pipes, etc., to the electricity works. Particulars from Mr. J. Douglas Knight, borough electrical engineer and manager, Electricity Department, Town Hall, Ealing, W. Tenders by July 19.

Greenwich.—The Guardians invite tenders for the erection and equipment of two electrical lifts at the infirmary, Vanbrugh-hill, East Greenwich, S.E. Specification and form of tender, containing full particulars, can be obtained on application at the Clerk's Office, Union Workhouse, Woolwich-road, Greenwich, S.E. Tenders by July 8.

London, E.C.—The Melbourne Corporation invite tenders for the supply of 18 transformers. Tender form, conditions of tendering, etc., obtainable from the Agents. Endorsed tenders must be sent to Messrs. McIlwraith, McEacharn, and Co., Proprietary, Billiter-square-buildings, E.C., agents for the Melbourne City Council, by July 7.

Hull.—The Education Committee of the Corporation invite tenders for the installation of heating apparatus in New Cross School buildings. Tenders, with schemes, sealed and endorsed, addressed to the Chairman of the Finance and General Purposes (Education) Sub-Committee, must be sent to the Town Clerk's Office, Hull, by July 12.

Haslingden.—The Corporation invite tenders for the provision of sub-station equipment with battery and reversible booster. Specifications can be obtained from the Town Clerk, Municipal Offices, Haslingden, or may be seen at the offices of the engineers, Messrs. Handcock and Dykes, 1, Victoria-street, Westminster. Tenders by July 3.

Dover.—The Corporation invite tenders for the supply and delivery of small Welsh and other coal suitable for use at the electricity works for 12 months ending July 31, 1910. Specification and form of tender obtainable from the Borough Electrical Engineer, Electricity Works, Park-street, Dover. Tenders to Mr. R. E. Knocker, town clerk, Castle Hill, Dover, by July 5.

Whitehaven.—Tenders are invited for lighting the harbour, quays, etc., by electricity, gas, or other means for five years, or such other period as may be agreed upon, from Jan. 1, 1910, for the Harbour Commissioners. Application must be made to the Harbour Master for particulars. Tenders to Mr. John Tyson, clerk, Harbour Office, Whitehaven, by July 20.

Clacton-on-Sea.—The Urban District Council invite tenders for the supply and delivery of about 50 tons of British cast-iron pipes and connections. Copy of specification and form of tender obtainable from the Council's engineer, Mr. Sydney Francis, Town Hall, Clacton-on-Sea. Tenders to Mr. Geo. T. Lewis, clerk, Town Hall Buildings, Clacton-on-Sea, by July 7.

London, S.W.—The Directors of the Madras and Southern Mahratta Railway Co. invite tenders for the supply of 32 pillar jib cranes, as per the specification, which can be seen at the offices of the Company. The charge for the specification is £1. 1s., which will not be returned. Tenders to Mr. H. Bonham-Carter, secretary, 91, York-street, Westminster, S.W., by July 13.

East Cowes.—The Urban District Council invite tenders for supplying and fixing a 30-b.h.p. gas-engine and suction gas plant, subject to the sanction of the Local Government Board being obtained to a loan. Plans and specifications can be seen and information obtained from Mr. Albert E. Barton, surveyor to the Council, Town Hall, East Cowes. Tenders must be sent to Mr. Atherstone Damant, clerk, Cowes, by July 5.

Bury.—The Corporation invite tenders for the supply and erection of three water-tube boilers, each capable of evaporating 25,000 lb. of water per hour. Copy of the specification and form of tender obtainable from Mr. S. J. Watson, M.I.E.E., engineer and manager, Electricity Works, Bury, on a deposit of £2. 2s. (returnable). Tenders to the Town Clerk, Bury, by Aug. 16.

Middleton.—The Corporation invite tenders for the supply of a Lancashire boiler. Particulars, specification, and form of tender, which will contain a fair wages clause, obtainable from Mr. C. F. Broadhead, gas engineer, Middleton. Tenders, addressed to the Chairman of the Gas Committee, must be sent to Mr. Frederick Entwistle, town clerk, Town Hall, Middleton, by July 14.

Wimbledon.—The Corporation invite schemes for the heating of the isolation hospital, Gap-road, and tenders for carrying out the work. On payment of £1. 1s. (returnable) general conditions and plans of the existing and proposed buildings will be supplied by the Borough Surveyor, Town Hall, Wimbledon. Tenders, addressed to the Chairman, Sanitary Committee, must be sent in by July 22.

Manchester.—The Corporation invite tenders for the supply of 20,000 tons of oil for the manufacture of carburetted water-gas. Particulars obtainable from Mr. Charles Nickson, superintendent of the gas department. Tenders and samples, addressed to the Chairman of the Gas Committee, must be sent to the office of the Superintendent of the Gas Department, Town Hall, Manchester, by July 1.

London, E.C.—Tenders are invited for the supply of 80 alternating-current flame arc lamps, required by the Melbourne (Australia) Corporation. Specification, tender form, conditions of tendering, etc., can be obtained on application to the Agents. Tenders to Messrs. McIlwraith, McEacharn, and Co., Proprietary, Billiter-square-buildings, London, E.C., agents for the Melbourne City Council, by July 7.

Manchester.—The Tramways Committee of the Corporation invite tenders for the supply of special (permanent way) track work. Specifications and forms of tender obtainable on application to Mr. J. M. McElroy, general manager, Corporation Tramways, 55, Piccadilly, Manchester, on deposit of £2. 2s. (returnable). Tenders to the Chairman of the Tramways Committee, 55, Piccadilly, Manchester, by July 13.

Edinburgh.—The Edinburgh and District Water Trust invite tenders for the supply of a quantity of cast-iron pipes, 16 in. in diameter, weighing about 219 tons. Drawings can be seen and copies of specification and forms of tender obtained at the Superintendent's Office, 12, St. Giles-street, Edinburgh. Endorsed tenders must be sent to Mr. William Boyd, W.S., clerk to the Trust, 12, St. Giles-street, Edinburgh, by July 7.

Eastington (Glos.)—The Wheatenhurst Board of Guardians invite tenders for the supply of workhouse boiler, with heating apparatus and cooking plant, at Eastington, near Stonehouse, Glos. Plan and specification can be seen at the Workhouse between 11 a.m. and 2 p.m. Copies of the specification can be supplied on payment of the cost thereof, 5s. Tenders to the office of Mr. R. E. Stuart, clerk, Bedford-street, Stroud, Glos., by July 7.

Londonderry.—The Corporation invite tenders for the supply of Welsh or English through-and-through steam coal, aggregating approximately 2,000 tons. Tender forms and further particulars obtainable from the Borough Electrical Engineer, Strand-road, Londonderry. Also for coal for municipal offices and markets. Forms of tender obtainable from Mr. F. Henry Miller, town clerk, Municipal Offices, Foyle street, Londonderry. Tenders by July 6.

London, S.W.—The London County Council invite tenders for the supply and delivery of 2,350 steel tyres, 31¾ in. diameter, for driving wheels, and 1,500 steel tyres, 21¾ in. diameter, for pony wheels for electric tramcars. Forms of tender and particulars obtainable from the Chief Officer, London County Council Tramways, 62, Finsbury-pavement, E.C. Tenders to Mr. G. L. Gomme, clerk of the County Council, County Hall, Spring-gardens, S.W., by July 6.

Greenwich.—The London County Council invite tenders for the supply and delivery of about 130,000 tons of coal of the kind known as washed singles to the generating station, East Greenwich, from Aug. 1, 1909, to July 31, 1910. Tenders, upon the official forms, obtainable from Mr. G. L. Gomme, clerk, County Hall, Spring-gardens, S.W., upon payment to the Cashier of the Council of the sum of £1 for the specification, etc. (returnable), must be sent in by July 13.

Salford.—The Electricity Committee of the Corporation invite tenders for the alteration and addition to buildings at the electricity works, Frederick-road, Pendleton. Plans, specification, and form of tender obtainable at the office of Mr. Victor A. H. M'Cowen, borough electrical engineer, Frederick-road, Pendleton, on payment of a deposit of £1. 1s. (returnable). Tenders, addressed to the Chairman of the Electricity Committee, must be sent to the office of the Electrical Engineer by July 6.

Pontypridd.—The Urban District Council invite tenders for the supply and delivery of an independent surface-condensing plant, together with circulating pump, air-pumps, pipework, etc., at the electric light and tramways department. Specification, general conditions, and form of tender obtainable from the Electrical Engineer and Manager upon payment of a deposit of £1. 1s. (returnable) to the Clerk. Tenders to Mr. J. Colenso Jones, clerk, Municipal Buildings, Pontypridd, by July 12.

London, E.C.—The Port of London Authority invite tenders for supplies of materials and stores, including carbons for electric lights and electric (incandescent) lamps. Specifications and forms of tender may be obtained on application at the Authority Stores Department, 106, Fenchurch-street, E.C., between the hours of 10 a.m. and 4 p.m.

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Tenders to Mr. Robert Philipson, secretary, Port of London Authority, 109, Leadenhall-street, London, E.C., by July 12. Full particulars in advertisement columns.

Leeds.—The Street-Lighting Committee of the Corporation invite tenders for the supply of the following materials during the ensuing year: copper lamps, lamp pillars, lamp furniture, pillar lamp irons and carriages, wall bracket irons, sheet copper and copper tops for lamps, glass for lamps. Particulars and forms of tender obtainable from the Superintendent of Street-Lighting, Springwell street Depôt, between 9 and 11 a.m. daily. Tenders to the office of Mr. Robert E. Fox, town clerk, Town Hall, Leeds, by July 14.

Dublin.—The Directors of the Great Northern Railway Co. (Ireland) invite alternative tenders for the supply of 1,500 tons or 3,000 tons of 90 lb. steel bullhead rails, with the necessary fishplates, and 500 tons or 1,500 tons of cast-iron chairs. Specifications and forms of tender obtainable from the Secretary on payment of 1s. each (not returnable). Sealed and endorsed tenders, on the forms supplied by the company, must be sent to Mr. T. Morrison, secretary, Amiens-street Terminus, Dublin, by July 5.

Egremont (Cheshire).—The Wallasey Urban District Council invite tenders for the supply, delivery, and fixing of a battery of accumulators, reversible booster, and switchboard. Copies of the specification can be obtained on payment of £1. 1s. (returnable) from Mr. J. A. Crowther, Sea View-road, Liscard. Tenders considered from makers only, and all material shall be as far as possible British manufacture. Tenders to the office of Mr. H. W. Cook, clerk, Public Offices, Egremont, Cheshire, by July 12.

Rotherham.—The Corporation invite tenders for the supply of electricity meters according to the requirements of the electric light department, between Aug. 1, 1909, and July 31, 1910. Ampere-hour meters of sizes for maximum currents of 2, 5, 10, 25 and 50 amperes. The supply pressure is 230 and 460 volts. Further particulars obtainable from the Borough Electrical Engineer. A contract containing the usual fair wages clause will be required to be entered into. Tenders to Mr. W. J. Board, town clerk, Rotherham, by July 13.

Manchester.—Tenders are invited for the supply of about 3,600 tons of welded steel pipes and collars, 44 in. and 40 in. diameter (Contract No. 9). Specification and form of tender obtainable from Messrs. G. H. Hill and Sons, civil engineers, Albert-chambers, Albert-square, Manchester, and 3, Victoria-street, Westminster, upon receipt of cheque for £2. 2s. (returnable). Documents to be sent back. Tenders, addressed to the Chairman of the Waterworks Committee, must be sent to the Secretary, Waterworks Offices, Town Hall, Manchester, by July 14.

Southend-on-Sea.—The Corporation invite tenders for the supply and delivery of approximately 1,450 tons of 33 in. cast-iron turned and bored pipes and specials. Copy of general conditions, specification, form of tender, and drawings can be obtained on application to the borough engineer, Mr. Ernest J. Elford, M.I.Mech.E., Municipal Buildings, Southend-on-Sea, on and after June 19, on payment of a deposit of £5. 5s. (returnable). Documents to be sent back. Tenders to the office of Mr. H. J. Worwood, town clerk (*pro tem.*), Town Clerk's Office, Southend-on-Sea, by July 8.

Cheltenham.—The Board of Guardians invite tenders for the carrying out of the following works: (*a*) chipping and cleaning two steam-boilers at the workhouse, the work to be done to the satisfaction of the Vulcan Boiler Insurance Co.; (*b*) providing and fixing to existing steam-boilers two cast-iron furnace mouthpieces; (*c*) brickwork—providing all materials and labour for renewal of furnace bridges and linings of new mouthpieces and all other necessary work required to boilers. Further particulars obtainable from the Master. Separate tenders must be sent to Mr. J. Meek, clerk, Union Offices, Swindon-road, Cheltenham, by July 7.

Eastleigh.—Persons desirous of tendering for the installation of low-pressure hot-water apparatus at the Eastleigh Derby-road Council School (1,200 children), in the county of Southampton, can, on deposit of £10. 10s., see plans, specification, and general conditions of contract, and obtain all other information at the office of Mr. W. J. Taylor, county surveyor, The Castle, Winchester, during office hours. No information sent by post. Deposits must be by cheque made payable to the Hants County Council and crossed "Bank of England." Endorsed tenders, on forms to be obtained from the County Surveyor, must be sent to Mr. H. Barber, clerk of the County Council, The Castle, Winchester, by July 12.

Swansea.—Tenders are invited for the supply, etc., of the following to the Corporation Electricity Department: (Contract 30) supply, delivery, adjusting, and testing of continuous and alternating current enclosed-type arc lamps, resistances, choking coils, etc.; (31) supply and delivery of plain lead-sheathed two-core conductor, fibre-insulated 660-volt cable (suitable for a draw-in system), also rubber-insulated and braided single-conductor arc lamp cable for a working pressure of 550 volts; (32) supply, delivery, adjusting, and testing of arc lamp raising and lowering gear, winches, wire rope, arc lamp pillars and brackets, together with all required clamps, straps, bolts and nuts, etc.; (33) supply and delivery of arc lamp feeder pillars, complete with switch and fuse gear, time switches, 'bus bars, sweating sockets, connections, and accessories, also cable joint boxes, complete with fittings, glands, bonds, compound, etc. Copies of the general conditions, specifications, and forms of tender obtainable from Mr. O. A. L. Prusmann, borough electrical engineer, Swansea, on payment of £1. 1s. for each of the specifications, etc. (returnable). Additional copies can be obtained on payment of 10s. per copy, which amount will not be returned. Contractors may tender for all or any of the contracts. Tenders to be sent to the office of Mr. Jno. Thomas, town clerk, Guildhall, Swansea, by July 7 for Contracts 30 and 31, and July 14 for Contracts 32 and 33.

COLONIAL AND FOREIGN.

Cologne.—The Municipality invite tenders for the supply of four electrically-driven lifts. Tenders by July 15.

Victoria.—The Postmaster-General invites tenders for the supply of 5,000 telephones complete. Tenders by Aug. 10.

Vernon.—The Municipality invite tenders for the provision of two gas motors. Particulars from the Maire. Tenders by July 27.

Bukarest.—The Roumanian State Railways Department invite tenders for the supply of steel tyres and copper tubes. Tenders by July 5.

Madrid.—Tenders are invited by the Public Works Department for the construction and working of a railway from Villajoyoso to Denia. Tenders by July 31.

Madrid.—The Public Works Department invite tenders for the construction and working of a railway from Cornellana to Cangas de Tinas. Tenders by July 8.

Emden.—Tenders are invited for the supply of two electrically-driven dredgers. Particulars can be obtained from K. Maschinen-bau-inspection. Tenders by July 20.

Stanislaw.—The Austrian State Railways Department invite tenders for the supply of a tubular boiler. Particulars from K. K. Staats-Eisenbahn. Tenders by July 15.

Rockhampton (Australia).—The City Council invite tenders for the provision of low-lift pumping plant. Specifications from the town clerk, Mr. T. V. Nobbs. Tenders by July 14.

Sofia.—Tenders are invited by the Bulgarian State Railways Department for the supply of bolts and rivets. Particulars from the District Finance Commission. Tenders by July 9.

Victoria.—The Postmaster-General invites tenders for the supply and delivery at the post office, Hawthorn, of eight sections of a common-battery switchboard and subscribers' apparatus. Tenders by Sept. 14.

Santiago.—Tenders are invited by the Chilian Railways Department for the supply of rails, fishplates, dog-spikes, and bolts. Particulars from the Direccion-General de Obras Publicas. Tenders by Sept. 1.

Saarbrucken.—Tenders are invited for the supply of seven travelling cranes, one fixed crane, and the provision of a transporter bridge. Particulars from the Preussischen Staats-Eisenbahnen. Tenders by July 19.

Sydney (N.S.W.).—The Postmaster-General invites tenders for the supply and delivery at departmental stores, Sydney, of 150 relays non-polar W.E. Co.'s type 12,505 wound to 250 ohms to schedule. Tenders by July 21.

Adelaide.—The Municipal Tramways Trust invites tenders for the supply and delivery of machine tool equipment. Particulars from Mr. W. G. T. Goodman, chief engineer and manager, to whom tenders must be sent by July 6.

Brussels.—Tenders are invited by the Scciété Nationale des Chemins de fer Vicinaux for the equipment of a sub-station in connection with the Spa to Verviers line—alternating current to direct current. Tenders by July 14.

Paris.—The Municipality invite tenders for the provision of a steam motor and dynamo. Particulars from the Ingenieur-en-Chef, Chef du Service Technique des Eaux et de l'Assainissement, 9, Place de l'Hôtel de Ville. Tenders by July 15.

Paris.—Tenders are invited by the French State Railway Department for the supply of tirefonds, steel bolts for fishplates, steel axle boxes, and other railway materials. Particulars can be obtained from the Direction, 42, Rue du Chateaudun. Tenders by July 8.

Rome.—The Italian State Railways Department invite tenders for carrying out various works of railway construction in connection with the Bivio-Sciacca-Bivio Greci Porto Empedocle line. Particulars from the Direzzione Generale, Ferrovie dello Stato. Tenders by July 20.

Melbourne.—The Corporation invite tenders for the supply of one direct-current steam-driven generating set. Tender form, conditions of tender, specification, and plans can be obtained on application to Messrs. McIlwraith, McEacharn, and Co., Ppty., Billiter-square-buildings, London, E.C., agents for Melbourne City Council. Tenders to the Town Clerk, Town Hall, Melbourne, by July 14.

Adelaide.—The Municipal Tramways Trust invite tenders for the erection of buildings for power station on the site of Ocean Steamers' Wharf, Port Adelaide. The sum of 10 guineas will be charged per copy of specification, which will only be refunded on receipt of *bona fide* tender and return of specification. Particulars from Mr. H. C. Mais, 31, Queen-street, Melbourne. Tenders to Mr. W. G. T. Goodman, chief engineer and general manager, 8, King William-street, Adelaide, by July 27.

Melbourne (Australia).—The Corporation invite tenders for the supply of one overhead travelling crane. Tender form, conditions of tendering, specification, and plans, etc., can be obtained on application to Messrs. McIlwraith, McEacharn, and Co., Billiter-square-buildings, London, E.C., agents for Melbourne City Council, by depositing the sum of £1. 1s., which amount will be returned on receipt of a *bona fide* tender. Tenders to the Chairman, Electrical Supply Committee, Town Hall, Melbourne, by 2 p.m. on Aug. 4.

Christiania (Norway).—The Commercial Intelligence Branch of the Board of Trade have received from his Majesty's Consul at Christiania copies of the conditions and specification relative to a call by the Norwegian State Railways for tenders for the supply of 28,800 pairs of carbon points of various dimensions. Tenders, marked "Anbud paa Kulspidser," must be sent to Styrelsens Expeditions Kontor by 3 p.m. on July 2. Copies of the conditions and specification can be seen by British firms interested on application at the

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Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

Brisbane (Australia).—The Board of Waterworks invite tenders for the supply of 42-in. and 48 in. steel pipes, or alternatively 42 in. and 48-in. wrought-iron pipes or 42 in. and 48-in. cast-iron pipes. The whole of the material to be used in the manufacture of the pipes must be the product of the United Kingdom or of the Commonwealth of Australia. Specifications and drawings can be obtained on application at the office of the Engineer to the Agent General for Queensland, 409 and 410, Strand, London, W.C., on payment of a fee of £3. 3s. Tenders must be sent to the Secretary, Brisbane Board of Waterworks, Brisbane, Queensland, by Sept. 1.

Christiania (Norway).—The Commercial Intelligence Branch of the Board of Trade are notified by his Majesty's Consul at Christiania that tenders are invited by the Norwegian State Railways for the supply of 8,300 tons of steel rails. Tenders, marked "Anbud paa Skinner," must be delivered at Styrelsen for Statsbanernes Expeditions kontor by July 9. A copy of the specifications and conditions of tender, together with drawings, may be inspected by British makers on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C., on any day between the hours of 10 and 5 (Saturdays, 10 and 1).

Rome (Italy).—The Rome *Gazzetta Ufficiale* of June 17 announces that tenders are invited for the construction of the Ostiglia-Nogara section of the Bologna-Verona Railway, nine miles long, and of various junctions. The upset price is placed at 3,650,000 lire (£146,000), and the competition will turn on the percentage of reduction offered thereon. To qualify any tender a deposit of 182,000 lire (£7,280) will be required, to be increased by the successful tenderer to 365,000 lire (£14,600). Tenders must be enclosed in sealed envelopes, marked on the outside "Offerta per Asta: tronco Ostiglia-Nogara," and addressed to Direzzione-Generale delle Ferrovie dello Stato (servizio 1, ufficio contratti), *via* Ludovisi 4, Rome, where they will be opened on July 31. Tenderers will be required to furnish certificates of competency. The award in respect of this competition will no doubt involve the purchase of a substantial quantity of permanent-way material, which may have to be obtained wholly or in part out of Italy. The *Gazzetta*, containing further particulars, can be seen by British firms interested on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall street, London, E.C.

Winnipeg (Canada).—The Board of Control invite tenders for the manufacture, delivery, and erection of the hydraulic, electric, and auxiliary equipment of the municipal generating station at Point du Bois, on the Winnipeg River. Specifications and plans will be on exhibit at the offices of the following: *Engineering*, London, England; *Engineering News*, New York City; Smith, Kerry, and Chace, Toronto; Wm. Kennedy, jun., Y.M.C.A. Building, Montreal; and Smith, Kerry, and Chace, Winnipeg. Copies of the instructions to bidders, of the plans, specifications, and form of tender can be obtained from the Power Engineer's Office, Carnegie Library Building, Winnipeg; and at the office of *Engineering*, London, England; but the application for these must be accompanied by deposit, as listed below, for each section applied for. This deposit will be returned to the applicant only upon the return to the Power Engineer's Office of the plans and specifications in good order. Each tender must be accompanied by a certified cheque payable to the City Treasurer for the sum called for in the corresponding instructions to tenderers, which cheque will become forfeit to the Corporation in the event of the successful tenderer refusing or neglecting to execute a satisfactory contract when called upon so to do. Tenders will be received upon the following sections: (A) Specifications Nos. 5 and 6—five 5,250-h.p. turbines and two 450-h.p. turbines; deposit, 250 dol. This tender returnable Aug. 2, 1909. (B) Specifications Nos. 7, 8, and 11—five 3,000 kw. generators, two 250-kw. generators, and switching and accessory apparatus; deposit, 250 dol. (C) Specification No. 10—six step-up transformers; deposit, 100 dol. (D) Specification No. 12—light, heat, and power systems; deposit, 50 dol. (E) Specification No. 23—protective apparatus; deposit, 50 dol. (F) Specification No. 25—three electric travelling cranes; deposit, 50 dol. (G) Specification No. 27—auxiliary apparatus; deposit, 100 dol. As an alternative, tenderers may include or group together one or more of the above sections, providing that they have also tendered for the individual sections of such grouping. Tenders, addressed to the Chairman of the Board of Control, must be sent to the office of Mr. M. Peterson, secretary, Office of the Board of Control, Winnipeg, Canada, by Aug. 2 and 16.

Pretoria (Transvaal).—The Department of Land and Irrigation of the Transvaal Government invite tenders for the supply of portable non-traction percussion rope drilling machines capable of drilling a hole of 6 in. diameter to a depth of 1,000 ft. Full particulars and sketches regarding the following points must be given: Frame of machine—Dimensions, length, width, whether wood or iron. Wagon wheels—Diameters, whether of wood or iron, width of tyres sizes of axles, and details of bushing. Boiler—Dimensions, type, thickness of plates, number of tubes, staying, firegrate area, horse-power, whether fitted on frame of machine or separate on wheels. Boiler and mountings must comply with Government machinery regulations of the Transvaal, and working pressure must not be less than 100 lb. per square inch. Copies of these regulations may be obtained on application to the Agent-General for the Transvaal, 72, Victoria-street, S.W. Engine—Type, diameter of cylinder, length of stroke, nominal and brake horse-powers, vertical or horizontal, and whether reversible. Spudding and beam attachments—Details of spudding and beam attachments, and how operated; sketches showing working of gears. Hoisting and sandline gears—Details of cable and sandline spools and shafts, and how operated; sketches showing working of gears. Derrick—Dimensions, height from ground to top of crown pulley, diameter of crown and sandline pulleys, whether single-pole or frame type. Tools—Each machine to be equipped with the following tools: one "New Era" rope socket, to take 1¼ in. manilla rope; one set 5½-in. steel drilling jars; one auger stem, 4 in. by 20 ft.; two 6 in. drilling bits, heavy section, with 150-lb. steel each; two 8 in. drilling bits heavy section, with 175-lb. steel each; two heavy tool wrenches, with 3½-in. square; one set 3½ in. heavy-drive clamps, with wrenches; one Barrett or Forgie jack, with rack complete; one 1½ in. diameter ball-bearing temper screw, to let out 4 ft.; one 12-in. rotary steam forge blower. Height—For convenience of transport by rail, machine when dismantled must not exceed 9 ft. in height from axles. Weight—Total weight of boiler and machine fully equipped. Tenderers for shipment to South Africa must quote free on rail South African ports, and if shipment is to take place from United Kingdom ports, or from ports on the Continent of Europe between Bordeaux and Hamburg (inclusive), tenderers must undertake to ship by vessels of the South African steamship lines, under the provisions of an agreement with the Transvaal Government, particulars as to which can be obtained on application to the Agent-General for the Transvaal, 72, Victoria-street, Westminster, London, S.W. Tenderers should state time required to deliver any given number of drills at a South African port after receipt of order, and should submit separate tenders for the supply of 10, 20, or 30 drills, which must, before acceptance, be erected (at port of delivery, if imported) and tested under steam to the satisfaction of the Chief Engineer, Irrigation, and if accepted must be loaded free on rail. Tenders must be sent to the Chairman of the Tender Board, P.O. Box 376 (or Room No. 53, Law Courts Buildings), Pretoria, Transvaal, by July 9.

RESULTS OF TENDERS.

Whitehaven.—The Corporation have accepted the tender of the Phœnix Dynamo Co. for the supply of a balancer.

Oldbury.—The tender of Stott and Son has been accepted for the installation of heating apparatus at Warley Schools for £485.

Walsall.—The Electricity Committee have accepted Doulton and Co.'s tender to lay 1,000 yards of stone troughing at 5d. a yard.

Willow Town.—The tender of W. A. Baker, Newport, has been accepted for installing heating apparatus at Willow Town new schools, at £318.

Swinton.—The Swinton and Pendlebury Urban District Council have accepted the tender of Callender's Cable and Construction Co. for the supply of cable, service boxes, etc., for £121.

Southampton.—The tender of Glover and Co., Manchester, has been accepted for the supply of sundry heavy cables for low-tension trunk mains required by the electricity department.

Hereford.—The Corporation have accepted the following tenders for the provision of machinery: Parkinson and W. B. Cowan, 10 in. governor, £41; Jenkins, four new coal hoppers, £19. 10s.

Devonport.—The Education Committee have accepted the tender of Corse and Co., 53, Union-street, Plymouth, amounting to £238, for the installation of electric light at the higher elementary schools.

Alloway.—The Alloway and Ayr Landward School Board have accepted the tender of D. Kirkland, Ayr, for the erection of an electric sub-station in the north-west corner of the school-house grounds.

Grimsby.—The Corporation Electric Lighting Committee have accepted the tender of M'Phail and Simpson for superheaters at £256, and that of Hebb and Co. at £140 for the renewal of dripping bars in existing cooling tower.

Aberdeen.—The Town Council have accepted the following tenders for the supply of material required for the reconstruction of the railway between the harbour and the gasworks: Fyfe, and A. and F. Manuelle, setts; Leith, metal and chips.

New South Wales. — The tender of J. Budge, Pyrmont, has been accepted for the supply and installation of refrigerating plant, together with electric motor of approved type, at Hawkesbury Agricultural College, Richmond, for the sum of £460.

Battersea.—The Borough Council have accepted the following tenders for annual supplies: British Thomson-Houston Co., incandescent electric lamps; Electrical Co., Nernst lamps and fittings; Price's Patent Candle Co., oils (electricity department) and soaps, oils, etc; Sloan Electrical Co., carbons for arc lamps, etc.

Boroughbridge.—The Ouseburn Rural District Council have received the following tenders for the installation of a sewage-disposal plant, including engine, tank, and engine-house, in connection with the disposal of the sewage of Boroughbridge: J. T. Hynas, Barton Leonard, £184. 11s.; F. Boddy, Boroughbridge, £119. 12s.

Glasgow.—The Corporation have accepted the tender of Glenfield and Kennedy, Kilmarnock, for the provision of a Blackman fan, 60in. diameter, fitted with special electrical motor, switch, and fuses one starting and speed regulating rheostat, and one set of louvred shutters, at £84. 18s., in connection with improvements at the sewage works.

Prahran (Australia).—The Prahran and Malvern Tramways Trust have accepted the following tenders: Noyes Bros., fastenings, bonds, etc., £89, 90 tons of rails, £623, 24 centre poles at £3. 14s., span poles at £4. 8s., anchor poles at £6. 4s., etc.—total £272, for steel poles; E. Allen and Co., Sheffield, construction of two loop lines, £154.

Mexborough.—The Electric Lighting Committee recommend the acceptance of the following tenders: Stewarts and Lloyds, Birmingham, pipework, £159. 10s.; Paterson Engineering Co., London, softener, etc., £193; Siemens Bros., Stafford, steam set with Bellis and Morcom engine and Korting condenser, £892. 10s.; Drake and Gorham, London, switchboard extension, £83.

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Sculcoates.—The Sculcoates Works Committee have recommended the Board to accept the tender of Greenwood and Batley, Albion Works, Leeds, for £165, for the supply and erection of a steam-driven dynamo at the workhouse, with £7. 15s. for steam dryer and trap.

Victoria.—The Railway Department have accepted the tender of A. Chattingsworth for the construction and erection of a steel verandah for No. 1 platform, Flinders-street new station, and that of C. Ebling for the construction and erection of 6,000-gallon combined tank and crane at Moorabbin, at £99.

Bedford.—The Town Council have placed an order with Allen, Son, and Co. for the supply of an exciter for the No. 7 alternator for £98. 10s., and also for the supply of an exciter for the No. 9 alternator for £150. The tender of Chas. Frankin has been accepted for the supply during the year ending June 30, 1910, of about 4,000 tons of "Cotes Park" coal at 10s. 10d. per ton, and about 1,500 tons of "Colliery small" at 9s. 7d. per ton, and of Ellis and Everard for the supply of about 1,000 tons of Newstead coal at 11s. per ton, for use at the generating station.

London.—The tender of Hurst, Nelson, and Co., amounting to £78,000, for the manufacture, supply, and delivery of 200 car bodies has been accepted by the London County Council; also of £23,900 for the manufacture, supply, and delivery of 200 sets of maximum traction swing bolster car trucks. The British Westinghouse Electric and Manufacturing Co. have successfully tendered for the manufacture, supply, and delivery of the electrical equipments required for the assembly of 200 cars, their price being £63,650; also for the supply, etc., of 200 sets of magnetic brake equipments for electric cars at the figure of £11,400. A full list of the tenders received appeared in our last issue.

Dublin.—The following tenders have been received for the installation of electric motors at Messrs. Tonge and Taggart's iron-foundry, Windmill-lane. Mr. A. E. Porte, M.I.E.E., electrical engineer:

J. Brunker, St. Andrew-street, Dublin (accepted)	£249	0	0
F. G. Sherwood, 12, Fleet-street, Dublin	255	0	0
J. C. Meldon, South Anne-street, Dublin	264	0	0
G. Farmer, Dame-street, Dublin	264	10	0
Egan and Tatlow, Fleet-street, Dublin	291	0	0
Cummins and Son	292	0	0
Mecredy, Eaton, and Davidson, Middle Abbey-street, Dublin	299	0	0
W. Coates and Son, Leinster-street, Dublin	325	0	0
Fletcher and Phillipson	369	5	0
Keatings, Limited	400	17	6

London, E.C.—The London County Council have received the following tenders for the execution of the roadwork and platelaying, exclusive of the supply of rails and special trackwork, in connection with the construction, on the underground conduit system of electric traction, of the authorised tramways along the Victoria-embankment east of John Carpenter-street, Blackfriars road and Southwark-street:

R. O. Brebner and Co., Edinburgh*	£11,420	6	0
Dick, Kerr, and Co., Abchurch-yard, E.C.	12,055	4	5
A. N. Cole, Westbourne Park	12,945	5	5
W. Manders, Leyton	13,598	13	10
J. Mowlem and Co., Westminster	14,707	0	0

Chief engineer's estimate, £11,953. 8s. 4d.

* Recommended for acceptance, with permission to sublet the following portions of the work—namely, (1) to Doulton and Co., the porcelain insulators; (2) to the Anderston Foundry Co., the cast-iron work; (3) to Bayliss, Jones, and Bayliss, the steel and wrought-iron work; (4) to the Improved Wood Pavement Co., the wood block paving; and (5) to J. Fyfe and Co., the paving setts.

Barking.—The following tenders have been received by the Electricity Committee of the District Council:

250-kw. three-phase alternator.

Brush Electrical Engineering Co.	£354	10	6
General Electric Co.	360	10	0
Crompton and Co. (accepted)	340	0	0
Electrical Construction Co.	405	0	0
Electrical Co.	395	0	0
British Thomson-Houston Co.	402	0	0
Vickers, Sons, and Maxim	456	0	0
Bruce Peebles and Co.	450	0	0
British Westinghouse Co.	438	0	0
Siemens Bros. Dynamo Works	536	0	0

Switchboard.

Brush Electrical Engineering Co.	112	5	0
General Electric Co.	154	0	0
Crompton and Co.	175	0	0
Electric Construction Co.	116	0	0
Electrical Co.	127	17	6
British Thomson-Houston Co.	143	0	0
Vickers, Sons, and Maxim	109	10	0
Bruce Peebles and Co.	120	0	0
British Westinghouse Co.	135	0	0
Siemens Bros (accepted)	102	0	0
Ferranti Limited	109	10	0

Motor.

Electrical Co.	100	0	0
British Thomson-Houston Co.	110	0	0
Bruce Peebles and Co.	107	10	0
British Westinghouse Co.	113	0	0
Brush Electrical Engineering Co.	32	12	6
General Electric Co.	87	0	0
Crompton and Co.	90	0	0
Electric Construction Co.	83	0	0
Vickers, Sons, and Maxim	91	10	0
Siemens Bros. (accepted)	80	5	0

PROVISIONAL PATENTS, 1909.

JUNE 18.

14318. Improvements in electrolytic apparatus having a liquid anode. Otto Schott and Carl-Zeiss Stiftung, trading as Schott and Gen, 29, Margaret street, Regent-street, London. (Date applied for under Section 91 of the Act, June 26, 1908, being date of application in Germany. (Complete specification.)

14330. Improvements in and relating to the electrical operation of gun mechanism and the like. Henry Cooke Leake, 322, High Holborn, London.

14352. Improvements relating to the fault protection of cables in electrical current distribution systems. William Charles Henry Maurice Georgi and A. Reyrolle and Co., Limited, 46, Lincoln's-inn-fields, London.

JUNE 19.

14363. Improvements in direct-working telephones for intercommunication purposes. Edwin Alfred Davis, 19, Seymour-road, Bath.

14391. Improvements in dynamos or electrical motors. John Halifax Garty, 151, St. Vincent-street, Glasgow. (Complete specification.)

14398. Improvements in electric switches and switch fuses. Herbert Henry Berry and William James Markham, 78, Upper Thames street, London.

14431. New or improved method of and means for preventing the pulsation of electric currents generated by small dynamos and rotary converters. Arnold Schulze, 31, Bedford-street, Strand, London. (Complete specification.)

JUNE 21.

14439. Electric bacteria destroyer tanks. Thomas Williams, 1, Gilfach-street, Bargoed, Glam.

14450. Improvements in methods of balancing three-wire systems. Alfred Mills Taylor, "Avondale," Ashfield-road, King's Heath, Birmingham.

14456. Improvements in auto-transformers for use on alternating-current circuits. Alfred Mills Taylor, "Avondale," Ashfield-road, King's Heath, Birmingham.

14457. Improvements in telephone exchange electric selecting systems. John Edward Kingsbury, 24, Southampton-buildings, London. (Western Electric Company, United States.) (Date applied for under Rule 13, Aug. 15, 1908. An invention comprised in application No. 17209, dated Aug. 15, 1908.)

14505. Improvements in and relating to electric arc lamps. Siemens Bros. Dynamo Works, Limited, Caxton House, Tothill-street, Westminster. (Siemens-Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

14548. Improvements in electric ovens. Joseph Gershom Childs and Thomas Sidney Hill, 322, High Holborn, London.

JUNE 22.

14579. Improvements relating to controllers for polyphase alternating-current induction motors. Benjamin Garver Lamme, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Section 91 of the Act, July 6, 1908, being date of application in United States.) (Complete specification.)

14582. Bonding and electrical continuity device. George Clarkson, 65, Okehampton-road, Brondesbury Park, London.

14598. Insulating cover for switch lampholders and ordinary lampholders. Meyer H. Goldstone and John Lightfoot, Sampson Works, Salford, Manchester.

14622. Improvements in or relating to non-interchangeable safety fuses for electrical circuits. Siemens-Schuckertwerke G. m. b. H., 139, Queen Victoria-street, London. (Date applied for under Section 91 of the Act, June 23, 1903, being date of application in Germany.) (Complete specification.)

14623. Improvements in apparatus for controlling a plurality of independent electric circuits. James John Stockall, jun., 290, Dashwood House, London.

14655. Improvements relating to the process of carbonising metallic glow lamp filaments manufactured with organic binding agents. Wolfram Lampen Akt.-Ges. and Otto Gelb, 31, Bedford-street, Strand, London. (Date applied for under Section 91 of the Act, Feb. 15, 1909, being date of application in Germany.) (Complete specification.)

14660. Improvements in electrolytic apparatus. William Thum, 46, Lincoln's-inn-fields, London. (Complete specification.)

JUNE 23.

14674. Improved device for controlling electric arc lamp carbons. Harley Dowding Weaver, 115, Vicarage-road, Wednesbury.

14675. Improvements in or relating to the suspending or supporting of electric incandescent lamps and the like, and to the raising and lowering of the same. John Lear, Gough-chambers, Savile-street, Hull.

14685. Improvements in and relating to electro-mechanical apparatus for the transmission, reception, and indication of preconcerted signals. Albert Edwin Vickery, 67, Goschen-street, Devonport.

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14717. Improvements in telegraphic instruments. Gordon Lissa Higgins, 20, Australian-avenue, London.

14731. Improvements in speed-control and braking apparatus for electrically-propelled vehicles. Willis Nelson Stewart and Edward Foss, 24, Gloucester-road, Finsbury Park, London.

14732. Improvements in and relating to the mounting or supporting of electric motors on electrically-propelled vehicles. Willis Nelson Stewart and Edward Foss, 24, Gloucester-road, Finsbury Park, London.

14763. Improvements in and relating to electric filament lamps and the like. Arthur Edwin Lamkin and Tom Rhodes Nuttwick, 1, Imperial-buildings, East Croydon.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on July 8.)

1908.

4666. Electric meters. Winn. (Post-dated, Sept. 2, 1908.)

10611. Alternate-current motors. Fynn.

10680. Safety devices for electric heating apparatus for liquids. British Prometheus Company, Cooper, and Sharp.

12736. Method of and means for adjustably suspending electric incandescent lamps. Heldbek.

12738. Electro-magnetic power velocity ratio devices, particularly applicable for driving automobiles and the like. Midgley and Vandervell.

13048. Automatic cut-out device for electrical conductors in tramway systems. Newbould.

13092. Electric transformers. Akt-Ges. Brown, Boveri, et Cie. (Date applied for under International Convention, June 28, 1907.)

13101. Party-line telephone selectors and cut-outs. Williams. (Rights under Section 91, Patents, etc., Act, 1907, not granted.)

13130. Apparatus for operating railway points and signals. Sykes and W. R. Sykes Interlocking Signal Company.

15341. Electric insulator. Graham.

15936. Automatic electric switches. Davy.

16126. Starting switches for electric motors. Garside.

16299. Electric voltage regulators. British Thomson-Houston Company. (General Electric Company.)

17112. Electrically-operated apparatus for controlling the movements of points or switches on tramways or railways. Munro and Rogers.

18628. Electric ignition appliances. Low.

18925. Method and apparatus for adjusting electrical resistances. Cox.

20633. Electrical recording instruments. Bevis and Penicud. (Post-dated Feb. 12, 1909.)

20708. Electric switches. Koe.

22263. Electrical alarm clocks Smith and Hearin.

23116. Electric candle fittings. Hirst and Collings.

24815. Electrical instrument for pyrogravure and surgical purposes. Berville.

25537. Means for starting and regulating compensated electric repulsion motors. Allmanna Svenska Elektriska Aktiebolaget. (Date applied for under International Convention, Nov. 27, 1907.)

27207. Time switches for gas or water cocks or valves and electric switches. Riasch.

27470. Manufacture of inductance coils for telephone cables and the like. Smith and Granville. (Cognate application, 4376/09.)

28438. Apparatus for transmitting power at a reduced and variable speed by means of dynamo-electric generators and motors Johannet. (Date applied for under International Convention, Feb. 3, 1908.)

1909.

78. Apparatus for controlling electric motors. Dey.

590. Continuous-current dynamo-electric machines. Marchal. (Date applied for under Rule 13, Aug. 14, 1908.)

2374. Electric servo-motors. Conade (Date applied for under International Convention, Feb. 25, 1908. Application for patent of addition to No. 3327/07.)

2379. Vents for use with electric accumulators or batteries. Cowderoy, and Reason Manufacturing Company.

3028. Electric liquid heater. Cutler and Barnett.

3599. Electrical induction furnaces. Grunwald. (Date applied for under International Convention, May 7, 1908.)

4576. Carbonic acid engine in which the carbonic acid is heated by electricity. Horst.

7396. Electrical induction furnaces. Grunwald. (Date applied for under International Convention, Aug. 15, 1908.)

8535. Fuse and switch boards. Schmahl and Henderson.

9987. Lightning arrester for overhead lines. Krause. (Date applied for under International Convention, July 29, 1908.)

12985. Electrically-heated cooking apparatus. Lowden. (Date applied for under Rule 13, June 12, 1908.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos 1-70,000	1	–	½-⅝
—— Ord., 1,125,000	1	–	½-⅝
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	23/32-27/32xd
—— Ordinary, Nos. 1-125,000	1	–	11/32-15/32xd
British Aluminium Co., Ordinary, 2,001-40,000	5	–	1-1¼
—— 7 per cent. Cum. Pref., 1-40,000	5	–	2¼-2⅜
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	–	3⅜-3½
—— 4 per cent. Funding Certificates, 1-20,000	5	–	3¼-4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	86-93
—— 5½ per cent. Loch Leven Deb. (Reg.), Red., 1-3,000	100	–	96-100
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	7⅛-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	–	6⅜-6½
—— 4½ per cent. Mortgage Debentures	100	–	105-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	91-96
British Westinghouse Elec. and Manuf. 10 per cent. Pref. 275,001-475,000	3	–	3/16-7/16
—— 4 per cent. Mortgage Debenture Stock	100	–	40-45
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	–	0-¼
—— Non. Cum., 6 per cent., Pref.	2	–	0-¼
—— 4½ per cent. 1st Debenture Stock	100	–	43-48
—— 4½ per cent. 2nd Debenture Stock	100	–	27-31
Callender's Cable, Debentures	100	–	105-107
—— Ordinary	5	–	9⅜-10⅜
—— 5 per cent. Pref.	5	..	5⅛-5½
Consolidated Electrical Co., Ordinary, 1-110,000	1	–	7/16-9/16
Crompton and Co., Nos. 1-85,000	3	..	1-1¼
—— 5 per cent. 1st Mort. Reg. Debs., Nos. 1-900 of £100, and 901-1,100 of £50, Red.	—	..	94-97
Dick, Kerr and Co., Ordinary, 1,260,000	1	–	1 1/16-1¼
—— 6 per cent. Cum. Pref., 1-305,000	1	–	1 3/32-1 7/32
—— 4½ per cent. Debenture Stock, Red.	100	–	99-102 xd
Edison and Swan United, "A" Shares, 1-99,261	5	–	¼-⅜
—— "A" Shares, 01-017,139	5	–	14-¼
—— 5 per cent. Debentures	100	..	6⅞-7
—— 4 per cent. Deb. Stock, Red.	100	..	96-98
Electric Construction, Nos. 1 to 112,100	2	..	7/16-½
—— 7 per cent. Cumulative Pref.	2	..	1 7/16-1 11/16
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	59-65
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	71-77
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	7⅛-7½ xd
—— 4 per cent. 1st Mort. Deb. Stock	100	..	86-88
W. T. Henley's Telegraph Works, Ordinary	5	..	11⅛-12⅛
—— 4½ per cent. Preference	5	..	5-5⅛
—— 4½ per cent. Debentures	100	..	104½-106½
India Rubber, Gutta Percha, and Telegraph Works	10	..	14½-15½
—— 4 per cent. Debentures	100	..	99-101
National Electric Construction Co., 1-170,000	1	–	¼-½
Telegraph Construction and Maintenance	12	..	35-37½
—— 4 per cent. Bonds	100	–	101-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	–	9½-10½ xd

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	–	5⅛-5⅜
Bournemouth and Poole, Ordinary	10	–	9½-10
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9⅝-10⅛
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	10¼-1 ⅜
—— 4½ per cent. Debenture Stock, Red.	100	–	99-103 xd
Bromley (Kent) Electric Light and Power Co.	5	–	4¼-5
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	85-96
Brompton and Kensington, Ordinary	5	–	8¼-8¾
—— 7 per cent. Preference	5	–	8-8½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-100,000	5	–	5⅛-6¼
Cambridge Electric Supply Company, £10 Ord.	8	–	12¾-13¾
Canadian General Electric Co., Common Shares	$100	–	117-120 x
—— 7 per cent. Cum. Pref. Stock	$100	–	121½-123½
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	–	97-100
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	–	3¼-3⅜
—— 4½ per cent. Cum. Pref., 1-80,000	5	–	4⅛-4¼
—— 4 per cent. Debenture Stock, Red.	100	..	98-99 xd
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000	5	..	3⅜-4⅛ xd
Chelsea Electricity Supply	5	–	3⅜-4
—— 4½ per cent. Debentures	100	–	100-103 xd
City of London, Ordinary	10	–	10½-11
—— 6 per cent. Cumulative Pref.	10	..	11½-12⅜
—— 5 per cent. Debenture Stock	100	..	119-122 x d
—— 4½ per cent. 2nd Deb. Stk., Red.	100	–	99-102 xd
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	–	90-93
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	2⅜-3¼
—— 5 per cent. Preference, 1-50,000	5	..	3¼-3⅜
County of London Elec. Supply, Ordinary	10	..	8¼-8⅜
—— 6 per cent. Cum. Pref.	10	..	10⅛-11¼
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	..	104-107
—— 4½ per cent. 2nd Debentures Prov. Certs	100	..	100-103
Edmundson's Electricity Corporation, Ordinary, 1-80,000	5	..	5/16-5/16
—— 6 per cent. Cum. Pref.	5	..	⅜-½
—— 4½ per cent. First Mort. Deb.	100	..	60-63
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	—	..	87-89 p.c.
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	–	85½ 83½ xd
Folkestone Electric Supply, Ord., Nos. 1-10,000	5	–	4¼-5
—— 5 per cent. Cum. Pref., Nos. 1-10,000	5	–	5-5¼
—— 4½ per cent. First Deb. Stock, Red.	100	–	98-101
Hove Electric Lighting, Ord., 1-13,000	5	–	7¼-7
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	5	–	1½-2
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100	–	74-78
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	–	25/32-⅞
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5	–	6¼-7
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	–	98-101

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Name.	Amount paid. £		Last price. £
London Electric Ordinary	5	—	1¾-2¼
—— 6 per cent. Pref.	5	—	5⅛-5⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red	100	—	90-94
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	—	76-80
Metropolitan Ordinary, 100,001-300,000	5	—	4⅜-4⅝
—— 4½ per cent. First Mortgage Debenture Stock	100	—	105-108 xd
—— 4½ per cent. Cum. Pref.	5	..	4⅜-5⅛
—— 5½ per cent. Mortgage Debenture Red.	100	..	83½-85½
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1-935, O 1-1,000 ($100) D 1-3,000 ($500) M 1-4,400 ($1,000) ($500) 4,001-14,000 ($1,000)	—	..	83-85 p.c.
	—	..	87-89
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	95-98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-87,500	5	..	4⅜-5¼
—— do, 87,501-137,500 (issued at £1 prem.). All paid (Prov. Certs.)	5	..	4⅜-5
—— do., 5 per cent. Pref., 1-87,500 (Prov Certs.)	2	..	4⅛-5⅜
—— 5 per cent. Pref., 87,501-137,500 (Prov. Certs.)	4	..	4⅜-5½
Notting Hill Electric Lighting	10	..	11½-12½
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	..	6-6½
—— 4 per cent. Debenture Stock	100	..	94-97
River Plate Electricity Co., Ord., 1-119,667 & 120,501-120,507	1	..	1⅛-1½
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	1 1/32-1 5/32
—— 5 per cent. Debenture Stock, Red	100	..	102-105 xd
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20,000	5	..	5 5/16-5 9/16
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5	..	5⅜ 6
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	102-104
Shawinigan Water and Power. Co., 5 p.c. Cons. 1st Mt. Bds.	—	..	106-108 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	..	9/16-13/16
South London, Ordinary	4	..	2⅜-3½
South Metropolitan Electric Light and Power, Ord.	1	..	5/16-7/16
—— 7 per cent. Cum. Pref.	1		1 2/16-1 5/16
—— 4½ per cent. 1st. Mort. Deb.	100	..	100-103
St. James's and Pall Mall, Ordinary, 101-80,080	5	..	8¾-9½
—— 7 per cent. Pref.	5	..	7-7½
—— 3½ per cent. Deb.	100	..	84-88
Urban Electric Supply Co., Ordinary, 8-30,007	5	..	⅝-1
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	1¼ 2⅜
—— 4½ per cent. First Mort. Debenture Stock, Red.	100	..	80-84
Westminster, Ordinary	5	..	8¼-9⅜
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	—	5⅛-5½

Electric Tramways.—

Name.	Amount paid. £		Last price. £
Anglo-Argentine, 6 per cent. Cum. Pref., 1-260,007	5	..	6-6¼
—— 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007	5	..	9¼-9½
—— Permanent 5 per cent. Debenture Stock, 1888	100	..	137-142
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	100-102
Bath Elec. Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	..	⅛-⅜
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1	..	⅜-½
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	..	87-90
Blackpool and Fleetwood Tramroad	10	..	13⅜-13⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	10	..	9½-10
—— 4½ per cent. Deb. Stock,. Red.	100	..	93-95
Brisbane Tramway Invest., Ord., 1-75,000	5	..	5¼-5⅜
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	5-5⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	100½-104½
British Columbia Electric Railway Co., Ord. Def.	100	..	143-147
—— Ord. Pref.	100	..	121-124
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	110-113
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	102-104
—— 4½ per cent. Vancouver Power Deb.	100	..	102-105
British Electric Traction, Ord. 1-30,000 & 60,001-90,000	10	..	⅝-1
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	2½ 3
—— 5 per cent. Perpetual Debenture Stock	100	..	92-95
—— 4½ per cent. 2nd Deb. Stock	100	..	68-72
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	..	81-86
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	..	102-107
—— 5 per cent. Deb. Bonds, Red., 1-2,275	100	..	103-106
Buenos Ayres Lacrose Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	98½-100½
Calcutta Tramways Ord., Nos. 1-137,610	5	..	4⅜-4⅝
—— 5 per cent. Cum. Pref., Nos. 1-30,000	5	..	4⅜-5
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	97½-100½
Cape Electric Tramways, Nos. 1-480,000	1	..	⅛-⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	4⅛-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	..	97-101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	..	5⅜-5⅝
—— 4 per cent. Deb. Stock, Red. (1985)	100	..	98-101 xd
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	96-98
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13-14
—— 6 per cent. Cum. Pref.	10	..	12⅜-13⅜
—— 4 per cent. Debentures	100	..	90-96
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	12½-13½
—— 5½ per cent. Mort. Debs., 1-3,000 Red.	100	..	90-95
Hastings and Dist. Elec Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	80-85
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000	..	93-96
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14½
—— 4½ per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	..	⅜-1⅛ xd
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	..	55-60
Kalgoorlie Electric Tramways, 1-250,000	1	..	1/32-3/32
—— 5 per cent. "A" Deb. Stock	100	..	87-90
—— 6 per cent. "B" Deb. Stock	100	..	63-67
Kidderminster and District Lighting and Traction, Pref.	5		9 15/16-10 3/16
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	..	88½ 90½
—— £286,500 2nd Mort. Deb. Stock	—	..	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	—	15/16-1⅛
—— 6 per cent. Cum. Pref., Nos. 1-495,553	1	—	1-1⅛
—— 5 per cent. Mort. Deb., 1-5,000, Red.	100	—	93-97
London United Trys. (1901) 5 per cent. Cum. Pref.	10	—	1½-2¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	64 68
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	..	90½-93½
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	..	94-96
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5	..	4½-5
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	86-91
Metropolitan Elec. Trams., Defd., 1,000,001-1 314,016	1	..	1/32-5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	23/32-27/32
—— 4½ per cent. Deb. Stock, Red.	100	..	96½-98½
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	—	92-94 p.c
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort. Bonds (1926) 1-5,500 and 7,001-8,000	$1,000	—	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922)	100	—	102-104
New General Traction, 5 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	—	⅛-¼
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	⅜
—— 5 per cent. Cum. Pref.	10	..	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mort. Deb. Stk.	100	..	100½-103½
Potteries Electric Traction, Ordinary, 1-245,000	1	..	3/16-7/16
—— 5 per cent. Cum. Pref., 300,001-545,000	1	..	⅛-⅜
—— 4½ per cent. Debenture Stock	100	..	86-89
Provincial Tramways Co., Ordinary, 1-24,912	10	..	4-4½
—— 6 per cent. Cum. Pref., 1-10,000	10	—	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	—	5⅜-5⅝
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	98-100
Sao Paulo Tramway, Light, and Power Co.	$100	..	145-148
—— 5 per cent. 1st Mort. Deb., Red. (1929) 1-12,000	$500	..	95½-97½ p.c
South Metropolitan Electric Tramways and Lighting Co. 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	⅜-½
—— 4 per cent. Deb. Stock, Red. (1940)	100	..	70-74
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red., 1-1,600	100	..	84-88
Yorkshire (West Riding) Elect. Tram. Co., Ord., 70,001-110,000	5	..	¼-1
—— 6 per cent. Cum. Pref., 1-46,261	5	..	2½ 2⅝
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	84 88

Electric Railways.—

Name.	Amount paid. £		Last price £
Central London, Ordinary	100	..	63-65
—— 4 per cent. Pref.	100	..	84-86
—— ,, ,, deferred	100	..	47-49
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	102-104
City and South London, Consolidated Ordinary	100	..	31-32
—— 4 per cent. Debenture Stock	100	..	102-104
—— 5 per cent. Pref. Stock '91	100	..	110-112
—— ,, ,, ,, '96	100	..	106-109
—— ,, ,, ,, '01	100	..	102-105
—— ,, ,, ,, '03	100	..	93-95
Liverpool Overhead, 5 per cent. Pref.	10	..	10-10½
—— Ordinary, 1-50,000	10	..	3¾-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	—	101½-102½

Telegraphs and Telephones.—

Name.	Amount paid. £		Last price £
Amazon Telegraph Co., 1-25,000	10	—	2⅜-3½
—— 5 per cent. Debs., Red., within 1-1,069	100	—	94-97
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	—	98¼-100½
Anglo-American Telegraph Co., Ordinary	100	—	55-58
—— 6 per cent. Preferred Ordinary	100	—	99-100
—— Deferred Ordinary	100	—	15⅜-15⅝
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	102-104
Chili Telephone Co., 1-44,000	5	—	8-8½
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	..	89-91
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	—	8½-7⅝
—— 10 per cent. Preference, 1-6,000	10	..	17-18
Direct Spanish Telegraph Co., Ordinary	5	..	2¾-3⅛
—— 10 per cent. Cum. Preference	5	..	8⅜-8½
—— 4½ per cent. Debs., 1-600	50	..	100½-102½
Direct United States Cable Co.	20	—	12⅝-13¼
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	—	101-103
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000 (1909)	100	—	100-102
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	25	..	102-104
Eastern Extension, Australasia and China, 1-300,000	10	..	11½-12½
—— 4 per cent. Mort. Deb. Stock, Perp.	100	..	102-104
Eastern Telegraph Co., Ordinary Stock	100	..	130-135
—— 3½ per cent. Preference Stock	100	..	—
—— 4 per cent. Mortgage Debenture Stock	100	..	104-106
Great Northern Telegraph Co. (of Copenhagen)	10	..	27-28
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	..	101-103
Indo-European Telegraph Co.	25	..	51½-53½
Marconi's Wireless Telegraph Co., Nos. 256,128-384,190	1	..	11/16-13/16
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	¼-1
—— 5 per cent. Preference, 1-86,492	1	—	13/16-15/16
National Telephone, Preferred	100	..	107-108½
—— Deferred Stock	100	..	119½-121½
—— 6 per cent. Cum. First Pref.	10	..	10½-11
—— 6 per cent. Cum. Second Pref.	10	..	10-10⅜
—— 5 per cent. Non. Cum. Third Pref.	5	..	5 7/16-5 11/16
—— 5½ per cent. Deb. Stock, Red.	100	..	97-99
—— 4 per cent. Deb. Stock, Red.	100	..	99-101
Oriental Telephone and Electric Company	1	..	1 5/16-1 7/16
—— 6 per cent. Cum. Pref.	1	..	1 1/16-1 3/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red	100	..	100½-102½
United River Plate Tele. Co., Ordinary, 1-100,000		..	6 13/16-7 1/16
—— 5 per cent. Cum. Pref., 1-40,000	5	..	4¼-5¼
—— 4½ per cent. Debenture Stock, Red.	100	..	102-103½
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	..	98½-100½
West African Telegraph Co.	10	..	12⅜ 13⅜
West Coast of America, 1-30,000 and 53,001-53,008	2½	..	1⅜-1⅝
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	..	100½-102⅝
West India and Panama Telegraph Co., Ordinary	10	..	9/16-1 1/16
—— 6 per cent. Cum. 1st Preference	10	—	8⅛-8⅜
—— 6 per cent. Cum. 2nd Preference	10	—	8-9
—— 5 per cent. Debs., Red., 1-800	100	—	102½-104½
Western Telegraph Co., 1-207,930	10	—	13⅜-13¾
—— 4 per cent. Debenture Stock, Red.	00	—	93-96

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns week. Ending	1909.	1908.	Increase or decrease. Week.	Current year.	Miles of track open. 1909.	1908.	Accounts for past year. Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	Cost per car mile.
		£	£	£	£				£						
Aberdeen Corporation	June 23	1,422	1,437	– 15	– 43	27¼	27¼	May 31	71,930	17,517,304	1,566,119	98	11·02	4,910	6·93
Ayr Corporation	,, 26	325	353	– 28	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	,, 26	3,035	3,015	+ 420	+ 7,470	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 27	1,017	1,091	– 74	– 453	23·53	23·53	—	—	—	—	—	—	—	—
Birmingham Corporation	,, 19	6,200	6,138	+ 62	—	56 792	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 23	1.043	1,219	– 163	– 261	23 8	28 3	—	—	—	—	—	—	—	—
Blackpool Corporation	,, 24	1,022	1,117	– 95	+ 998	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Aug. 8	2,304	2,329	– 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	June 27	2,276	2,475	– 210	– 533	42	42	March 31	117,799	25,492 902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	,, 25	1,583	1,579	+ 4	+ 226	23¼	23½	,, 31	86,225	13,991,328	1,766.038	1 47	11·71	2,912	7·22
Bradford Corporation	,, 19	5,020	4 537	+ 483	+ 1,353	98½	98½	,, 31	235,258	47,839,569	5,331,007	1 17	10·59	2,378	—
Brighton Corporation	,, 27	906	956	– 50	+ 697	—	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	,, 25	5,348	5,206	+ 142	—	57	51½	Dec. 31	265,362	46 652 389	5,756,842	—	—	—	—
Burnley Corporation	,, 26	1,229	1,270	– 41	—	19½	19½	March 31	64,261	12.355,958	1,202,330	1·23	12 83	5,971	7·92
Burton Corporation	,, 27	297	290	+ 7	—	10	10	,, 31	14,9 8	3,221,596	430,913	1·04	8 30	1,460	5 85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	,, 31	109,979	25,058,146	2,497,169	—	10 57	—	—
Carlisle Tramways Company	June 19	170	175	– 5	– 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	,, 26	5,861	7,745	– 1,884	– 17,196	6 32	5·77	Dec. 31	350,150	41,898,373	1,4 6,781	2 01	6·769	55,404	30 8·6
Charing X, Euston, & Hamp. Ry	,, 26	3 970	3,450	+ 530	+15,850	—	—	—	—	—	—	—	—	—	—
City and South London Railway	,, 27	3,325	3,126	+ 199	+ 1,359	—	—	—	—	—	—	—	—	—	—
Colchester Corporation	May 26	176	190	– 14	—	8	—	March 31	10,983	2,308,721	349,519	1·09	7 74	1,477	6 56
Cork E. T. and L. Company	June 24	515	526	– 11	– 935	—	—	Dec. 31	24,044	5,737,478	896,945	—	6 43	—	4 45
Croydon Corporation	,, 18	1,458	—	—	—	11½	—	March 31	74,132	16,277,418	1,884,137	1·06	9 56	3,703	7 109
Darwen Corporation	,, 18	253	233	+ 20	– 78	7·23	7·23	,, 31	13,493	2 557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	,, 19	193	211	– 13	– 129	7	—	,, 31	11,593	2,697,672	316,754	·98	8 78	—	—
Dublin and Lucan Electric Ry.	,, 25	144	153	– 9	+ 253A	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	,, 25	5,683	6,264	– 576	+ 255	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 23	1,184	1,236	– 52	– 276	—	56½	May 15	60,573	16,367 911	1,581,552	·875	1·9	2,371	7·36
East Ham Corporation	,, 26	990	892	+ 98	+ 1,955	15	15	March 31	47,430	15,355,703	1,091,536	·73	10 26	—	6·96
Glasgow Corporation	,, 19	17,970	18,031	– 91	+ 1 844	1 85½	179	May 31	907,494	226,948,290	20,756,722	·96	10 49	5,08	5 89
Gloucester Corporation	,, 16	285	265	+ 20	+ 128	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton.	,, 26	6,025	5,750	+ 275	+ 9,375	—	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	March 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	,, 26	1,565	1,668	– 103	+ 466	28½	28½	,, 31	84 704	16 260,020	1,960,323	1·29	10 37	2,421	5 10
Hull Corporation	,, 26	2,497	2,375	+ 122	+ 162	26	26	,, 31	128,722	30,964,254	3,022,844	1	10·22	—	6 04
Ilford Corporation	,, 19	504	458	+ 46	+ 554	10	10½	,, 31	25 328	6,383,466	631,446	·87	9 58	2 066	6·42
Ilkeston Corporation	,, 23	139	136	+ 3	– 127	4	4	,, 31	7,214	1,968,850	198,415	9 1	7·9	1,803	7·04
Kirkcaldy Corporation	,, 23	247	277	– 30	—	7½	7½	May 15	14,993	4,874,199	459 066	·711	7·238	1,856	5·26
Lancashire United Tramways	,, 23	1,295	1,348	– 53	– 194	39	39	Dec. 31	68,904	12,554,593	2,214,344	—	—	—	—
Leeds Corporation	,, 12	6,698	7,881	– 1,183	+ 2,168	96½	96½	March 31	340,768	75,734,083	7,694,989	1·06	10 62	3,527	5·51
Leicester Corporation	,, 26	2,320	2,384	– 64	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 19	10.816	11,036	– 220	– 2 909	104	104	Dec. 31	572,822	124,043,239	12,231,789	1 108	11·24	5 503	7·94
Liverpool Overhead Railway	,, 27	1,419	1,510	– 91	– 2,751A	6 65	2 40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	,, 12	34,692	39,378	– 4,686	+19,392	121	115½	March 31	1274,660	279,166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	,, 26	177	209	– 32	– 633	3½	—	Sept. 30	11,299	2,645,206	3:0,32	1·03	7·36	2,279	6·12
Maidstone Corporation	,, 26	171	202	– 31	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 26	14,652	15,975	– 1,313	– 862	181	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	,, 26	10,941	9,788	+1,153	+23 911	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 27	17,416	16,905	+ 511	+13,512	24½	24½	June 30	680,357	99 846,735	—	1·46	—	—	—
Nelson Corporation	,, 19	115	176	– 2	– 57	2⅜	2⅜	March 31	7,362	2,060,712	204,78.	·85	8 63	1,507	—
Newcastle-on-Tyne Corporation	,, 26	6,052	6,277	– 225	+ 274	60½	59⅛	,, 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	,, 12	641	968	– 327	– 150	14½	14½	,, 31	35,531	8,174,003	798,029	1·04	9 89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	– 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	March 31	97,741	21,247.048	2,309,419	1·10	10·15	—	
Reading Corporation	June 24	626	656	– 30	+ 157	13½	13½	,, 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	,, 31	56,558	10,196 148	1,252,925	1·32	10 83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	– 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	June 21	4,410	4,696	– 286	– 1,435	78	74½	March 31	244,065	45,771,511	5,486,150	1 25	10 67	3,185	
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Sheffield Corporation	,, 20	5,510	5,557	– 47	– 1 218	68½	66½	March 25	289,745	17,568,686	7,065 380	·996	9 842	4,225	5·04
Southampton Corporation	,, 23	1,051	1,085	– 33	– 253	18	18	,, 25	52,647	10,121,887	1,157,451	1·25	11·35	—	7 30
Southend-on-Sea Corporation	,, 23	525	456	+ 69	+ 883	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	March 31	52,004	9,155,172	1,335,911	1 34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	– 26	– 7,284	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	May 26	137	150	– 13	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	June 24	865	305	– 40	—	5·16	—	Dec. 31	15,065	2,880,420	353,297	1·40	1 0·3	—	—
Wallasey U.D.C.	,, 26	920	957	– 37	+ 373	12 68	12·45	March 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	,, 17	2,277	2,146	+ 131	+ 1,766	14·7	14·7	March 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	,, 23	784	815	– 31	– 588	20½		,, 31	44,432	3,440,369	975,714	—	10·529	2,190	6·508

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THE

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THE CONSERVATION OF WATER FOR POWER.

The conservation of water power over large areas might be difficult of accomplishment in England, where the value of land is so high and where the cities lie very close together in so many districts. Moreover, the cheap supply of coal fuel and the relative scarcity of water render the problem still more difficult. But the development of the power schemes at Foyers and Loch Leven, coupled with the recent promise of the Local Government Board to take action with regard to the conservation of all British rivers (each of which it is proposed to place under the control of one central authority), serves to bring the question to the front again in so far as this country is concerned. At a recent meeting of the Faraday Society Mr. E. R. Taylor, chairman of the Conservation Committee of the American Electrochemical Society, delivered an address on "The National and International Conservation of Water for Power." The lecture was a lucid exposition of the efforts of our American confreres to utilise a vast source of power which is allowed to go to waste, and although the situation in the United States does not present an exact parallel to that prevailing in the United Kingdom, there are still many features of the American situation, admirably sketched by the lecturer, which suggest the lines of further action in this country. The water-power capacity of the United States, with proper conservation, was stated by Mr. Taylor to be not less than 150 million h.p., without considering the storage capacity of brooks. The annual stream flow in the same country is 70 million cubic feet, of which less than 1 per cent. is restrained and utilised for municipal supply and such purposes, less than 2 per cent. is used for irrigation, 5 per cent. for navigation, and less than 5 per cent. for the production of power. From 85 to 95 per cent. is wasted in floods. This illustrates the kind of waste that is going on all over the world, and typical examples of such wasted resources were described and illustrated by Mr. Taylor, who strongly advocated the impounding of flood waters in the uplands with its accompanying afforestation of the hills, and the simultaneous conservation of sources of power, which are vast in the aggregate, and which at present are almost entirely uncontrolled and untapped. Many instances were given of the advantages that have accrued from the proper utilisation of this waste water, both on small farms from the impounding of a mere brook, to the damming of great rivers and the consequent enrichment of vast tracks of country. The electrochemical industries, in particular, stand to benefit by the creation of cheap and abundant sources of power. But it is necessary to bring home to the nation the value of water power if this value is to be realised. An international conference on this problem will be held at the Hague in 1910, and we look forward to this being a beginning of the awakening of the public to this important economic and industrial problem of the conservation of our water.

ELECTRICITY IN THE NAVY.

It might appear somewhat strange that electricity should play such a relatively small and unimportant part in the manipulation of modern ordnance, but it is, nevertheless, the case that the ordnance authorities in this country, and particularly of the Admiralty, show a marked preference for hydraulic power for working heavy ordnance. The most important operation to which electricity can be applied is in the mounting of the gun, and here it is interesting to compare the inclination of the British authorities to the hydraulic system with the marked preference displayed in some other countries for the

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electric system. Such a comparison is suggested by the very instructive lecture on "The Engineering of Ordnance," which Lieutenant A. Trevor Dawson delivered at the anniversary meeting last week at the Junior Institution of Engineers. In a brief abstract of this lecture, which appears in another part of this issue, the relative advantages of hydraulic and electric mountings are fairly if not too exhaustively discussed, and it will be seen from this that Lieutenant Dawson inclines on the whole to the hydraulic system of power on account of the greater degree of "reliability and adaptability" in that system "when well constructed." While this might represent in a large degree the opinion of the Admiralty, the fact must not be overlooked that in the "Invincible," one of the latest additions to the navy, electric power is applied to the working of heavy ordnance. No doubt the comparative merits of the electric and the hydraulic systems were carefully studied at the Admiralty before it was decided to install an electric system in the "Invincible," and if, as has been alleged, this installation gave a little trouble at the outset, we are convinced that time and further practical experience will eliminate the defects that have presented themselves. In fact, Lieutenant Dawson mentioned that the use of the Janney controller (which is described in our abstract of his lecture) had overcome many of the objections of electricity. There is almost unlimited scope for the application of this device, and there can be no doubt that it will be a great factor in the development of electric mountings for guns.

TRAMWAYS CONCILIATION BOARD.

Considering the great public inconvenience caused by a strike of tramway men, to say nothing of the loss of revenue which tramway undertakers have to suffer from this cause, it is not surprising that the Board of Trade should have stepped in with a view to providing the necessary machinery for avoiding such deadlocks. The London County Council recently asked the Board to assist in the formation of Conciliation Boards covering the employés of the tramways department of the Council, and it was decided to ascertain by ballot whether a majority of the employés affected were in favour of the scheme. The result of this ballot, which was made known this week, showed that an immense majority of the men are in favour of the establishment of Conciliation Boards; 4,734 voting in their favour and only 759 against. We hope that the spirit of conciliation will extend to all other centres, and that we shall not have to witness any more unreasonable and irritating disputes, such, for instance, as recently occurred on the London United Tramways. The reference of points in dispute to an impartial and independent Board should readily lead to their adjustment, and the knowledge of this fact by the men should tend to check threats to strike on what are, after all, trivial grounds.

ELECTRICITY IN MEDICINE.

There appeared in last week's issue of the *Lancet* an interesting research by Dr. Charles Russ upon microbic electric movements. It was found that certain bacteria tend to aggregate at one or other electrode when a suitable current is passed through a fluid in which they are suspended, and that when the current is reversed they move in the opposite direction—*i.e.*, towards the electrode the polarity of which now becomes the same as that at which they had previously collected. This aggregation varies with the nature of the electrolyte in the fluid in which the bacteria are suspended. Dr. Russ discusses the cause of this aggregation, and offers as the most probable explanation the suggestion of an affinity between products of electrolysis and the bacteria, leading to their conveyance together with the electrically disassociated ion towards the appropriate pole. By using a special form of electrode so arranged as to trap the bacilli when aggregated in the vicinity of the urine, Dr. Russ was able to recover tubercle bacilli from urines to which they had been added in relatively small numbers, although attempts to prove their presence by centrifugalisation failed. The whole research seems of extreme value to medical science. To us it is of interest inasmuch as further research on the same lines may possibly serve to assist in the specific discrimination of bacteria. In any case the results so far obtained serve to demonstrate that the electric current is of substantial assistance in diagnosis.

THE CHARGING OF SMALL ACCUMULATORS.

BY X. Y. Z.

The number of small accumulator cells in use is, owing to the general adoption of motorcars and motor cycles, now very considerable. The charging and renewal of acid, etc., required by such cells is undertaken by many of the smaller central stations. The revenue obtained from this business is, in the majority of cases, small, while the trouble and vexation arising therefrom is correspondingly great. The dissatisfaction often expressed by the owners of the batteries as to the sufficiency of the charge, their demands for batteries to be "done" in an unreasonably short time, and their tendency to attribute any fault that may from time to time develop to the inefficiency of the staff of the supply undertaking, constitute annoyances that may well make engineers seriously consider the advisability of refusing to undertake this class of business. For several reasons, however, this course would not be wise, especially in view of the fact that the periodical charging of these small batteries affords a medium of acquaintance between the supply authority and prospective consumers. The class of people who possess a motorcar or a motor cycle are those whose acquisition to the list of consumers of the central station would be very valuable. The publicity manager attached to the undertaking should, therefore, make it his business to keep in touch with these people. As an extra inducement to them to avail themselves of the authority's supply of electricity, he will be able to explain that, by the provision of inexpensive arrangements at the time of the installation of the wiring, they will be enabled to charge their batteries on their own premises. As the small battery charging business is, for what it is worth in itself, of no financial use to the undertaking, a doubly good end will have been accomplished. The consumer will have additional satisfaction, and the central station will be rid of a source of considerable and unprofitable annoyance. For this reason it is desirable to undertake the charging of these small consumers, at any rate from a publicity point of view. Especially should care be taken that this business does not fall into the hands of the small cycle and motor engineer. These individuals, who have often a slight knowlege of electrical work, frequently have a service run for the sole purpose of charging motor batteries. Their maximum load is often that of a 16-c.p. lamp, and if they have not a specially good meter to deal with low currents, a loss to the undertaking is incurred. The installation inspector should, therefore, view with disfavour any arrangements for charging cells on premises of this kind.

The question of the payment to be demanded for the charging of these small batteries is one of considerable importance. If a graduated system be adopted, a difficulty arises in view of the fact that all batteries are not marked with their capacity. If such capacity were left to the judgment of an official, his estimates on two occasions, separated by any considerable period of time, might very possibly differ one from another, and thereby give occasion for undesirable disputes. If a flat rate be adopted, specially large batteries are charged at a loss to the supply company, while in the case of small cells the payment to

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be made may be out of all proportion to the value of the electricity required for the charge. In some cases a rule is adopted by which a number of cells brought at one time is reckoned as one battery, and charged for accordingly. This works well if the cells are all of equal size, but if this be not the case, the cells have to be charged separately at a loss to the supply company. The privilege is, too, often used very liberally by the public, who sometimes bring to the central station such large boxes, containing such a heterogeneous collection of batteries, that one is led to suspect that two or more establishments have made arrangements to "club together," and so decrease the running expenses of their motor cycles. The most satisfactory method of payment for charging motor accumulators seems to be to adopt a flat rate, with a special small or augmented payment to be made for batteries of unusual sizes. All cells of similar size brought at one time to be counted as one battery, but otherwise to be paid for separately. The special payment will be demanded at the discretion of a responsible official, and the junior who attends at the public entrance to the works should be instructed to refer to him if necessity arise. It is very important that an increased payment should be demanded in the case of new batteries in view of the acid required and the longer charge. It is advisable that a cell voltmeter be kept in the public entrance, in order that the persons taking away charged accumulators may be satisfied that such charging has been sufficient.

A further difficulty that arises in this connection is that of identifying the particular cells as they are called for by their respective owners. Especially is this difficulty felt when the business done in this way is at all extensive. The method adopted sometimes is that of attaching to each battery, at the time that it is received at the works, a gummed label bearing the name of the owner. It is found that this plan is far from satisfactory, as under the influence of the acid the labels soon drop off, and in some cases, when acid happens to be spilled, are acted upon to such an extent as to be unreadable. A good plan consists of the following: A counterfoil book is kept in the entrance office, and each person bringing a battery, or batteries, is given a slip which he is requested to produce when calling subsequently to take his cells away. A supply of wooden tabs, each varnished and having painted on a number, is supplied, and to each separate battery one of these tabs is attached by a wire to a terminal. If several batteries are brought by one person, each will bear the same number. This number will be marked on the counterfoil before the batteries are sent to the particular department where they are charged. By this means batteries can be immediately identified, and the possibility of confusion is almost, if not entirely, eliminated.

The actual charging of these batteries is apt to give a good deal of trouble. If batteries of widely varied sizes are in the station at the same time much waste is incurred, and to thoroughly carry out the whole business a not inconsiderable amount of time must be devoted thereto. It is always advisable that the supervision of the charging and making up with acid be definitely in the hands of certain members of the staff, and not be left to any who can find time to connect up the cells. A frequently adopted plan to supply the accumulators with current is to use a properly-constructed bank of lamps. It will be necessary to provide several circuits in order to deal with batteries of varying size. Under special circumstances, where batteries of unusually large size have to be charged, it might be advisable to put down a small motor-generator or adapt the station milking booster. Such arrangements will, however, in the majority of cases be unnecessary. The most economical method consists of using the current necessarily required for lighting the works. It will not be difficult for a wireman to arrange for pairs of terminals to be interposed in several of the station lighting circuits. Such terminals, each with a controlling and a short-circuiting switch, would be mounted over a suitable stand on which the batteries could be placed. By suitably choosing the circuits, provision can be made for all ordinary sizes of batteries, and the current usually taken by these circuits be approximately determined once for all. By this means accumulators can be charged on the evening and night shifts without costing the department anything for current.

Care should be taken as far as possible to comply with any instructions that may be supplied with the battery regarding rate of charge, specific gravity of acid, etc. It should be borne in mind that every effort should be made to satisfy these indirect consumers of electricity. The level of the acid should be maintained and no battery disconnected before thoroughly charged unless required by the owner. Any defect in the battery should be noted before the receipt is given, and pointed out at the time. After a person has seen his cell tested by the voltmeter and indicated his satisfaction by giving up the receipt for his cell and paying for its charge, such cell should on no account be further charged without another payment. It is not advisable, except under special circumstances, to allow persons to run accounts for charging batteries, unless such be ordinary consumers, all such business being treated as cash sales.

It is probably the experience of most engineers who undertake the charging of small accumulators that this business is far from profitable and is productive of considerable trouble. It is therefore hoped that the foregoing suggestions may help to improve this undesirable state of affairs.

ELECTRICALLY-DRIVEN ROLLING MILLS.

Engineers are now turning their attention to the problem of driving rolling mills by electricity, and the number of electric mill drives now installed and run with entire success makes it possible to clear up many points that have hitherto proved obstacles in the way of further electrification of steam-driven rolling mills. In the United Kingdom much has been done in this direction, but still much more work remains to be executed. Progress in the United States of America has been exceedingly rapid when it is remembered that electrically-operated steel-rolling mills were installed there about four years ago; the latest achievement being the noteworthy installation at the Gary Steelworks, Indiana, which was described in these columns some time ago. In the July issue of the *Proceedings* of the American Institute of Electrical Engineers there are two papers dealing with this problem. One of these shows the advantageous results obtained from electrically-driven rolling mills and notes various points in connection with the electrical equipment of the mills, while the other deals specially with the motors. In the first-named paper Mr. E. Friedlander points out the functions of the watt-hour meter, and it is interesting to note that, among other things, it shows that rolling "squares" and "rounds" takes per square inch displacement much less power than shapes with large peripheries and many flanges, as the latter cool off quickly and cause much friction in the rolls. Test on rail-mills have shown that the foot-pounds per square inch of displacement gradually increase the nearer the rail is to the finishing pass. A 75-lb. rail required 1,100 foot-pounds at the first pass on the first "rougher." On the same stand in the seventh pass it required 3,000 foot-pounds, in the first pass on the second roughing rolls 4,800 foot-pounds, in the fifth pass 8,150 foot-pounds; 9,500 foot-pounds were required for the last or finishing pass. The large increase in foot-pounds is partly due to the greater density and rapid cooling of the steel, especially at the thinner flanges near the finishing pass. For this reason, the flanges are rolled out as late as possible. Whenever required, exact power consumption can be given for each phase of rolling.

The ideal motive power for rolls should drive them slowly when the steel enters and should drive the roll faster as the piece lengthens. The reciprocating engine will do just the reverse—namely, run very fast without load and slow down as the load increases, finally stopping if the load becomes too great. Reciprocating engines must be made very large because their maximum torque is fixed by the size of the cylinders and the pressure. They are thus often run with only half load, causing high steam consumption per horse-power. For this work the characteristics of the electric motor are much better. Even with

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double its full torque the efficiency is good and the motor will not stop, but will take more and more current, finally becoming overheated and burning unless properly protected. If desirable, its speed-changes from no load to full load can be made small. The current can also be limited to a certain maximum, without stopping the motor, in this manner preventing excessive strains and probably serious breakdowns. Where high speeds are necessary, motors can be direct connected to rolls, increasing the energy of the rotating parts and at the same time decreasing the size of motor, the power required, and the fuel consumption. Heavy reciprocating engines cannot run at such high speeds, and must be connected to the rolls by means of gears, ropes, or belts.

With regard to the question of flywheels. The weight of the rotating parts is much greater in large motors than in reciprocating engines, and as the energy of the rotating parts increases as the square of the speed, it is obvious that even a small change of speed is of great importance. While admitting that careful study of this feature should be made in each case, Mr. Friedlander points out that while the steel is being rolled both the motor and the flywheel should furnish the power, but as soon as the steel leaves the rolls the motor should accelerate the rotating masses to the same speed before rolling. The time available and the number of revolutions will determine the size of the motor more than anything else.

The total motive power required in a steel plant is changeable and fluctuates continuously, the average in many plants being often below one-fourth of the total horse-power installed in motors. The electric-driven rolling mills will, however, demand considerably larger power stations to take care of the large currents, especially when all the motors happen to be overloaded at one time, as, for instance, when rolling cold steel. It is very important to find out beforehand how much of this fluctuating load the power-house may have to supply, assuming the worst conditions, as the shut-down of the electric power station for even a very short time will stop the operation of a large number of machines and cause enormous losses. The short, high-peaked current demands should be kept off the power station as much as possible, and only the average current be supplied. The least number of units can then be kept running under nearly full load with the most economical fuel consumption and the least wear and tear of moving parts. By means of storage batteries or flywheel sub-stations the occasional large demands for current can be taken off the station and supplied from these two sources, where it is stored up when the current demand is below the average. The exchange of current from one motor to another, in connection with electric roll drives, is often considerable, and should not be overlooked.

Mr. Friedlander next proceeds to deal with the problem of reversing mills, and arrives at the conclusion, from experience at the Illinois Steel Company's works at South Chicago and other mills in the States, that the electric motor is much better adapted for this kind of work than the reciprocating engine. With the use of electric motors in place of reciprocating engines the problem of reversing rolls becomes much simpler and better in regard to manipulation, fuel consumption, and cost of maintenance. Operation of electrically-driven reversing mills is nearly automatic; no skilled operator is required and all danger to the motor and the mill is eliminated. It is observed that only one-fourth of the power required at the reversing-roll motor is the average supplied from the power station. The large current demands are furnished by the motor-generator through the energy of the high-speed flywheel, and a considerable amount of current is sometimes sent back into the line. As for all other mill work where power and speed variation are considerable, the direct-current motor, on account of its load and speed characteristics, is better adapted for driving rolls than the alternating-current motor. For reversible roll drives it is used exclusively. There is no reason, states the author of the paper, why the direct-current motor should give any more trouble than the direct-current generator at the power station. Four years' experience has shown that the wear of the commutator and the cost of maintenance amount to practically nothing. The transmission of large low-tension currents is much more serious, especially when tens of thousands of horse-power have to be supplied and the distance of the motors from the station is considerable.

The use of higher direct-current voltages in connection with large rolling-mill motors should be satisfactory, but no doubt high-tension alternating-current transmission and induction motors direct on the line will be generally employed, especially in new installations. Where conditions demand it, the induction motor characteristics can now be made nearly similar to the compound-wound, direct-current motor. However, much of its simplicity and efficiency will be sacrificed in doing this. Among some of the earlier disadvantages of the induction motor were: very large current required for starting under heavy load; one speed fixed by the number of poles, and the tendency always to run at synchronous speed; low power factor with light loads; small air-gaps; impracticability of reversing large units; and inability to change speed to flywheel requirements. In the design of the modern rolling-mill motor most of these objectionable points have been remedied by different means, such as wound rotors, the introduction of variable resistance, changing the number of poles, shifting the phases, slip-rings, etc. Whether direct-current power stations and direct-current motors are used, or alternating-current stations are installed for high-tension transmission with alternating-current motors directly on the line or fed through transformers, or direct-current motors are supplied from an alternating-current station through converters or motor-generators, batteries, or flywheel sub-stations, is a matter of detail. No doubt any one of these systems will give satisfaction if properly designed and installed.

The question of the motor is, however, discussed with rather more detail in the paper by Mr. E. W. Yearsley. This author considers main motor drives to be superior to engine drives. The controlling apparatus for mill service is usually the weak part of the system, and the author draws attention to the need for an improvement of the apparatus. For large main-drive motors, the advantage of continuous running at constant speed is so great that it would appear advisable to make the design of the mill suit the characteristics of the motor, and avoid the extra expense and complication of devices like the reversing drive. The tendency has been to build a machine and then to couple on a motor somewhere to drive it.

There seems to be no great difficulty in designing mills for continuous-running motors. By combining such motors with a suitable flywheel it should be possible to keep the line load sufficiently uniform. This combination has not, in the writer's opinion, received sufficient attention, possibly because of lack of knowledge of power and speed regulations of the rolling operation. Tests of these characteristics will be comparatively easy on electric mills, so that data will rapidly become available for supplying the system with the proper inertia. In some installations the author has seen the flywheel so badly proportioned as to be detrimental to the operation of the motor. Initial speeds should be carefully selected, especially when the drive is direct, and, if possible, a considerable speed regulation should be provided, so that the speed may be increased with increase in proficiency of the operators. The importance of low armature inertia for reversing motors is now well recognised, but designs could be improved by still further reduction in speed. The author is decidedly against the use of high-speed motors for any kind of mill service, and believes the extra cost of slow-speed machines well warranted. Electric motors subject to excessive vibration communicated from the gearing and other parts of the machine should be protected by a flexible coupling.

For mill apparatus which must be handled directly, especially for direct-current apparatus, Mr. Yearsley favours a maximum of 250 volts. Safety of employés requires that with higher voltages special guards be provided to isolate the apparatus. Alternating-current and direct-current motors and apparatus both have their advantages for steel mill installations. Local conditions must determine which is superior. Unless transmissions are too long, the author favours a direct-current installation, especially if the plant has many machine tools. With an alternating-current system as few direct-current motors as possible should be used.

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ELECTRICITY IN THE HOME.

The growth of the power load has dwarfed the increase in the consumption of electricity in private houses, and the central-station engineer has, perhaps, devoted rather an undue proportion of his efforts to securing power consumers. The metallic-filament lamp has also affected the situation, but it has added to the value of the mains laid through residential districts. The light-distributing capacity of these has been trebled by the higher efficiency of the metallic filament. The reloading up of these mains will be effected partly by new lighting, but we believe that an active campaign with electrical heating apparatus will provide a most profitable load with a diversity factor not obtainable otherwise. The electrical home which has been erected and furnished by Simplex Conduits, Limited, at the White City is a splendid help to this end. Practical demonstration always does more good than any other method of putting the advantages of a novelty before the public, and enables them to see what help can be obtained from electricity. Convenience and comfort, together with moderate cost, will then lead to business.

The Simplex electrically-equipped model house is erected in the Elite Gardens at the White City, and the large number of visitors afford abundant proof of the interest, we might even say thirst for knowledge, which is displayed by the public in connection with matters electrical, particularly the application of electricity for domestic purposes. So far there can be no doubt that the trade, and especially central-station engineers, much appreciate the individual effort of Simplex Conduits, Limited, in taking upon themselves the onus of demonstrating to a considerable section of the public, comprised by visitors to the White City, the wide application of electricity for heating cooking, lighting, etc. The exterior of the building, combining as it does coloured tiles and rough cast work, presents a strong contrast to the dazzling white of the surrounding buildings, the endeavour having been in the design of the building to incorporate attractiveness of exterior, and with a view to bringing the maximum number of visitors. The internal arrangement of the building has been carried out with a view to ordinary requirements only, and an avoidance of complicated and expensive arrangements has enabled the company to demonstrate to the public that the application of electricity to domestic purposes is within the bounds of even the man of the most moderate means The building is divided into five rooms, comprising a large showroom, in which visitors may examine the various classes of electrical apparatus, dining-room, drawing-room, bedroom, kitchen, showing the practical application. To describe these in detail we would mention first the showroom. Here is found a representative display of electric lighting, cooking, heating apparatus, and so on at various prices, in addition to other important manufactures of the company, such as conduits, wires, cables, accessories, distribution boards, which are prominently displayed on specially-designed showboards.

In the dining-room is shown a dining table laid for four with various electrical apparatus which can be profitably employed in connection with the dinner table, such as plate warmers, water heaters and water jugs, entrée dishes, food warmers, coffee machines, and so on. The lighting is carried out by means of a specially-designed six-light pendant, in addition to small standards on the table. The heating arrangement is provided by a four-light radiator. The ventilation is carried out by means of a porthole fan fitted with an automatic shutter, which opens and closes as the fan is started or stopped.

Fig. 1.—Bedroom in "Simplex" Model House at White City Exhibition.

The drawing-room is carried out in Adams style, the lighting being by means of a central ceiling fitting having a large cut-glass bowl distributing the light from four metal-filament lamps. Additional lighting is provided by a floor standard and two candle brackets. Here is shown also an electric kettle on a floor stand, and such desirable features as standard lamps for use in connection with the writing and reading table.

In the bedroom (Fig. 1) is shown a number of electrical appliances, amongst which may be mentioned a bed warmer, hot-water can, and foot warmer; toilet requisites,

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including curling-iron heater, hair dryer, shaving pot, and special mention may be made of a new design in hand glass and shaving mirrors. These are provided with a special lens, behind which is fixed an 8-c.p. electric lamp; a brilliant light may, therefore, be concentrated upon any part of the face at will. A further item is a towel dryer.

The kitchen (Fig. 2), perhaps, forms the most interesting exhibit. A specially-designed equipment has been laid down with the object of providing a neat and compact set which can be obtained at a moderate figure. Here is shown the new Silundum method of heating, upon which system the central oven and auxiliary cooker is worked. The further items include hot-plate and toaster on this system, porringer, saucepan, frypan, stewpan, hot cover, water-tank, water heater, and several types of kettles on the "ship" system. The outfit is controlled from the central switchboard, carrying on it sunk switches and plugs; the wiring is carried out behind the board and enclosed by a wooden case, the whole of the front is easily detachable so that the wiring is made accessible, and the fuses (separate fuses being provided for each plug) may be replaced, if necessary, with the minimum of trouble and without the aid of a skilled person, and a small red lamp is inserted to act as a pilot light showing when any piece of apparatus is connected. The capacity of the outfit is rated at 12 persons, and the maximum consumption allowed for is 30 amperes at 220 volts. The total cost, including the cooking table, comes out at about £45 (list), but a smaller set, suitable for a family of six to eight persons, can be had at a cost of slightly over £30, which covers all the necessary articles for complete cooking. Mention may be made of the water-tank situated at the side, which has capacity of two gallons, and when put into circuit by means of a plug the contents are merely maintained at a regular temperature, but to heat up the article is switched on by means of a sunk switch in the base of the tank, and this allows of the full capacity of water being raised to boiling point in about 20 minutes; thus a constant supply of hot water is always available. On the other side of the cooking set is placed a small hot cupboard for warming plates or maintaining the temperature of the food. The kitchen is also fitted with ironing arrangements, and the simplicity of this method is clearly demonstrated to visitors. Ventilation is carried out by means of an automatic porthole fan in direct connection with the outside air, and also a small cabin fan-type ceiling fan, and it is remarkable that the temperature of the kitchen is always maintained at a comfortable level even after cooking has been in operation for some hours. The equipment is probably one of the most ideal yet devised, being inexpensive and yet covering all the necessary features. Cooking demonstrations are given daily by an expert lady cook, and these have been well attended by visitors to the exhibition.

The whole of the wiring for the house is carried out in Simplex conduits concealed in the walls and above the ceiling and beneath the floor. In order to prevent interference with the lighting arrangements, however, the whole of the control is situated from the two boards, and a further one the power. These boards are of standard Simplex design, and not in any way special to the particular application to which they are put in this case. Connection to portable apparatus and cooking appliances are in every case taken from two pin plugs. In the case of the rooms these are fixed upon the skirting board and in the showroom on shelves.

It is anticipated that the exhibit will considerably stimulate public interest in the subject of electricity and act as a further demonstration of its simplicity and wideness of application.

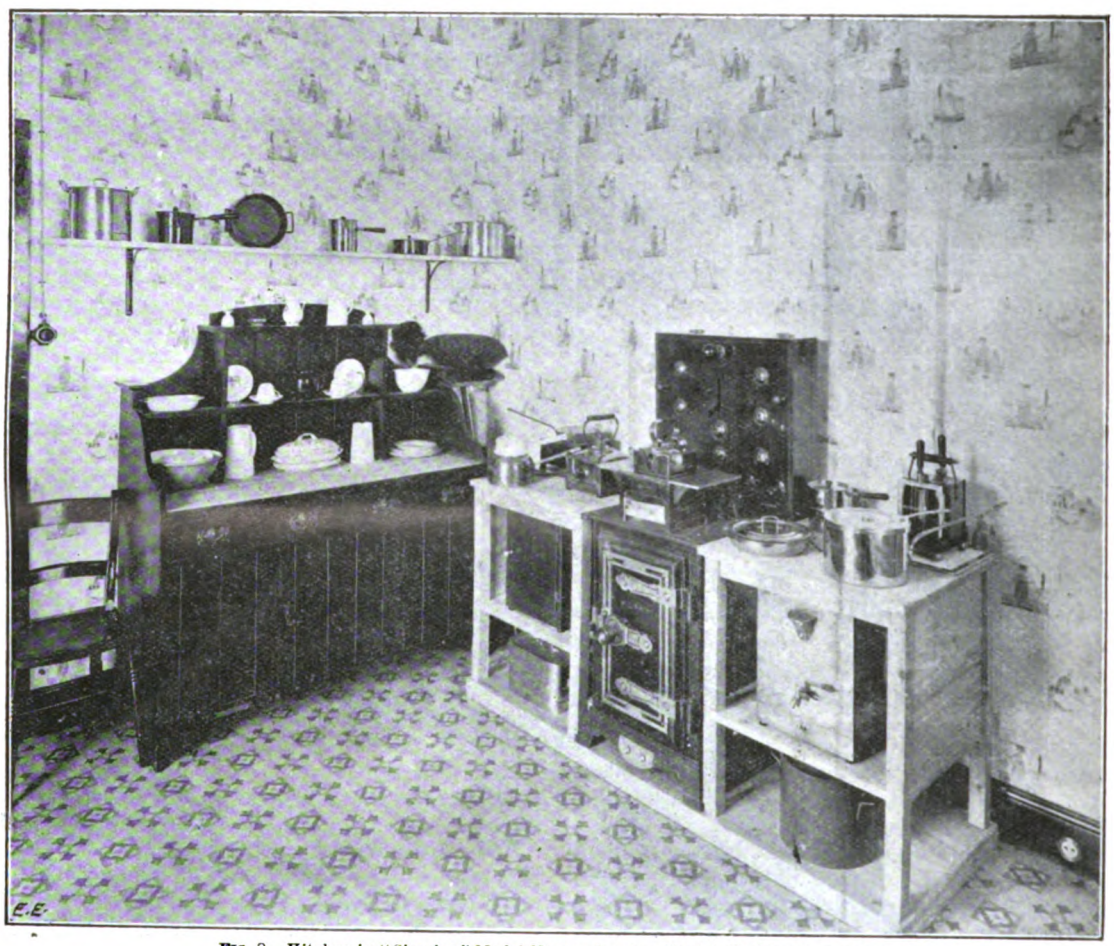

FIG. 2.—Kitchen in "Simplex" Model House, showing Electric Cooking Apparatus.

INSTITUTION OF ELECTRICAL ENGINEERS.

The annual conversazione was held on Wednesday evening, June 30, at the Natural History Museum, South Kensington. Mr. W. M. Mordey (the president), assisted by Mrs. O. Henrici, received the guests, among whom were Mr. J. Ardron, C B, Prof. H. E. Armstrong, F.R.S., Prof. H. T. Bovey, Prof. H. L. Callender, F.R.S., Prof. H. S.

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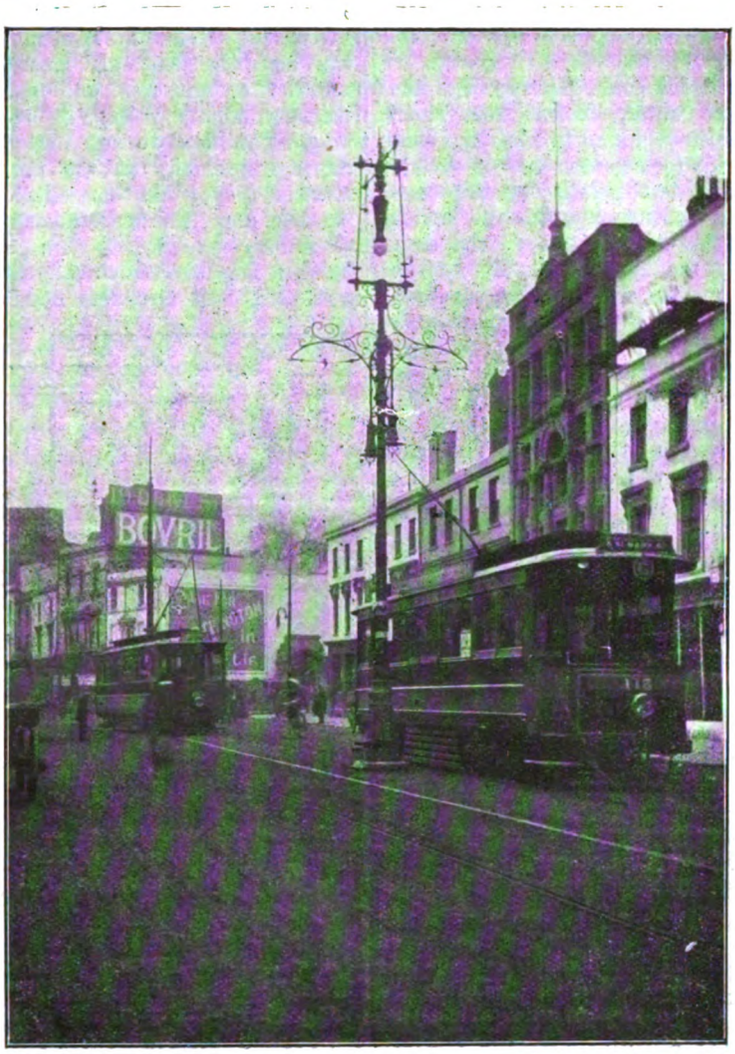
Carhart, Prof. H. Cox, Prof. H. T. Davidge, Mr. W. Duddell, F.R.S., the Right Hon. W. G. Ellison-Macartney, Mr. G. K. B. Elphinstone, Colonel J. A. Ferrier, C.B., R.E., Prof. G. Forbes, F.R.S., Mr. S. G. Gamble, Sir John Gavey, C.B., Mr. F. Gill, Mr. J. Hunter Gray, Mr. R. K. Gray, Mr. Charles Hawksley, Captain the Hon. F. Hemphill, Prof. O Henrici, F.R.S., Colonel H. C. L. Holden, R.A., F.R.S., Colonel Sir T. H. Holditch, R.E., Mr. W. Judd, Dr. G. Kapp, Mr. J. E Kingsbury, Mr. G. C. Lloyd, Dr. T. M. Lowry, Mr. C. O. Mailloux, Mr. T. Mather, F.R.S., Major W. A. J. O'Meara, R.E., C.M.G., Sir C. J. Owens, Sir Robert J. Parker, Mr. G W. Partridge, Prof. J. Perry, F.R.S., Sir William H Preece, K.C.B., F.R.S., Mr. J. H. Rider, Mr. R. A Robinson, Brigadier-General R. M. Ruck, R.E., Mr. J. F. C. Snell, Mr. C. E. Spagnoletti, Mr. C. P. Sparks, Mr. J. Swinburne, F.R.S., Prof. S. P. Thompson, F.R.S., Prof. Sir T. E. Thorpe, F.R.S., Prof. W. A. Tilden, F.R.S., Sir C. E. Troup, K.C.B., Prof. W. C. Unwin, F.R.S., Mr. A. J. Walter, K.C., Mr. G. G. Ward, Mr. C. H. Wordingham, and Prof. W. P. Wynne.

STREET-LIGHTING FITTINGS.

The accompanying illustration will serve to show the change which is being effected in the brackets for public street-lighting in the city of Cardiff, where, as will be noticed, centrally-hung lamps with lowering gear are displacing fixed lamps on swan-neck brackets. Not only is the change to be welcomed on æsthetic grounds, but it must lead to an appreciable increase in economy, and it will, moreover, obviate the necessity for taking out the cumbersome tower ladder to trim the lamps.

The lowering gear in use here is manufactured by the London Electric Firm, of Croydon. It will be noticed that the contact and suspension device is fixed in the hood of the carrier. A cross-arm is fitted right through the hood, and a wire rope, working over pulleys, unlocks the suspension device, draws the lamp out horizontally clear of the pole, and then lowers it vertically, a single winch fitted in the base of the pole (operated in the same direction all the while) doing the whole of these operations, and, conversely, rehoisting and taking the weight of the lamp off the rope. The contact suspension device is positive in action, and does not depend on the operation of springs, levers, balls, clutches, or other similar contrivances, and, being on the concentric principle, does not require to be manœuvred to ensure correct polarity. The winch is self-sustaining in all positions without ratchets, pawls, or gear wheels, and will not run back, thus avoiding accidents.



TESTING CONDENSERS FOR LEAKAGES.

BY HARBEE.

The number of condensing plants (chiefly surface condensers) yearly installed is rapidly increasing, and keen competition is constantly going on between engine builders with regard to water consumption or pounds of water per brake horse-power on the various engines. Tests are often carried to the third decimal place when speaking of pounds of water per brake horse-power or electrical horse-power, as the case may be; of course, depending on how load was made up, whether on dynamo or pony brake. If this minute estimation is likely to continue, I think it high time we had it more widely known how simple yet very reliable tests can be made for leaky condensers. The makers' usual practice is to put a light water pressure first on the cooling surface side and afterwards on the condensed water side, at the same time carefully looking out for any water trickling through. The station engineer, if doubtful, will run condensing plant for several hours

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with only circulating water going through, and carefully note if any condensed water is thrown up by the pumps. Both of these methods for ordinary working conditions may suffice, but for a close competitive test they would not be, to my mind, sufficiently accurate, because I have known the behaviour of leakages to be very different when both waters are going through than when only on one side. My contention is that a condenser, like any other machine, should be tested under its full-load working conditions, and, so far as I know, there is no mechanical means of doing this. It is purely one for chemistry, and personally I consider the silver nitrate test for chlorine or chlorides to be the most suitable. Even in the hands of an amateur it is possible to trace salt in water, although it may be only one part salt to 100,000 parts of water. Therefore, the leakage, however slight, is quickly disclosed by the test mentioned.

The water frequently used for cooling purposes is that generally known as surface water, drawn from rivers, canals, etc., and such are always found to contain, among other things, sodium chloride (or common salt) in variable quantities. This, together with the fact that condensed water should never contain sodium chloride salts, enables one to make a very reliable test for any leakages in condensers. To carry out the test we shall require a standard solution of silver nitrate, which can be purchased from any qualified chemist, or for those who care to make it themselves the particulars are as follows: dissolve 2·394 grm. of pure recrystallised silver nitrate in distilled water and make solution up to one litre. We shall also require a solution of potassium chromate, made by dissolving potassium chromate in distilled water, one part chromate to ten parts by weight of water. The potassium chromate solution is used as a colour indicator. The principle upon which the indicator depends is that silver combines with chlorine in preference to chromic acid, and that accordingly no red chromate of silver is capable of being formed so long as chlorides are in the water, but that red chromate of silver instantly forms the moment nitrate of silver is in the slightest excess. Therefore, if we take a sample of water known to contain chlorine salts, and into this drop spot by spot the silver nitrate solution, a white precipitate of chloride of silver will form, and continue to do so until all the chloride in the water has been precipitated. But, as will be seen on making the experiment, there is a difficulty in observing the exact point at which the formation of the precipitate ceases. This difficulty is overcome by the use of the colour indicator, potassium chromate.

The details of analysis are as follows: Measure out carefully 50 c.c. of the condensed water, which should then be passed through a filter paper into a clean porcelain dish. To this add about half a dozen spots of the colour indicator, potassium chromate, at the same time stirring with a glass rod; the colour of the water then will be distinctly yellow. This being so, the silver nitrate solution, which should be contained in a properly graduated burette, is carefully dropped spot by spot into the water, which should be constantly stirred the whole time. As will be observed, the first few spots will become red instantly they touch water and die away to a pale yellow on stirring, that is if sodium chlorides are present. The dropping in of silver solution should be continued, also the stirring, until the water becomes permanently red. The very earliest point at which the chromate of silver begins to form or the redness becomes persistent the addition of silver solution should be stopped and the amount used read off from the graduated burette; from this we can ascertain the quantity of salt present in the water. One cubic centimetre of silver solution practically corresponds to one grain of salt per gallon of water. If on adding the first one or two spots of silver solution to the condensed water (which had previously been coloured by the indicator) becomes permanently red, it is quite certain that there is little or no salt in the water, consequently the condenser might be considered quite bottle tight. If, on the other hand, it requires several cubic centimetres of silver solution to bring about a permanent red colour, then the condenser is certainly leaking; to what extent may be judged by the quantity of salt found to be present.

"C.M.B." PATENT DIRECT-CURRENT ROTARY TRANSFORMER.

BY J. C. MACFARLANE, M.I.E.E., WH.SCH., AND H. BURGE, A.M.INST.C.E., A.M.I.E.E.

In the following paper the construction is described, and several applications discussed, of a new type of rotary electric transforming machine developed by the authors for reducing supply voltages for the economical working of metal-filament and arc lamps, for battery charging, gun-fire and navy phone circuits, and also for balancing three-wire circuits.

The lines along which this machine has been developed are easily followed by reference to Figs. 1, 2, etc. Fig. 1 shows an ordinary two-pole dynamo-electric machine, in which *n* and *s* represent the field poles, and *a a* the main brushes. If cross brushes, *b b*, are placed on the commutator and short-circuited, and if the primary supply voltage is represented by P, then this may be reduced to any desired value represented by S, depending chiefly on the position of the short-circuited brushes, *b b*, on the commutator in relation to the main brushes, *a a*. The machine as shown in Fig. 1 would have several serious defects—viz: (1) The presence of the iron poles, *n s*, immediately over the shorted brushes, *b b*, would not permit of sparkless commutation at these brushes.

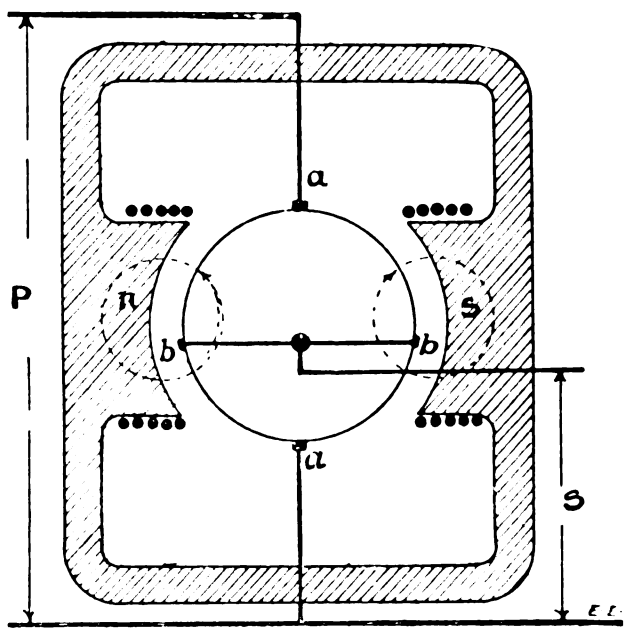

FIG. 1.

(2) It would not be possible to regulate the secondary voltage, S, either automatically or by hand. (3) The M.M.F. of armature reaction would cause a large cross flux to pass through the armature between the shorted brushes across the pole faces, as shown by the dotted lines in Fig. 1. The armature revolving in this flux would create a large circulating current in the shorted brushes, either causing the machine to race dangerously or lose speed. Such a circulating current would also be very wasteful, and would tend to make one of the short-circuited brushes spark more than the other. (4) The weight of the field magnets and space occupied would be excessive.

The method adopted to get over the sparking difficulty has been to sub-divide the poles into two parts, to correspond with the position of the shorted brushes. This step is shown in Fig. 2, where the poles are shown divided unequally, as would be required for an unequal division of the voltage.

It will be noted that when the E.M.F. applied to brushes *a a* is to be split unequally that the field should be divided unequally, and the shorted brushes should divide the armature in a corresponding manner, as this will lead to greater efficiency and economy in material. In reducing from a constant potential of 220 to a constant potential of 50, say, the part pole ratios should be approximately 2 : 1 for maximum economy.

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If the supply voltage is constant, and the speed of rotation is to remain unchanged, any increase of flux on one side of the shorted brushes must necessarily take place at the expense of the flux on the other side. In order to regulate the secondary voltage, therefore, or compensate for voltage drop in the converter, the authors provide the machine with a ring-wound armature and entirely isolate the two magnetic circuits from one another. It should be noted that it is quite impossible to get any regulation of the secondary voltage without absolutely isolating the one magnetic circuit from the other, and also impossible to prevent wasteful circulating currents in the shorted brushes It is obvious that the machine in Fig. 2 would be unsatisfactory for two reasons: firstly, because any reduction in the M.M.F. on poles n_1 and s_1, say, and a corresponding increase in n_2 s_2 would have no effect on the quantity of flux passing through the two parts of the armature, thus preventing any alteration to the division of voltage; secondly, the armature reaction flux has still a low resistance path, as indicated by the dotted lines in this figure. As mentioned above, a variation of the voltage on either side of the shorted brushes cannot take place unless a ring armature is used, due to the fact that the armature conductor of a drum armature spans across the pole pitch.

The construction adopted for completely isolating the magnetic circuits (shown diagrammatically in Fig. 3) consists primarily in placing the pole parts, n_1. s_1, n_2. s_2, into a vertical position with relation to the plane passing through the shorted brushes. It will be seen from the diagram that

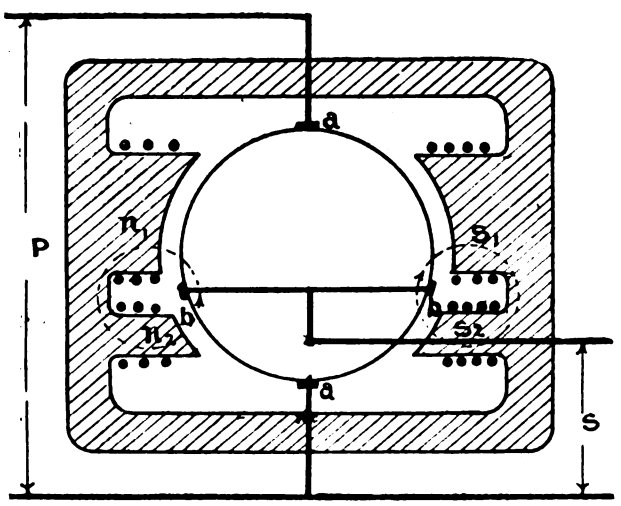

Fig 2.

the length of the mean resistance path for the flux, due to the armature M.M.F., is increased considerably, and that as the yoke length is shortened the weight and costs must be considerably reduced.

Although all the precautions as outlined above were taken in the earlier designs, these machines still gave considerable trouble, due to the short-circuited current flowing through the armature across the shorted brushes. As already stated, this short-circuit current, if not properly controlled, makes the operation of such a machine practically impossible, and it was found in the earlier machines referred to above that there was a very great liability for the machines to take charge and race dangerously, more especially when the secondary voltage was varied between wide limits. This, of course, is due to the fact that the armature reaction, caused by circulating current in this case, may be in direct opposition to the M.M.F. on the main field poles, resulting in a demagnetisation of these poles and raising the speed. To get over this difficulty in the most effective and simple manner possible, the poles are provided with series windings in addition to the ordinary shunt coils, and connected as shown in Fig. 3, where A and A1 represent the series coils. These coils are each connected to one of the shorted brushes, and their other ends connected together at one of the secondary terminals of the machine. Under normal circumstances when there is no circulating current flowing through the armature across the shorted brushes, then each brush and each main coil will be carrying half the secondary load current; if, however, a circulating current arises, it will flow in opposition to the load current in coil A1, say, and in conjunction with the load current in the other coil, A2; in effect, therefore, the current in coil A1 will be less than in coil A2, and if these coils are suitably coupled up will have the effect of correcting or preventing the short-circuit current from rising to any considerable value. In other words, as the current in the coil A1 is less than the current in the coil A2, the M.M.F. on pole n_2 is less than the M.M F. on the pole s_2, and this tends to cause a greater voltage to be generated under the pole s_2 than under the pole n_2, thus opposing the voltage which is creating the circulating current. A little consideration will show that these balancing series coils can be placed on all the poles, and can be wound not only to effect the governing of the circulating current, but also at the same time to create either a compounding or differential effect on the secondary circuit. When these series coils are used there is no tendency for the machine to race, and the currents coming from each of the shorted brushes are always within 10 per cent. of each other, even when the maguet poles are entirely unsaturated, which would be impossible without these windings.

These converters may be divided into three classes, depending on the use to which they are to be put: (*a*) for giving a constant secondary voltage for any value of the secondary current; (*b*) for giving a secondary current which is to remain approximately constant for a given

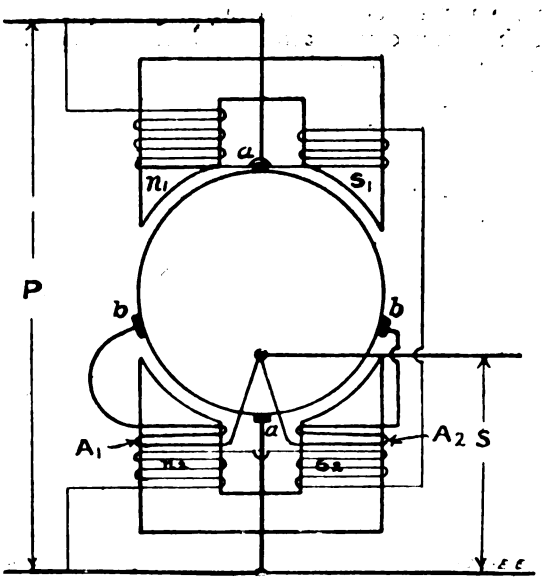

Fig. 3.

range of secondary voltage; (*c*) machines which are to be used for converting from alternating to direct current, the direct-current voltage being capable of variation without affecting the power factor of the alternating side.

As a general rule, the coupling diagram as shown in Fig. 3 is suitable for machines giving constant voltage. Such machines would be the direct current equivalent of an alternating-current auto-transformer, but would have the advantage that the secondary voltage could be easily altered at will, independently of the primary voltage, or compounded for voltage drop. As machines of this class, having a capacity of between 2 kw. and 3 kw., will have an efficiency of from 75 to 80 per cent., it is obvious that their application to transforming the voltage for metallic-filament lamps has led to very good results in many cases. For instance, in large shops, hotels, and theatres when the full load can be switched on at once and kept on for a considerable time, the saving will be something like 70 per cent. in power over the most efficient carbon lamp. The secondary voltage can be made to vary up or down, either automatically or by hand regulation, to suit the various conditions to which the machine may be applied.

In all the above cases it is desirable to arrange the values of the ampere-turns on the poles on both sides of the shorted brushes so that both poles and yokes are unsaturated magnetically. This permits of good regulation and perfect governing for short-circuit current. With the poles on the primary side of the shorted brushes—viz, n_1, s_1—absolutely unsaturated magnetically, and the poles on the secondary side highly saturated, it is possible to use

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this machine, by applying a flywheel to its shaft, for reducing the voltage from a tramway trolley circuit to, say, 220 or 110 volts, and at the same time to smooth out the variations in voltage on the secondary side, so that the machine can be used for supplying incandescent lighting successfully from its secondary terminals. With the usual variation of pressure of a tramway circuit, a practically constant voltage can be obtained at the secondary terminals of the machine.

The machines have also been applied to balancing three-wire circuits with great success, the largest as yet made being two machines for the Calcutta Electric Supply Corporation, dealing with an out-of-balance load of 60 kw. on either side of the middle wire, the voltage of the outers varying from 460 to 580 volts. These machines were required to balance the voltage within 1 per cent. of the mean value on either side of the middle wire at all voltages between 460 and 580. Their efficiency was 94 per cent. on test, which is 4 or 5 per cent. higher than that obtained with double machines. The advantages of using such machines as balancers are the small weight and space taken up, absolute reliability, small wear and tear on the brushes, and high efficiency. When used as a balancer the armature is divided into two equal parts by the shorted brushes; also the polar limbs are all equal in dimensions, the series compounding coils are arranged on all the poles, not only for the purpose of voltage regulation, but also to balance the circulating current across the shorted brushes.

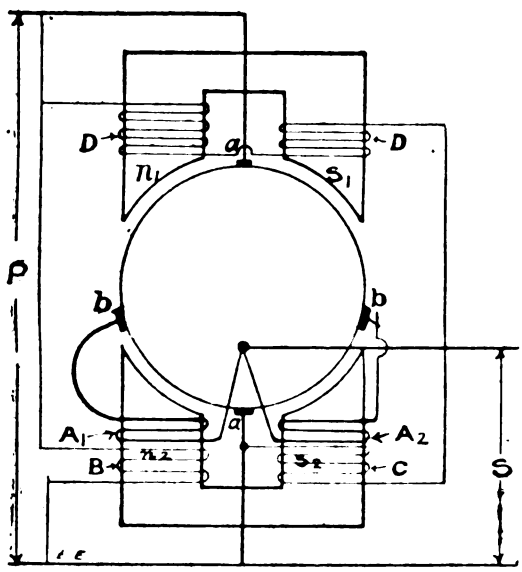

FIG. 4.

From the foregoing it will be seen that there is an unlimited field for the use of this converter, owing to the high efficiency and small space required.

We will now describe briefly the construction of the machine used for the purpose set forth under heading (*b*), having a constant secondary current over a given range of secondary voltage. The characteristic of the secondary is shown by the curve in Fig. 5, and is suitable for supplying a single arc lamp, or two or more arc lamps in series, without the use steadying resistances.

Fig. 4 shows the winding diagram of the machine arranged to give automatically a practically constant secondary current. On examining this diagram it will be noticed that the shunt winding on the part poles n_1 s_1 are connected between the positive supply main and the shorted brushes, whereas the shunt coil, marked B, is connected right across the supply mains. The shunt coil C is connected between the shorted brushes and the negative supply main. The series coils, A1, A2, on the part poles n_2 s_2 are each connected to a shorted brush, in the same way as described with reference to Fig. 3, but in this case the series coils, A1, A2, are so connected that their M.M.F.'s oppose the M.M.F.'s of the shunt coils, B and C. The action of the machine is as follows: If the secondary current tends to increase, the opposition M.M.F.'s of the series windings, A1 A2, are increased, which reduces the secondary voltage, S, the presence of the separately-excited coil, B, preventing the flux in the poles n_2 s_2 being wiped out altogether. The secondary voltage having dropped, the voltage between the shorted brushes and the positive main brushes must rise, causing the shunt coils D to increase the flux through the part poles n_1 s_1, thereby replacing the flux withdrawn from the part poles n_2 s_2, and so keeping the speed constant.

When under load the armature is divided into a motor portion and a generator portion by the shorted brushes, and the M.M.F. of the motor part will be in opposition to that of the generator part. With a certain transformation ratio these M.M.F.'s are equal and opposite, but in the case of the arc lamp converter just described, on approaching the short-circuit condition the M.M.F. of the generator portion is much greater than the motor part, and a cross flux already referred to passes between the shorted brushes, following the path shown by the dotted lines in Fig. 1, causing a large parasitic current to flow between the shorted brushes. This cross flux can be neutralised by strengthening the M.M.F. in the pole n_2 and weakening s_2, and the parasitic current traversing the coils, A1 A2 performs this function to a great extent; but to entirely neutralise the cross flux the authors place the shunt coil B, which maintains its strength throughout, on the pole n_2, and the coil C, which becomes gradually weaker towards short-circuit, on the pole s_2.

These machines are absolutely automatic in their action, and will run for any length of time on open circuit, full load, or with the secondary terminals of the machine short-circuited, for any length of time. They can be worked

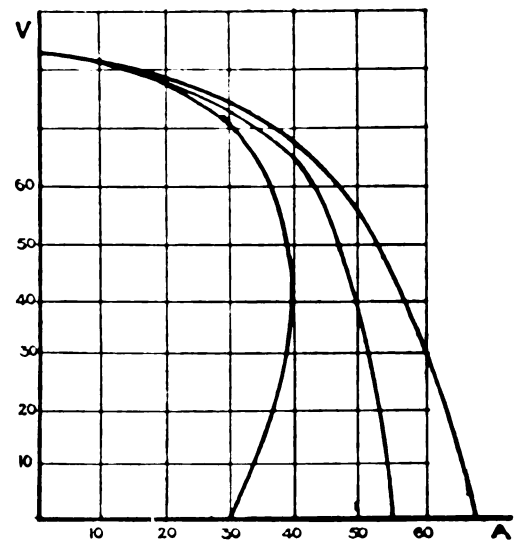

FIG. 5.

with perfect safety to the operator, and no damage can be done to the lamp, as the current can never exceed the full-load working current. In cases where the lamp has to strike automatically, this is ensured by the fact that when the carbons are brought together there is an instantaneous rush of current of about twice the full-load working current, which makes the lamp strike. This current settles down to the full load value in less than a second, and if the lamp does not strike the machine merely allows normal current to pass through the shorted carbons. A variation in the secondary characteristic can be produced by inserting a shunt regulator. Similarly, a constant current of practically any value, covering a very wide range, can be obtained for a given range of voltage by merely fixing the position of a shunt regulator handle.

Fig. 5 shows some actual curves taken from a test on a machine. The curve (1) is vertical, and one might suppose there would be instability when working on the vertical part of the curve. This is not the case, as it is quite possible to arrange these machines to work two arc lamps in series. When one lamp only is working, the other being short-circuited, the machine is quite stable, and supplies the remaining lamp satisfactorily with the same current, but at a lower voltage. As far as the authors are aware, this is the first time such a result has been obtained.

The various characteristic curves as shown in Fig. 5 are produced by altering the resistance in circuit with the shunt coil B, and this being an extremely simple thing to

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do, such a machine is specially adapted for working a cinematograph, and, in fact, any kind of projector lamp, because of the ease with which the light intensity can be altered—by adjusting the amount of current passing through the arc 50 per cent. above or below the normal. It is possible with such a machine to place it at a long distance from the operator and merely bring two small wires to the shunt regulator at the operator's hand; any alteration to the intensity of the light can be obtained by adjusting the shunt regulator handle. A cinematograph machine capable of giving a supply of 50 amperes to a 50-volt arc is 22 in. high by 21 in. wide by 14 in. long, and weighs 5 cwt. The efficiency of such a machine works out at from 75 to 80 per cent. on full load, and it will therefore save, when replacing a steadying resistance worked off a 440-volt circuit, about £13 per week; when replacing a steadying resistance worked off a 220-volt supply some £5 per week; and when replacing a steadying resistance worked off an 110-volt supply the saving will be about £1. 10s. per week. These figures are based on the assumption that the price of current is 3d. per unit and that the lamps are used for 50 hours per week. The price paid for such an installation, working on these assumptions, will be saved, in the first case in four weeks, in the second case in about 10 weeks, and in the third case about 35 weeks.

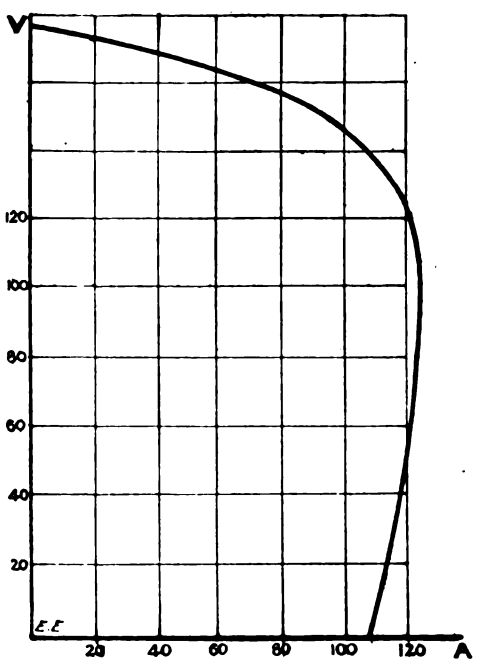

FIG. 6.

In the electric welding any of the characteristics shown in Fig. 5 will be suitable. The primary supply voltage should be low, for the machine can be made rather lighter, more efficient, and of better proportions, the lower the primary supply voltage. A very good portable welding set could be made by supplying in conjunction with such a machine an 80 or 90 volt battery capable of giving high discharges for short periods.

Fig. 6 shows the relationship between the secondary amperes and voltage of a 220-volt machine made for the purpose of supplying two 120-ampere 60-volt arc lamps in series The efficiency of this machine, when supplying the two lamps in series, was over 92 per cent. The dimensions of the machine are 24 in. high by 22 in. wide by 24 in. long, and it weighs 8 cwt. net. The weight of the set and the space taken up have probably never been reached before within 100 per cent. The weight and the space taken up are remarkably small, when it is considered that each part of the armature and each part of the field system has to be capable of dealing with the full primary voltage and the full secondary current at the same time.

Under heading (3) are machines which are used for converting alternating currents to direct currents; these are really the machines which come under headings (1) and (2), supplied with a suitable number of collector rings to suit the number of the phases of the supply. The advantages to be obtained by using such machines for this purpose are as follows: The direct-current voltage taken from the secondary is more or less independent of the alternating supply voltage, and can be varied either automatically or by hand without altering the power factor of the alternating current supply to any appreciable extent. It is evident, therefore, that machines of this kind can be used for all the purposes set forth under headings (1) and (2) by applying similar windings to the part poles, n_1, s_1 and n_2, s_2, and when supplied with collector rings and a belt pulley this machine is extremely valuable for teaching purposes in technical colleges. With the cross brushes up such a machine can be used as a direct-current dynamo, a direct-current motor, an alternating-current dynamo, an alternating-current motor, a combined direct and alternating current dynamo, and a split-pole rotary converter. With the cross brushes down it can be used as a direct-current auto-transformer, converting, if desired, from constant potential to constant current, and again, as a rotary converter, converting from alternating to direct current of practically any voltage between given limits.

A demonstration of the uses of this apparatus was given to representatives of the technical Press last Friday at the works of Messrs. Crompton and Co., Chelmsford, and its

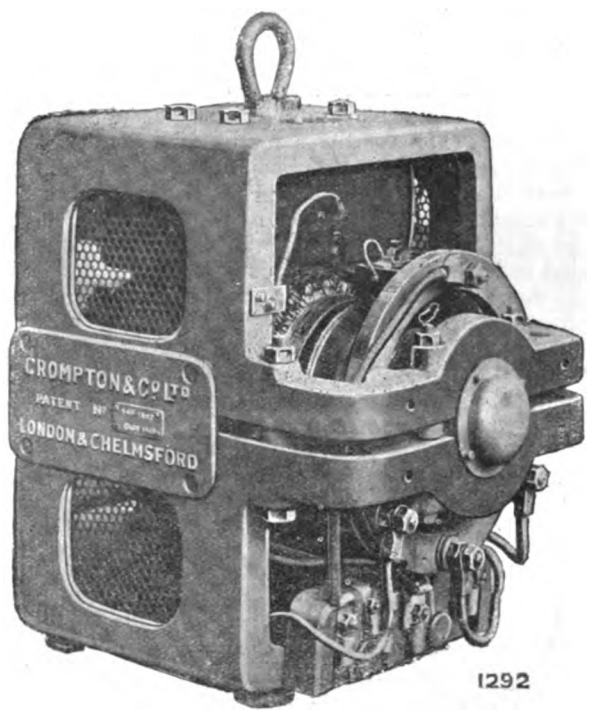

FIG. 7.—"C.M.B. Auto Converter.

possibilities of control, the general safety of the system, and the simplicity of it were very noticeable. The machines can be obtained for primary voltages of 550 and under, and with transforming ratios up to 1 to 10. We were informed that the efficiency for normal ratios in the case of a 2-kw. machine from 75 per cent. at full load to 70 per cent. at half load. For a 20-kw. machine the efficiency varies from 91 per cent. at full load to 88 per cent. at half load. The weight of a transformer of this pattern is stated to be about half that of a motor-generator of the same capacity. The application of the "C.M.B." auto-converter for the control of an electric omnibus which was fitted with this device created much interest. This electrical equipment possesses a number of distinct advantages over the ordinary equipments, in that it provides a wide range of control over the accelerating and running speed of the motors and enables electric braking by returning power to the batteries to be employed. In this way the whole manipulation of the electrically-driven vehicle is under the influence of one small regulating switch connected to the field of the auto-converter. A further winding on the "C.M.B." auto-converter limits the current taken from the batteries and supplied to the motors, doing away with all steading resistances and main circuit controller contacts, preventing the speed limit from being exceeded even when running

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down hill, and automatically regulating the supply of current to the motors.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

CHEAP UNITS.

SIR,—There are one or two points in connection with the discussion on the above subject to which, with your permission, I should like to make reference.

I was very glad that one or two engineers emphasise the desirability of avoiding all difficulties about the consumer's load factor by the method of making a fixed charge per annum per kilowatt of maximum demand coupled with a low price per unit, and I should like particularly to call attention to the importance of taking account of the diversity factor in a systematic way in making the fixed charge. With your permission I shall give you my views as to how the diversity factor should be applied in reducing the fixed charge. The effect of the diversity factor may be taken account of in two ways: (1) it may be expressed as the new ratio of the sum of the maximum demands of the various consumers (including the new consumer under consideration) to the new maximum demand at the station; or (2) it may be expressed as the *increment* of the sum of the existing maximum demands of the various consumers to the *increment* of the maximum demand at the station. The corresponding analogy in the matter of load factor would be that (1) a consumer would only get the benefit due to the percentage improvement that he conferred upon the load factor of the station; or (2) he would get the whole benefit due to his own load factor. I contend that in the matter of diversity factor the consumer ought to be treated under the second method.

In the case which I cited at Manchester, the ratio obtained under the first method (assuming for the sake of argument that the existing maximum demand at the station was 20,000 kw. and that the sum of all the maximum demands of the power consumers amounted to, say, 40,000 kw.) would be $\frac{40,000 + 4,000}{20,000} = 2\,2$, whereas in the second case it is $\frac{4,000}{0}$ = infinity. In other words, in the first case the consumer is only given a 10 per cent. betterment upon what he would get if he came on at the time of peak, the same as the other consumers, whereas in the second case he would be *entirely* relieved of his capital and other fixed charges, owing to his only coming on in the small hours of the morning, as in the case considered by me at Manchester.

If this principle be granted, and I cannot help feeling that it is the right one, then the allocation of the fixed charges becomes an easy matter, and it is only necessary to add a percentage of profit on to the true running cost to cover all cases. My point is that a consumer coming on in this way in the dead of night is just as profitable to the station if he is charged in the above manner as the ordinary consumer would be, and in some cases even more so. In the one case the station incurs a very big expenditure for the sake of getting a consumer; it has to pay heavy charges on account of that expenditure, and my contention is that there is no advantage to the municipality in the mere spending of greater capital sums of money and paying back the interest on these sums to the Government, but that the real advantage comes in the question of what is the *net profit* after all the other expenses have been met. It is this which goes to relieve the rates, or to reduce the cost of energy to future consumers. I do not, therefore, agree with the suggestion that has been made by some speakers that a consumer with a maximum demand occurring between midnight and 6 a.m. should contribute something towards *capital* charges, but suggest that it is quite sufficient that he contributed towards the *net profit* charges.

It also appears to me that in the desire to be scrupulously fair towards the old consumers some of our friends are overshooting the mark, and are grossly unjust towards the new consumers. Really, we are hardly to expect that the old consumers started supporting the station from purely philanthropic motives, any more than we are to expect that the new consumers are going to be enormously more generous in *their* philanthropic motives. Anyway, the existing consumer has his remedy. He, too, can become a "restricted-hour" man if he chooses. Lastly, I am not at all sure that if the restricted-hour system could be applied in the way I suggest, and carried up till reasonably late in the afternoon, a considerable amount of business might not be done in heating and cooking as well as in power. Surely there can be no harm in offering the terms if the station is properly protected against spurious peaks. There is at least the *chance* of capturing some new consumers, and that is worth something.—Yours, etc,

A. M. TAYLOR.

King's Heath, July 6, 1909.

THE NEW HOME OFFICE REGULATIONS.

SIR,—In connection with the new Home Office regulations for the generation, transformation, distribution and use of electrical energy in premises under the Factory and Workshop Acts of 1901 and 1907, which come into force to day and on Jan. 1, 1910, there is a sentence in regulation No. 13 which seems to require a little explanation. This regulation reads as follows:

"13. Every flexible wire for portable apparatus, for alternating current, or for pressure above 150 volts direct current, shall be connected to the system either by efficient permanent joints or connections, or by a properly constructed connector.

"In all cases when the person handling portable apparatus or pendant lamps with switches, for alternating current or pressure above 150 volts direct current, would be liable to get a shock through a conducting floor or conducting work or otherwise, if the metal work of the portable apparatus became charged, the metal work must be efficiently earthed, and shall not itself be the only earth connection for the metal of the apparatus. *And a lamp-holder shall not be in a metallic connection with the guard or other metal work of a portable lamp.*

"In such places and in any place where the pressure exceeds low pressure the portable apparatus and its flexible wire shall be controlled by efficient means suitably located and capable of cutting off the pressure, and the metal work shall be efficiently earthed independently of any flexible metallic cover of the conductors, and any such flexible covering shall itself be independently earthed."

It is the last sentence of the second paragraph of the regulation, and which I have italicised, which seems to me to call for comment. If the rest of metal work of fitting is earthed, it would also seem to be advisable to earth the holder. If the holder is insulated it is liable to become charged, and anyone turning on or off switch, if holder of switch type, putting in new lamp or tightening up barrel while holding metal stem or fitting, or while making contact in some other way with earth, would be liable to get a shock. I can only conclude that a printer's error must have occurred here and that the word "not" should be deleted. It seems a little late in the day to be writing in reference to this matter, seeing that we have all had so much time in which to give these excellent regulations our consideration, and it is possible that I have not interpreted the sentence correctly in its relation to the rest of regulation. If so, I should like to be put right.—Yours, etc.,

F. JOHNSTON.

Strathleven, Holywood, co. Down, July 1, 1909.

FORTHCOMING EVENTS.

SATURDAY, JULY 10.

Institution of Mining Electrical Engineers.—At 7 p.m., meeting at the Grand Hotel, Manchester.

SATURDAY, JULY 17.

Junior Institution of Engineers.—At 10 a.m., visit to the ordnance engineering works of Messrs. Vickers, Sons, and Maxim at Erith.

Axbridge.—Colonel Llewellyn, on behalf of the Electric Light Committee, has presented a lengthy report to the Board of Guardians in regard to the lighting of the workhouse by electricity, the committee asking to be supplied with further details.

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INQUIRY CONCERNING FIRE AT A METROPOLITAN DISTRICT RAILWAY STATION.

Mr. A. P. Trotter has reported to the Board of Trade the result of his inquiry into the fire which took place at Charing Cross Station on the Metropolitan District Railway last month. It appears that the fire was not of an electrical character, but was due to a spark from a brake block, or from a lighted match or cigarette end, which ignited dust and dirt in a concrete chamber flush with the ballast immediately under the edge of the north platform. The low-pressure mains from the sub-station come out from below the platform into this chamber. One main supplies the station section of the conductor rails and others branch to the east and to the west to supply the conductor rails beyond the station section. The mains pass from the concrete chamber below the ballast in ducts to junction pillars. The cover of this concrete chamber was made of ordinary plank. It was intended that jarrah wood should be used, and Mr. Trotter remarks that if that material had been employed the fire would probably soon have burned itself out, as jarrah wood is nearly non-inflammable. The passage between the concrete chamber and the sub-station through which the cables are laid forms one of the intakes of air into the sub-station, which is powerfully ventilated. The first notice of trouble was given by smoke entering the sub-station through the low-pressure cable ducts. The strong draught appears to have fanned the fire and accounts for the fierceness of it. An attempt was made to extinguish the fire by sand from the platform. While these efforts were being made it was seen that the fire would soon reach and damage the low-pressure cables, and orders were given to cut off the electrical supply. The proper course, says Mr. Trotter, would have been then to have disconnected the low-pressure cables from the junction pillars at the ends of the east and west sections, and to disconnect the station section altogether, and to "jump" the station section, or to work the traffic on the south line by the cross-overs. A train running eastward entered the station, although an attempt was made to prevent it, and it stopped with a motorcar immediately over the feeder supplying the station section. One of the motors happened to be immediately over this feeder, leaving only a few inches intervening space. One of the attendants sawed through this cable under great difficulties, not only owing to the confined space, but working within a short distance of the burning planks. If the train had not been allowed to come up to this point, it is probable that traffic might have been resumed after a few minutes. At the time when the current was cut off no electric damage had been done. The current was cut off for precaution against electrical mishap. No circuit breakers came out either at this station or elsewhere, showing that the electrical arrangements were not interfered with. The fire, which seems to have first burned the plank cover, was fierce enough to melt the lead sheathing of the low-pressure cables, and when the oil-impregnated paper insulation caught fire there was considerable smoke. But most of this was drawn into the sub-station, and there is hardly any visible trace in Charing Cross Station. The fire was confined to the concrete chamber, about 20 cubic feet capacity, and to the passageway below the platform leading to the sub-station.

The conclusion arrived at by Mr. Trotter is that this accident appears to have arisen mainly from the inadvertent use of ordinary planks instead of jarrah planks. Owing to the peculiar position of the cover of this chamber, he does not recommend that metal should be used. No danger was involved, and the delay of the traffic was chiefly due to the stoppage of a train with a motor immediately over the cable which had to be cut off.

"A DISTRACTED INDUSTRY."

There appeared in the *Times* of yesterday's (Thursday) date a letter under the above heading from Mr. E. Garcke, in which the writer said: "The Electric Lighting Acts (Amendment) Bill has been read a second time in the House of Commons, and it appears probable that the Bill will pass with all its present imperfections unless the Board of Trade can be induced to reconsider the matter.

"In 1898 a Select Committee of both Houses of Parliament, presided over by Lord Cross, made various recommendations for the amelioration of the onerous conditions imposed upon the electrical supply industry. In 1902 a deputation waited on the then President of the Board of Trade to urge the Government to give effect to the principles laid down by that committee. Mr. Gerald Balfour, the then president, stated that a new Bill had been drafted to incorporate the recommendations of the Joint Select Committee. This Bill, he thought, 'would go very far to meet all reasonable objections that had been urged.' With this implied promise the industry was content, but nothing whatever was done until the following session, when a Bill was printed, but not presented. Another year passed and in May, 1904, the Bill was read a second time in the House of Lords, but was not introduced into the House of Commons. In 1905 not even a pretence was made of bringing the Bill forward.

"In the present session a Bill has been introduced which, however, does not contain a vestige of the promises made in 1902, but, on the contrary, it contains matters detrimental and harassing to electric supply companies, without benefit to the public. It was hoped that the Bill was, like its predecessors, introduced without any intention of being proceeded with, but now there appears a likelihood of the Bill passing in its present objectionable form. It was hoped that the Government would accept Mr. Harmood-Banner's motion that the Bill should be referred to a Select Committee, so as to give the industry an opportunity of obtaining amendments on clauses, but it is understood that the Bill has been referred to a Standing Committee, which will preclude the views of the industry being put forward."

Mr. Garcke, in conclusion, makes, "on behalf of an industry which is already sadly oppressed by legislation," a final appeal to the President of the Board of Trade not to deal it this further blow. He points out that there is no other industry in the country which labours under such onerous legislative restrictions, obligations, and burdens as the electrical.

PUBLICATIONS RECEIVED.

Proceedings of the American Institute of Electrical Engineers, vol. 28, No. 7, July, 1909.

The Physical Review, vol. xxviii., No. 6, June, 1909. New York: The MacMillan Company.

"Atlas der Elektropathologie." By Dr. S. Jellinck. Price, 35 mark. Berlin and Vienna: Urban and Schwarzenberg.

Bulletin No. 6 E of the engineering department of the National Electric Lamp Association, Cleveland, Ohio, U.S.A., relating to tungsten sign lamps.

Journal of the Institution of Electrical Engineers, vol. 42, part 195, June, 1909. London: E. and F. N. Spon, Limited, 57, Haymarket, S.W. Price, 5s.

Transactions of the North-East Coast Institution of Engineers and Shipbuilders, vol. xxv., part 6. Newcastle-on-Tyne: Andrew Reid and Co., Limited.

"Arbeiten aus dem Elektrotechnischen Institut" (the Technical High School, Karlsruhe). Edited by Dr. Ing. E. Arnold. 10 mark. Berlin: Julius Springer.

"Les Deconvertes Modernes en Physique," by O. Manville. Paris: A. Hermann et Fils, 6, Rue de la Sorbonne. Price, 8 fr. This is the second edition of Dr. Manville's work, which has been entirely rewritten. The first part contains an exposition of the theory of ions and electrons, and leads up to their application to physical phenomena, which is explained in the second part of the book.

Illuminating Engineer, June, 1909. No. 6, vol. 2. Edited by Leon Gaster. Published by the Illuminating Engineering Publishing Company, 13, Bream's-buildings, London, E.C. Price, 1s. This issue contains an interesting article by Dr. M. Gaster on the subject of the worship of light, in which the author conveys the idea that the most recent results of the illuminating engineer and the discovery of the remarkable effects disclosed by the latest investigations of the ultra-violet rays upon the human body corroborate the ancient beliefs in the influence which the light of certain stars and of certain colours have upon the human body and upon human well-being in general. Mr. A. P. Trotter deals with photometric scales, and gives a description of the perforated screen type of photometer. An important feature in the present number is the publication of the draft constitution and by-laws of the Illuminating Engineering Society as ratified at a recent meeting. Other articles relating to the various phases of scientific illumination appear.

"Electrical Installations," by Rankin Kennedy. Vol. 4 London: The Caxton Publishing Company, Clun House, Surrey-street, Strand, London, W.C. This volume of the revised edition of this popular work comprises the subjects of electrical storage and electrolysis, the uses to which the conversion of heat to electrical energy and electrical energy to heat may be put to practice. It also reviews the various systems of electric traction on tramways and railways. Reference is made to special applications of motors for electric cranes, hoists, machine tools, and mining, concluding with general information on distribution and transmission systems, main cables, and the maximum demand system of payment for electrical energy. The treatment of the subjects included in this volume is of the same thoroughness as characterises the subjects treated in the preceding volumes. With the publication of the fifth and concluding volume there will be available a standard work on electrical engineering which for soundness of matter, clearness of illustrations and of letterpress, is bound to maintain a leading place in technical literature gained for preceding editions.

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NEW COMPANIES REGISTERED.

Warrington Tube Co., Limited.—Registered June 12. Capital, £1,000 in £1 shares. Objects: to carry on the business of manufacturers of and dealers in metallic tubes of all kinds, ironmasters, steel makers and converters, engineers, etc. Private company.

Blythswood Motor and Engineering Co., Limited.—Registered June 12. Capital, £1,000 in £1 shares. Objects: to carry on the business of motor engineers, dealers in and agents for the sale of motorcars, motors, marine motors, ships and launches, etc. Private company.

Liverpool Lighting and Heating Co., Limited.—Registered June 3. Capital, £1,000 in £1 shares. Objects: to carry on the business of manufacturers of or dealers in incandescent lights, lamps, mantles, appliances, and apparatus, etc. Private company. Registered office: 5, Castle-street-arcade, Liverpool.

Atlas (Canton) Engineering Co, Limited.—Registered June 2. Capital, £5,000 in £1 shares. Objects: to carry on the business of engineers, founders, boilermakers, iron and steel merchants, tinplate makers, metal workers, machinists, smiths, etc. Private company. Registered office: 20, Atlas-road, Canton, Cardiff.

Aspley Motor and Engineering Co., Limited.—Registered June 3. Capital, £20,000 in £1 shares. Objects: to adopt an agreement with the International Rotary Motors, and to carry on the business of proprietors of motor cabs, carriages, van, and other public or private conveyances, etc. Private company. Registered office: Aspley Works, Asp'ey, Nottingham.

Grassington Electric Supply Co., Limited.—Registered June 8. Capital, £1,000 in £1 shares. Objects: to carry on at Grassington and elsewhere in Yorkshire the business of an electric supply company in all in all its branches, and to adopt agreements (1) with J. S. Fielden and (2) with C. Pullan. Minimum cash subscription, £100. Registered office: 51, King's-arcade, Bradford.

Ulu Bulch (Selangor) Rubber Co., Limited. — Registered June 11. Capital, £30,000 in £1 shares. Objects: to acquire and develop land situated in the Mukim of Sungei Bulon, Selangor, Federated Malay States, and to carry on the business of planters, cultivators, importers and exporters of trees yielding rubber and other produce, etc. Registered office: 8, Hill-street, Edinburgh.

Eaton Telephone Disinfector Co., Limited.—Registered May 28. Capital, £500 in £1 shares. Objects: to carry on the business of manufacturers and suppliers of contrivances and appliances for use in connection with telephones, speaking tubes, and the like, and other articles capable of being used either chemically or as disinfectants, etc. Private company. Registered office: 35, Jewin-street, E.C.

Klabang Rubber Co., Limited.—Registered June 24. Capital, £50,000 in £1 shares. Objects: to acquire the Para rubber estates, known as Auckland and Richmond, and a block of virgin jungle, known as Klabang, Malay Peninsula; to adopt an agreement with J. I. Philips, and to carry on the business of growers, exporters, and manufacturers of and dealers in indiarubber, guttapercha, and other products, etc. Registered office: 38, Eastcheap, E.C.

Ford Tyre and Engineering Co.—Registered June 26. Motor, cycle, electrical, and general engineers, Ashford, Middlesex. Partnership for two years from June 26, and dissolvable thereafter on six months' notice. Power is taken to dissolve at any time on breach of provisions of articles of partnership on seven or fourteen days' notice. General partner: L. C. Freeman, above address. Limited partner: J. Portsmouth, 12, Little College-street, Westminster.

Tangkah Rubber Estate, Limited. — Registered June 24. Capital, £125,000 in £1 shares (107,500 6 per cent preference participating). Objects: to acquire certain rubber plantations or estates in Johore, Straits Settlements, known as the Tangkah Estate, to adopt an agreement with the F. M. S. Syndicate, and to carry on the business of cultivators of and dealers in rubber, guttapercha, rambong, balata, and other gums, etc. Registered office: 5, Whittington-avenue, E.C.

Magnum Steel Co., Limited. — Registered May 7. Capital, £25,000 in £1 shares (13,000 preference). Objects: to adopt an agreement with C. H. Kelsall and T. Wood for the acquisition of certain British and foreign patents relating to the manufacture of high per cent. manganese steel, and to carry on the business of manufacturers of and dealers in steel, vanadium, iron, and other metals, ironmasters, steelmakers, etc. Private company. Registered office: St. Helens Junction, St. Helens, Lancs.

Automobile Electric Lighting Syndicate, Limited.—Registered May 15. Capital, £5,000 in £1 shares (2,500 deferred). Objects: to adopt an agreement with Polkey Automobile Electric Lighting Syndicate for the acquisition and exploitation of certain patents or rights or privileges, and to carry on the business of mechanical and electrical engineers, generators, accumulators, distributors, and suppliers of electricity for motive power, light, heat, or otherwise, etc. Private company. Registered office: Queen's College, Paradise-street, Birmingham.

Jong-Landor Rubber Estates, Limited.—Registered June 23. Capital, £65,000 in £1 shares. Objects: to acquire the estates in Perak, Federated Malay States, known as the Sungei Landor Rubber Estate, and the Sungei Jong Rubber Estate; to adopt agreements (1) with Chenderiang Rubber and the Melantang Syndicate, and (2) with the Sungei Jong Rubber Co. and the Melantang Syndicate; and to carry on the business of growers of and dealers in rubber, guttapercha, tea, coffee, and other plants and natural produce, etc. Registered office: 138, Leadenhall-street, E.C.

Premier Lighting and Engineering Co., Limited.—Registered May 19. Capital, £2,000 in 2,999 ordinary shares of £1 each and 15 deferred shares of 1s. 4d. each. Objects: to adopt an agreement between W. C. Sharpe, W. C. Sharpe, jun., and H. C. Robottom, and to carry on the business of engine builders in accordance with the patents referred to in the said agreement, engineers, machinists, manufacturers of and dealers in sanitary, heating and lighting appliances, electricians, etc. Private company. Registered office: 4, Lloyd's-avenue, Fenchurch-street, E.C.

Liens Registered, etc.

Cleveland and Durham Electric Power, Limited.—Issues on June 5 of £6,500 and on June 7 of £31,000 debentures, parts of series of which particulars have already been filed.

Institution of Electrical Engineers.—Mortgage and charge, dated June 1, to secure £26,000, charged on leasehold premises known as the Examination Hall, Thames-embankment, W.C. Holders: Economic Life Assurance Society.

Mexican Light and Power Co., Limited.—Particulars filed May 5. Capital, 12,000,000 dol. in shares of 100 dol. each. Registered in Canada on Sept. 15, 1902. British address, 31, Bishopsgate-street Within, E.C., where H. M. Hubbard and B. H. Binder are authorised to accept service.

Aspley Motor and Engineering Co, Limited.—Particulars of £25,000 debentures, created June 12, 1909, filed pursuant to Section 93 (3) of the Companies (Consolidation) Act, 1908, the amount of the present issue being £10,000. Property charged: The company's undertaking and property, present and future. No trustees.

Rhymney Valley and General Electric Supply Co., Limited. Particulars of £1,250 debentures created Jan. 1, 1909, filed pursuant to Section 93 (3) of the Companies (Consolidation) Act, 1908, the amount of the present issue being £1,100. Property charged: the company's undertaking and property, present and future, including uncalled capital. No trustees.

Manica Copper Development Co., Limited.—Trust deed, dated June 15, 1909, to secure £15,000 10 per cent. second mortgage debenture stock, charged on the company's assets, present and future, including uncalled capital, subject to £15,000 prior debentures. Trustees: G. R. Bonnard, 80, Coleman-street, E.C.; E. P. McClean, 34, Sydenham-park, S.E.; and R. A. Dawbarn, Wierton, Sidcup.

Works Construction Co., Limited.—Charge dated June 16, 1909, to secure all moneys advanced up to £42,000, charged on the company's uncalled capital and 4,500 preference and 15,493 ordinary shares of £5 each in the Para Electric Railways and Lighting Co. Holders: Anglo-American Debenture Corporation, 20, Birchin-lane, E.C.; R. Fleming, 2, Princes-street, E.C.; and J. G. White and Co., 9, Cloak-lane, E.C.

APPOINTMENTS VACANT.

Motor Inspector to undertake duties of motor instructor, Bournemouth Corporation Tramways. Wages, 36s. per week. Applications to the General Manager.

Switchboard Attendant, Stockton-on-Tees Corporation. Wages, 27s. 6d. per week. Applications to Mr. J. J. Smith, borough electrical engineer. See advertisement in last issue.

Superintendent for track and equipment, under general manager, Shanghai Tramways. Applications to the Shanghai Electric Construction Co., Limited, Basildon House, London, E.C.

Engineer to take charge of the steam, electric, ventilating, etc., plant at University College Hospital and Medical School, Gower-street, London, W.C. Wages, £2. 16s. per week and dinner daily. Applications to the Secretary by July 17.

Postmasters.—Vacancies at Birkenhead, salary £500 a year; Abingdon, salary £260 a year; Ellesmere, salary £170 a year; salaried sub-postmastership of Beeston, Nottingham, salary £160 a year. Applications to the office of the Postmaster-General.

Electrical Instrument Teacher for one evening a week during the session 1909-10 at the London County Council Shoreditch Technical Institute, Pitfield-street, N. Salary, 7s. 6d. an attendance of about three hours. Applications, on official forms, to the Education Officer, London County Council Education Offices, Victoria-embankment, W.C., by July 10.

Chair of Engineering.—The University Court of the University of St. Andrews invite applications for the professorship in engineering and drawing in University College, Dundee, University of St. Andrews. Particulars as to emoluments, etc., obtainable from Mr. Andrew Bennett, secretary and registrar, the University, St. Andrews, to whom applications, etc., must be sent by July 10.

Assistant Engineer.—The Municipal Council invite applications for the position of assistant engineer. Age not above 25 years. Candidates must have been articled to a civil engineer and possess a practical knowledge of municipal engineering in all its branches. Salary, Rs.4,500 per annum, and allowance Rs.900 per annum—*i.e.*, Rs 600 for a horse and Rs.300 for a rickshaw. Applications, stating age, etc., must be addressed to the Chairman, Municipal Council, Colombo, by Aug. 15. Further particulars from Mr. R. Skelton, municipal engineer, care of Crown Agents for the Colonies, London.

Assistant Engineer for the Public Works Department of Southern Nigeria, for two tours each of 12 months' residential service, with possible extension. Age between 25 and 30 years. Salary, £300 a year, rising to £400. Free single quarters provided at established stations. Free first-class passage out and home again on satisfactory termination of engagement. Candidates should have served their articles with a member or an associate member of the Institution of Civil Engineers. Applications, stating age, whether married or single, giving full particulars of experience, must be sent to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., by July 14.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

QUESTIONS.

1,196. The magnets of some meters of the mercury motor type have become demagnetised to an extent which makes satisfactory adjustment of the meters impossible. Describe the process necessary for remagnetising them, and any other treatment necessary to ensure their future reliability.—F. B. H.

1,197. If the maximum speed of an electrically-driven winding engine is given, show how the rate of acceleration and retardation may be arrived at in order to obtain the most efficient conditions of winding. How does this rate of acceleration compare with that of a steam-driven winding engine, and what is the maximum practicable rate?—POM.

ANSWERS.

Question No. 1,187.—What size of water-softening apparatus is most suitable in the case of a battery of five Lancashire boilers, 28 ft. by 7 ft. 6 in., three of which will be constantly working on maximum (winter) loading, say between 500 kw. and 600 kw.? State disinterestedly, considering all circumstances, whether the apparatus will pay for itself in a plant of the above capacity, at present using canal water (small annual charge) chemically treated in feed tank.

Answer to No. 1,187 (awarded 5s.).—As "Economist" gives no definite information as to the conditions under which the 600 k.w. is generated, whether running on vacuum or to atmosphere, etc., one can only give an approximate size for softener. Again, as the question reads, there is a "constant" load of 600 kw. presumably throughout the 24 hours, so that the softener must be capable of passing the full amount of feed water plus a margin for safety; whereas if it was a peak load of 600 kw., a much smaller softener would suffice if used in conjunction with a storage tank. Assuming a figure of 30 lb. of steam per kilowatt-hour, the softener must be capable of dealing with at least 2,000 gallons of water per hour. An automatic softener of this capacity with wood-wool filter and self-cleaning sand filter would cost between £150 and £250, exclusive of means for raising water to tanks. It is doubtful whether the present method of treating the water in the feed tank is successful, as there will be no means of adequately mixing the chemicals, and, as is probable, the pump suction takes from the bottom of the tank, thus passing a large proportion of the precipitate into the boilers. It would be interesting to know what amount of scale is produced in the boilers at present, as upon this depends the economy to be derived by installing a more elaborate apparatus.

The working costs will depend upon the hardness of the water used. If only calcium carbonate is to be removed lime only is required, but if calcium sulphate is present an alkali will be needed as well. The cost of the chemicals will be somewhat as follows, with quicklime at 20s. per ton and alkali at £4 per ton: with an initial hardness of 16 deg., about ·5d. per 1,000 gallons; with a hardness of 60 deg., about 4·5d. per 1,000 gallons. The actual upkeep of the plant is very little: it will need a thorough scraping and two coats of paint once a year; the wood-wool filter will need replacing from two to six times a year, according to the hardness of the water; and if the sand filter is fitted with a self-cleaning steam injector, this will run for several years without renewal. In practice, the hardness can be reduced to and kept at about 4 deg. without any undue attention, and at this figure the boilers may be run continuously without any sign of scale.

Without knowing the actual details of the case in question, it is impossible to give definite figures as to capital and working costs; but "Economist" may rest assured that the cost of the plant will be saved by the reduction in the costs of boiler cleaning in a very short time, compared to the life of the plant.—J. A. V.

Answer to No. 1,187 (awarded 5s.).—The amount of water required per hour for a load of 600 kw., taking as an average 35 lb. per kilowatt-hour, would be 21,000 lb.; allow for emergency, say, 5,000 lb per hour—total required per hour 26,000 lb. A convenient size of softening plant to install for such a case would be one of 3,000 gallons per hour capacity, which would allow for future load expansion, a plant, that is to say, which would be capable of softening 3,000 gallons per hour *continuously* down to 3 deg. hardness. A concrete case may show that water softening is a paying investment, though the writer believes that even if the annual cost is greater it is always advisable to install water-treating plant. The boiler is the last place in which water treatment should take place.

(*a*) Present cost of chemicals per annum, £25; cost of scaling boilers, £20—total, £45.

(*b*) Using water-treating plant: cost of softening plant, 3,000 gallons per hour, erected complete, including piping, etc., £300; annual charges, £24; scaling charges at half present cost, £10; cost of reagents at ½d. per 1,000 gallons for treating 5,500,000 gallons, £6—total annual cost, £40; showing a saving of £5 by installing a softener, which would probably be increased, as the scaling charges would be decreased by more than half. This estimate is based on a plant for softening a water of about 9 deg. hardness, the cost of lime and soda ash being taken as £1 and £5 per ton respectively. There is also to be taken into account the gain in efficiency due to the cleanliness of the boilers and the pure feed water. Even if the cost of softening exceeded the previous cost when no softener was used, the fact that pure water is used, and the consequent longer hours of steaming before the boilers need opening out, constitute advantages which are well worth the slight extra cost, not forgetting the decreased wear and tear of the boilers under the better conditions.—T. H. J.

Question No. 1,188.—It has been decided to install an electrically-driven lift in an hotel in British Columbia. Electricity is supplied at about 400 volts, three-phase (four-wire), 50 to 75 cycles. Give the relative advantages and disadvantages of driving by (*a*) repulsion motor or, if preferred, by induction motor; (*b*) direct-current motor per motor-generator set. A quick start is favoured. Assume a five-storey building. Capital outlay need not be discussed.

Answer to No. 1,188 (awarded 5s.).—We will consider in order the relative advantages and disadvantages of (*a*) the repulsion motor; (*b*) the induction motor; (*c*) the motor-generator set and direct-current motor.

Briefly, the repulsion motor is a type of single-phase alternating-current commutator motor, possessing distinct primary and secondary circuits, which have no electrical connection with each other. The primary or stator circuit is similar in construction to that of a single-phase induction motor, and consists in its simplest form of a laminated electromagnet excited by means of the single-phase alternating current supplied, and which produces a simple alternating magnetic field. The secondary or rotor circuit is similar to the armature of a direct-current machine, and is fitted with a commutator upon which press brushes, these brushes being connected together or short-circuited. It is seen, therefore, that the repulsion motor requires a supply of single-phase alternating current, this being easily obtainable from the three-phase system supplied. In operation the repulsion motor possesses many of the properties of the series-wound direct-current motor, its characteristics and advantages being: (1) maximum torque at starting; (2) increased torque with increase of current and decrease of speed; (3) comparatively constant efficiency through a wide range of speed. These points are well brought out in the curves shown, which are for a 60-h.p. 25-~ 500-volt machine. The repulsion

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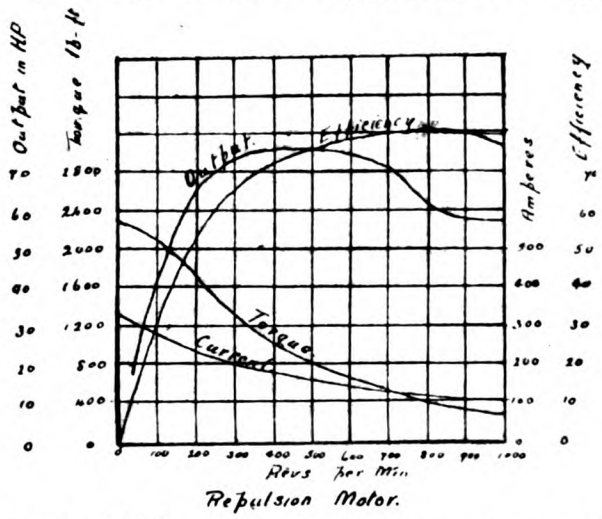
motor is, in fact, admirably adapted for acceleration work, the efficiency being higher than in the direct current motor, due to the possibility of obtaining fractional E.M.F.'s with alternating currents, without increasing the dead resistance losses as with the direct-current system of control. The greatest disadvantage of the repulsion motor is the sparking at the short-circuited brushes, and this is somewhat excessive at low speeds on account of the greater current in the short-circuited coils. The tendency to heat and spark is, therefore, rather a serious matter. The curves shown (taken from a paper read by Mr. W. I. Slichter before the American Institute of Electrical Engineers) are for a 25-~ machine, but would be equally adaptable to a 50-~ or 75-~ machine, provided the stator was built with a correspondingly increased number of stator poles.

(*b*) The only suitable method of using an induction motor for lift work is by arranging for the introduction of variable resistances into the rotor circuit. A three-phase slip-ring motor is used, with the slip-rings connected either to a water resistance or to an ordinary grid resistance. The speed can thus be controlled over a wide range of speed, but with a serious loss of efficiency, for, roughly, the efficiency of an alternating-current slip-ring motor decreases in the same proportion as the speed



decreases. Briefly, the advantages of the motor are: (1) high starting torque, and consequently good acceleration; (2) increase of torque, with increase of current and decrease of speed; (3) easy control of speed. The disadvantages are: (1) excessive resistance losses; (2) comparatively low but constant efficiency over a wide range of speed; (3) low power factor at start, probably in the nature of 60 per cent.

(*c*) The case for the motor-generator set is well known. If direct current is available for generator excitation, the most efficient method is to install a three-phase squirrel-cage induction motor, rigidly coupled to a separately excited direct-current generator. The current from this generator is used for driving a series-wound direct-current motor connected to the lift. The excitation of the generator being adjustable, the terminal voltage of the direct-current series motor can be varied over a wide range, and thus the motor can be operated very economically at all speeds. The advantages of this system are: (1) easy control of speed; (2) very efficient working; (3) high starting torque, and therefore high acceleration; (4) increased torque, with increase of current and decrease of speed; (5) high power factor for alternating system. The disadvantages are: (1) increased capital cost owing to the three units being required instead of only one; (2) direct-current excitation needed for the generator.

It might be advantageous, however, to have a compound-wound direct-current generator, and so have a constant voltage on the series motor terminals. The control of this motor would then be effected by means of a variable resistance connected in series with the motor armature. This would decrease the efficiency of the combination owing to the resistance losses in the controller, but, on the other hand, no direct current would be needed for generator excitation.—S. G. W.

Answer to No. 1,188 (awarded 5s.). — There is no doubt that direct-current motors are far preferable for lift service where direct-current and alternating-current supplies are equally available, and even in such cases as the present, where the use of direct-current motors involves the installation of a motor-generator or rotary converter, the writer is of the opinion that the extra capital expense is well justified by the results attained. In this instance, where capital cost is apparently no object, the direct-current installation should certainly be employed, a more flexible, reliable, and efficient service being obtained. To justify

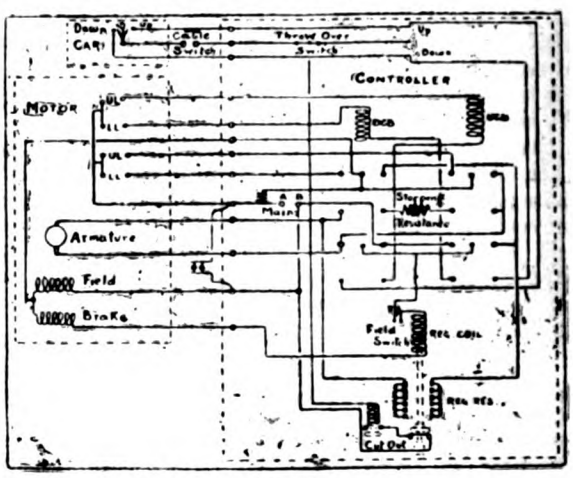


FIG. 1

this statement, let the *general requirements* of lift motors be first considered: these machines must start and run quietly under all loads, their speed must be practically constant under all conditions, a rapid acceleration must be possible, and the motor must have a high overload capacity. The gearing employed must be efficient and noiseless, and it is now usual to employ a steel worm gearing into a phosphor-bronze wheel, this enabling the use of a light high-speed motor and maintaining high efficiency of speed reduction (80 to 90 per cent. or over). With regard to noise of running and general mechanical robustness, there is little

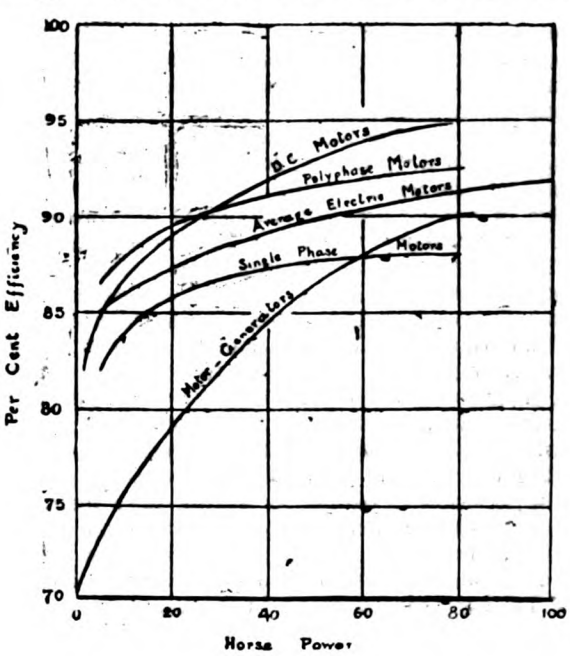


FIG. 2.

to choose between alternating-current and direct-current motors, the advantage resting with the direct-current motor on the first point and with the alternating-current motor on the second. The mechanical advantages possessed by alternating-current machines are now very slight, since wound rotors are practically essential in lift service to obtain the starting torque required, and with the use of slip-rings or a commutator (if a commutating machine be adopted) all advantages of the alternating-current machine from the mechanical point of view disappear. It is shown below that the electrical and efficiency characteristics of

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alternating-current motors are very unfavourable to the application of these machines to hoisting service. It is well known that an alternating-current motor of given horse-power is more costly and heavier than the direct-current machine of similar capacity and equal efficiency. The advantages of alternating current which frequently determine its adoption—viz, ease of transformation and efficiency of transmission at high voltage—do not apply here. The switchgear required by an alternating-current plant is more costly and complex, and hence more liable to derangement than is that of a direct-current installation. Bearing in mind the necessary complexity of any efficient lift motor controller connections (see Fig. 1), any addition to this without substantial added advantages is to be deprecated. Whichever type of motor be employed, the cage should be counterbalanced by a weight equal to the total deadweight of the moving system on the cage side + average live load, so that the motor installed has only to be of sufficient capacity to deal with the frictional resistance + a small net load, which may be positive or negative. In most cases the motor will generate current under certain conditions of load and direction of motion (depending on the net load), the operation being thus regenerative to a certain extent, and the running costs still further reduced. This regenerative action is best taken advantage of by a direct-current motor, which, in the same way, are best suited to electric braking, which forms the most satisfactory means of retardation. Iron-clad enclosed construction is best for lift motors, especially as these machines are frequently placed in rather inaccessible positions at the top of the lift shaft, and exposed to dust, dirt, damp, and indifferent attention. Open motors are frequently preferred in America, mainly on grounds of cheapness. In any case high mechanical and electrical factors of safety must be allowed, and the rating of the motor should be based on similar assumptions to those governing traction motor rating. Enclosure of a motor may be taken to reduce its rating by 70 per cent.

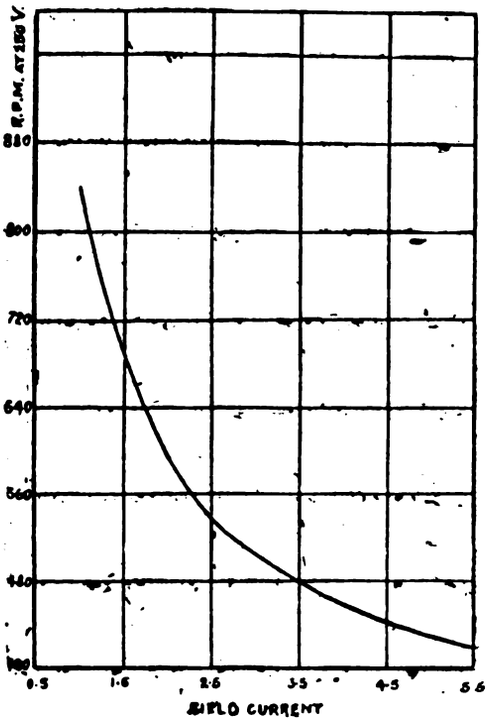

FIG. 3.

Efficiency.—The efficiency of alternating-current motors is, in general, appreciably less than that of direct-current machines of equivalent design in other respects. This is well shown by the curves of Fig. 2, plotted from Goldschmidt's data, and including Geipel's curve for the average efficiency of electric motors as a whole. To this data and for reference below may be added the facts that the efficiency of alternating-current commutator motors of 50 h.p. on 50 ~ supply, and running at 750 r.p.m., is about 72 per cent, while the efficiency of rotary converters rises to 94 to 95 per cent. on full load. The curve for the efficiency of motor-generator sets is based on the assumption of efficiencies practically equal to the square of the efficiencies of direct-current machines. Then, assuming a 10-cwt. load and a winding speed of 200 ft. per minute, the horse-power of motor required would be $\frac{10 \times 112 \times 200}{33{,}000} = 6\cdot8$, or, say, 10 h.p. to 12 h.p., to allow for acceleration, overload, etc. On this basis, and using a motor-generator and direct-current lift motor, the over-all electrical efficiency would be about $\cdot755 \times \cdot87 = 65\cdot8$ per cent.; while with a rotary converter the corresponding efficiency would be $\cdot95 \times \cdot87 = 82\cdot8$ per cent. The efficiency of a three-phase induction motor would be about 88 per cent., while that of a one-phase machine would be about 84 per cent. (such a motor could be used for this system, the unbalancing of the three-phase system not being important owing to the use of a fourth-wire return). An alternating-current commutator motor, while being equally unsuitable from other points of view, would have an efficiency of only about 72 per cent. In spite of the apparently low efficiency of the direct-current installation in this case, such is to be preferred on account of the much greater simplicity and reliability of the apparatus required, and the superior characteristics of direct-current motors for hoisting purposes. Again, the motor-generator, once its installation had been decided on, would probably be made of such capacity as to enable it to supply all other motors used in the hotel, and also the lighting load. This would greatly improve its load factor, would permit of the use of direct-current motors in all applications, and would favour the use of metallic-filament lamps, these being very unsatisfactory on alternating-current circuits.

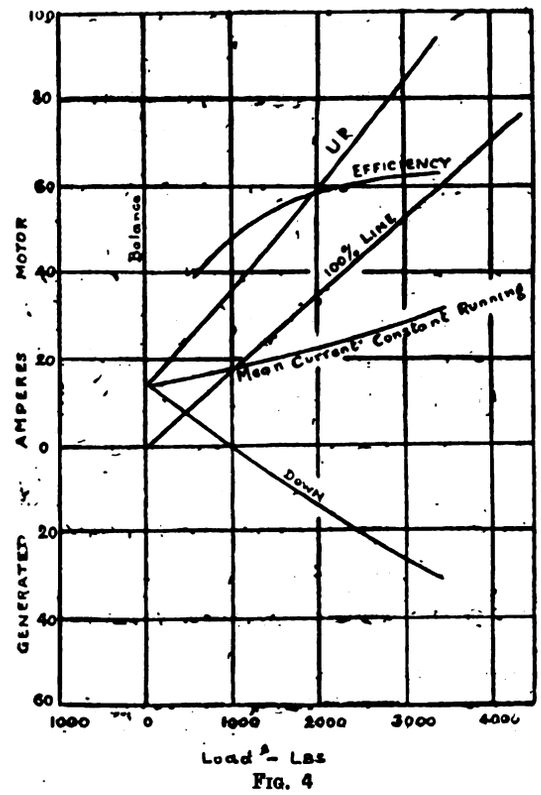

FIG. 4

Characteristic Curves.—Lift motors must be capable of exerting a high starting torque to give rapid acceleration, and once full speed is attained it must be constant till retardation is desired. Of the three classes of direct-current motors, series-wound machines are not suitable; they have a high starting torque, but would run away with the lift after the first acceleration was complete. Shunt motors and compound motors are, however, both used, the latter being preferable, but the former being often installed on account of the simpler control gear required. If a shunt motor be employed, it should have a very strong field to enable high starting torque and subsequent speed variation over a wide range by field resistance alone. Thus, in a particular case the motor speed could be varied from 400 r.p.m. to 750 r.p.m. by field regulation alone, and the speed regulation possible on the Central London Railway's

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shunt lift motors by field regulation is shown in Fig 3. If a compound motor be used, a high starting torque and subsequent constant speed is naturally obtained, and it is usual in such cases to short-circuit the series winding of such a motor once the machine is up to full speed. This is effected as in Fig. 1. Direct-current lift motors in general are of the four-pole iron-clad type with laminated pole tips, and field run at a high saturation to keep down the effects of magnetic inertia and enable a rapid build up of field on starting. Electric braking is very conveniently performed when direct-current motors are used (see Fig. 1). The peculiar conditions of service of lift motors—alternately motoring and generating—are shown in Fig. 4, which represents the average conditions in many hotel lifts.

Where alternating-current motors are employed, the difficulty is at once incurred that these machines as a class have very poor starting torques. It is true that many new types of alternating-current motors have recently been invented which overcome this objection to a greater or less extent, but most of these machines are still in the experimental stage, and few, if any, can be considered really standard machines suitable for the rough usage of lift service. A crude system in use in many factories consists in keeping an induction motor always running at the top or bottom of the lift shaft, and throwing the lift winding drum into gear forwards or backwards, as may be required, through friction clutches. Apart from the noisy action of such devices, the system is clearly inefficient, and the energy consumed is from two to five times that

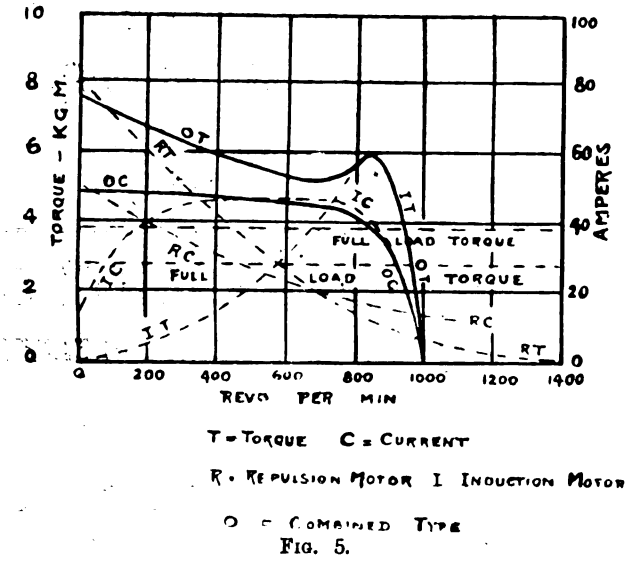

FIG. 5.

required by a direct-coupled motor which is only run during the use of the lift. Alternatively to this wasteful system we may employ an ordinary three-phase induction motor using a wound rotor with variable series resistance to improve the starting torque available, but even then the performance obtained is unsatisfactory and the switchgear complicated. If a squirrel-cage induction motor be used, the conditions as to starting torque are much worse: switching the machine straight on to the line volts, 3 × full-load current will flow, but will only produce about the full-load torque. Using an auto-transformer to limit the current rush on starting, the torque obtained = 25 – 30 per cent. full-load torque, while the current = 1 – 1¼ × normal. Needless to say, synchronous motors are quite inapplicable to liftwork. Turning, in conclusion, to one-phase motors, large starting torques with moderate current flow can be obtained by repulsion motors, but unless these are "compensated" or converted to induction motors, when up to speed they will race like direct-current series machines, there being no limiting or synchronous speed.

Many repulsion-induction motors are subject to the disadvantage that heavy current rushes flow momentarily on converting from repulsion to induction operation. This objection may be overcome by fitting the rotor with commutator and slip-rings, and, after running up to speed, shorting the latter through a considerable resistance, which is then gradually cut out, finally leaving the rotor phases dead shorted; in this condition the effect of the short-circuited commutator brushes, initially responsible for the "repulsion" action, is merely that of an additional short-circuit on the rotor. The characteristic curves of such a motor as a pure repulsion, pure induction, and combined machine are shown in Fig. 5, the improved torque during the accelerating period being due to the temporary repulsion connections. Instead of reversing such a machine by altering the direction of the brush lead, it is preferable to use a three-phase stator winding, terminals 1 and 2 being used for forward and 3 and 2 for backward operation. The whole motor control is then effected electrically, and the necessity for mechanical operation of the brush gear is avoided. The Fynn alternating-current commutating motor—a compensated machine—can be employed for lift service. In Fig. 6 S_3 is only connected in D D when H reaches the last stop of S_2; the motor characteristic is, therefore, simply series on all other stops of S_2. If S_3 be "in" throughout, speed variation is obtained, even on no load, by moving back the controller arm. The speed of the motor now falls with increased load and the more rapidly the more of S_2 in circuit (cf., the action of a shunt motor with weak field). Speed regulation by this arrangement is dearly bought, the efficiency and power factor being only about 66 per cent. Such a motor is suitable for lift service and high-frequency circuits. The machine is free from racing tendencies and requires no accessory

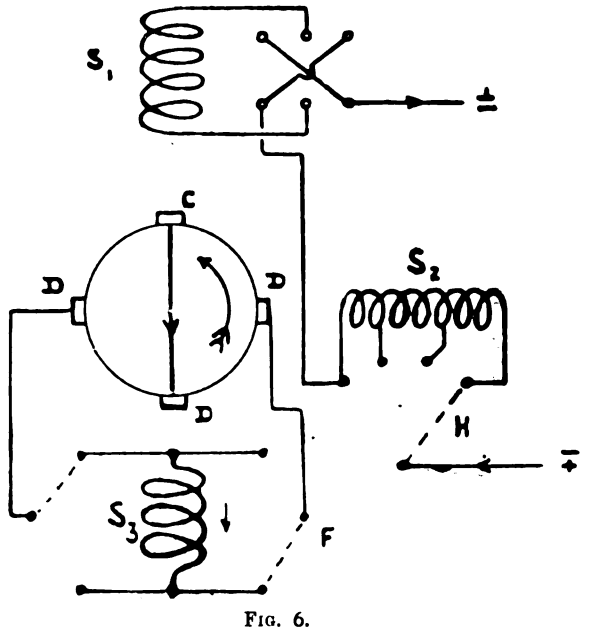

FIG. 6.

starting apparatus. With normal line volts the starting = 4 × normal. The machine is equally suitable for operating with series characteristic or as a constant-speed motor.

As hydraulic lifts are the only ones at all likely to compete with electrically-operated sets in this connection, it may be pointed out that the advantages of the electric type include easy transmission of power to any out-of-the-way spot in which the motor may have to be placed, quiet operation, and higher efficiency and quicker service than is possible with hydraulic lifts. Though the hydraulic lift costs from 25 to 50 per cent. less than the corresponding electric equipment in the first place, yet the working efficiency is 5 to 6 per cent. lower, and in a particular case in which a five-passenger lift made 100 lifts a day at 150 ft. per minute over a height of 50 ft. the annual costs of hydraulic and electric operation were:

	High-pressure hydraulic.	Direct-current electric.
Capital cost	£200	£320
Interest and depreciation at 10 per cent.	£20	£32
Working cost	*40	†10
	£60	£42

* 2s. 10d. per 1,000 gallons. † At 2d. per B.T.U.

Saving in favour of electric operation = £18 per annum = 30 per cent. of cost of hydraulic working.—WREN.

[Other replies to Question No. 1,188 will be given in our next issue.—ED., *E. E.*]

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CONTENTS.

The Conservation of Water for Power	29	Publications Received	41
Electricity in the Navy	29	Technical Problems, with Solutions by Practical Men	41A
Tramways Conciliation Board	30	New Companies Registered	42
Electricity in Medicine	30	Liens Registered, etc.	42
The Charging of Small Accumulators	30	Appointments Vacant	42
Electrically-Driven Rolling Mills	31	Personal	43
Electricity in the Home	33	National Electrical Manufacturers' Association	43
Institution of Electrical Engineers	34	Institution of Mining Electrical Engineers	43
Street-Lighting Fittings	35	Legal Intelligence	43
Testing Condensers for Leakages	35	Companies' Meetings and Reports	43
"C.M.B." Patent Direct-Current Rotary Transformer	36	Lighting Notes	44
Correspondence	40	Traction Notes	46
Forthcoming Events	40	Contracts for Electrical Supplies	48
Inquiry Concerning Fire at a Metropolitan District Railway Station	41	Provisional Patents, 1909	53
"A Distracted Industry"	41	Specifications Accepted	54
		Companies' Stock and Share List	54
		Traffic Returns	55

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.

The secretary of the above association has furnished us with the following information: "At a largely attended meeting of electrical manufacturers of the United Kingdom held on Thursday, July 1, 1909, at the Hotel Cecil, it was unanimously resolved that the action of the National Electrical Manufacturers' Association in their negotiations with the Electrical Contractors' Association regarding the proposed agreement to give special terms to the members of that association be endorsed and that the terms set out in the official journal of the Electrical Contractors' Association, April, 1909, could not be entertained." We are given to understand that the meeting was not confined to members of the association, manufacturers being invited regardless whether they were members or not.

INSTITUTION OF MINING ELECTRICAL ENGINEERS.

A meeting, under the auspices of the Institution of Mining Electrical Engineers, was held on Saturday evening in the Institute of Engineers and Shipbuilders, at Elmbank-street, Glasgow, for the purpose of forming a branch for Scotland.

Mr. J. Glynn Williams, the secretary, in explaining the purposes of the institution, said it had been founded for the advancement of technical knowledge relating to the applications of electricity in mining, to extend the experience and increase the efficiency of those engaged in such applications, and generally to form a meeting-point for a rapidly growing but hitherto unorganised section of electrical engineers and craftsmen.

For the Glasgow branch, Mr. J. E. Sayers, 157, West George-street, was appointed acting local secretary.

PERSONAL.

Mr. H. F. Foster has resigned his position as resident engineer to the Epsom Council.

The Wednesbury Town Council have decided to increase the salary of Mr. W. Fennell, electrical engineer, from £200 to £225 per annum.

The Aberdeen Town Council have agreed to increase the salary of Mr. R. S. Pilcher, tramway manager, by £100, extending over three years.

Mr. W. Hockley, the resident engineer of the electric light installation at Frinton-on-Sea, has been elected an associate member of the Institution of Electrical Engineers.

The Marylebone Borough Council have appointed Mr. H. H. Holmes, of the West Ham Electricity (Sales) Department to the position of sales manager in the Borough Council's electricity department.

Mr. J. R. S. Barkshire, late station supervisor at H.M. Dockyard, Devonport, has been appointed resident supervisor-in-charge of the electric light and power installation at the Royal Naval Ordnance Depôt, Bull Point.

On Saturday, June 26, the mains and public lighting staff of the St. Pancras Borough Council electricity undertaking celebrated their fifteenth annual staff outing and dinner at Bournemouth, and a very pleasant time was spent.

Mr. A. H. Seabrook, late borough electrical engineer at West Ham, has been the recipient of a gold watchchain from the staff and employés at the Canning Town generating station, on the occasion of his leaving to take up his duties as electrical engineer and manager at Marylebone Mr. Lloyd-Jones made the presentation.

The council of the Royal Society of Arts attended at Marlborough House on Wednesday morning last, when his Royal Highness the Prince of Wales president of the society, presented its Albert medal to Sir Andrew Noble, Bart, K.C.B., D.Sc, D.C.L., F.R.S., "in recognition of his long-continued and valuable researches into the nature and action of explosives, which have resulted in the great development and improvement of modern ordnance."

On Saturday, July 3, the employés of the British Electric Calibrated Fuse Co., Harpenden, the fuse specialists, went for their fourth annual outing to Brighton. After the dinner in the evening at the Clifton Hotel the usual toasts were proposed, and Mr. Weekes, the general manager, in his speech stated that the progress of the firm during the last year had been entirely satisfactory. Although trade was supposed to be bad in the electrical profession, the firm had succeeded in keeping up their record of beating by a very big margin the turnover of the year before. This has been done every year since the start of the firm.

LEGAL INTELLIGENCE.

OVERTIME AND ELECTRICAL WORK.

In the City of London Court last week, before Judge Rentoul, K.C., a claim was made by Mr. J. J. Roche, trading as J. J. Roche and Co., 83, Queen Victoria-street, E.C., electrical engineers, to recover the sum of £3. 6s. 6d. against the London Electrobus Co., Whitehall House, Charing Cross, for electrical engineering work done. Mr. Aldis, plaintiff's solicitor, said that the claim was for the difference between ordinary time and overtime. In October the plaintiff was instructed by an insurance company to do certain work to the defendant's motor-generator. While that was being done the defendant's manager, Trehern, saw plaintiff's workmen and instructed them to work overtime, as he was anxious to get the work done immediately. The ordinary time had been paid by the insurance company, and the plaintiff now claimed for the overtime. Plaintiff said that the defendants were afraid that some of their omnibuses would be stopped if the work was not done at once. They worked all day Sunday and all night to do it. No date of finishing the work was agreed to. From 6 p.m. to 10 p.m. they paid their men time and a quarter, and from 10 p.m. during the night time and a half. Part of the claim was for work involving the employment of a sub-contractor. Mr. S. G. Trehern, defendant's manager, said that the plaintiffs were employed originally by the British Engine, Boiler, and Electrical Insurance Co. He had only agreed to pay the plaintiffs overtime if the work was finished by a particular Monday, and that was not done. Judge Rentoul, K.C., found for the plaintiff for the amount claimed, with costs.

COMPANIES' MEETINGS AND REPORTS.

ANGLO-ARGENTINE TRAMWAYS.

An extraordinary general meeting of this Company was held on Wednesday last, Mr. J. B. Concanon (chairman of the Company) presiding.

The CHAIRMAN explained that the meeting had been called for the purpose of passing a resolution approving of the new regulations and articles of association of the Company. One of the articles gave the Company power to pay a commission of not exceeding 20 per cent. on any shares which they might offer for subscription. This was equivalent to issuing shares at a discount. Having in view the fact that they would probably find it necessary, owing to capital requirements, to offer within the next 12 months or so some portion of the unissued 160,000 of £5 per cent. cumulative shares which were now first preference, and, as the equivalent market value of the shares ranking *pari passu* with them was at present about £4. 12s. 6d., they might have to adopt this policy. Under the new articles the number of directors had been fixed at 14, which was an increase of two,

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and the fees payable to the Board had been raised to £9,000 per annum, or an increase of £3,000 per annum. He reminded the shareholders that as from the 1st inst. the old 6 per cent. cumulative first preference shares of £5 each had been converted into 4½ per cent. debentures, and that the holder of each old 10 per cent. cumulative second preference share of £5 became entitled to two new 5 per cent. cumulative first preference shares of £5 each, and that the old 5 per cent. cumulative third preference shares had become 5 per cent. cumulative preference shares. Those conversions necessitated the filling up of about 7,000 new certificates, which were now being prepared, and would be ready on the 19th inst. In conclusion, the chairman moved: "That the regulations contained in the printed articles of association submitted to this meeting (a copy of which has, for the purpose of identification, been signed by the chairman) be and the same are hereby adopted as the regulations of the Company to the exclusion of and in substitution for all existing regulations."

Mr. C. H. SANFORD seconded the resolution, which was agreed to unanimously.

ELECTRIC AND GENERAL INVESTMENT.

The ordinary general meeting of this Company was held on Wednesday last, under the presidency of Mr. J. B. Braithwaite.

In moving the adoption of the report, the CHAIRMAN said that the past year had been a year of comparative stagnation in electrical business, and therefore that Company had not had the opportunities which it had had in former years of employing its capital to the extent which it would have liked. They had considerably reduced their liabilities during the year, however. The profit for the year had amounted to £11,566, against £7,889, or very nearly £4,000 more, which was an increase of about 40 per cent. The directors proposed to pay the preference dividend, and they would then be left with a balance of profit to carry down of £4,095, against only £568 last year, so that there was a net improvement of about £3,500. That sum represented about 15 per cent. of the amount of capital paid up upon the ordinary shares, but looking at the continued depression in many of the electrical securities which were held by that Company he believed that the directors would have the support of the shareholders in their proposal to transfer that amount to the contingency fund, which was a reserve against depreciation in the market value of their securities. If the market improved later on that contingency fund might be drawn upon, if necessary, for dividend purposes, providing, of course, that the value of their investments in the market stood at a price which was equal to or in excess of the cost at which they were taken in the books. As regarded the current year, it was a little early to say much, as they only commenced on June 1, but looking all round the market he felt that on the whole he could say that there were indications of a slight improvement in business, and in all probability they would be able to present better results when he next had the pleasure of meeting them.

After some discussion the report was adopted.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Bexhill.—In a short time the streets of the town will be entirely lighted by electricity, the Council having decided to abolish the remaining gas lamps.

Bedford.—There was a net loss of £369 on the working of the Corporation's electricity undertaking last year, mainly attributed to the use of new metallic-filament lamps.

Halifax.—The Tramways Committee are asking the Council to instruct the gasworks and electrical engineers to submit a joint report on the question of prices of gas and electricity for lighting and power purposes.

Lanchester.—The Board of Guardians have given the Assessment Committee authority to defend an appeal at quarter sessions by the Cleveland and Durham Electric Power Co. against the assessment of their property and plant.

Notting Hill Electric Lighting Co.—The Board have declared an interim dividend of 3 per cent. and a bonus of 1 per cent. on the ordinary preference shares, and an interim dividend of 3 per cent. on the ordinary shares for the past half-year.

Cuckfield.—At the last meeting of the Urban District Council notice was received from the Haywards Heath Electric Supply Co. of their intention to apply for a provisional order to authorise them to supply electrical energy within the district.

Sheffield.—Mr. S. E. Fedden, the city electrical engineer, has stated that the electric lighting revenue of the Corporation has fallen £4,000 owing to metallic-filament lamps, although only a small percentage of the lamps in use have been converted.

Leek.—The Urban District Council have decided to pay the sum of £1 per annum to the North Staffordshire Railway Co. as wayleave in respect of carrying the cable over the railway bridge at Leek Station, also to increase the insurance of the works from £3,000 to £6,790.

Wood Green.—The Urban District Council have decided to apply for sanction to borrow £31,150 for the purposes of obtaining a bulk supply of electricity and distributing it to consumers. Five years ago the Council asked the Local Government Board for a loan of £40,000 to generate and supply electric light, but at that time the Board refused the application.

Darlington.—The Electricity Committee have been empowered to extend the lighting mains along certain new streets on the West Lodge Estate, according to the plan and estimate submitted by the engineer, also to extend the mains to Messrs. G. Denham and Son's works, subject to a guarantee of a minimum income of £20 per annum. Sanction is to be sought by the Council to the borrowing of £700 for the purchase of new meters.

Jerusalem.—The success of electrical enterprise in lighting and traction in cities of the East is reported to the Department of Commerce at Washington by various consuls. Damascus already has its electric tramway system, and the streets of the city are now lighted with 1,000 electric lamps. A scheme is under consideration for supplying Jerusalem with electricity for light and power, and for the construction of an electric tramway between that city and Jaffa.

Dundee.—The erection of the machinery and plant at the new station at Stannergate having now for some time been completed, a start was made last week to supply a large jute mill in the town, the Corporation being under agreement to supply by July 1. Operations in this direction have, however, been greatly curtailed owing to the city architect's department, which is responsible for the erection of the buildings, being much behind time in completing its part of the work.

Longton.—The output of gas from the Corporation works for the four weeks ended June 17 showed an increase of 173,000 cubic feet compared with the corresponding period of the previous year. The number of units of electricity generated was 21,134, against 16,153 for the corresponding period of the previous year, being an increase of 30 per cent. During the past four weeks 75 additional lamps have been fixed. The general manager submitted to the committee a schedule of prices and particulars from various makers of engines and dynamos, two of which were selected for further inquiry, and the matter left in the hands of the chairman, vice-chairman, and manager.

National Telephone Co.—The directors at their meeting resolved, subject to final audit, to recommend at the forthcoming general meeting of shareholders the following dividends for the half-year ending June 30, 1909, after payment of the dividends on the preference shares: at the rate of 6 per cent. per annum on the preferred stock, at the rate of 6 per cent. per annum on the deferred stock, less income tax in all cases, carrying £150,000 to reserve and about £11,000 forward. The transfer books of the company will be closed from the 9th to the 22nd inst., both days inclusive, and the dividend warrants will be posted on the latter date.

Haslingden.—In connection with the application to the Rawtenstall Corporation to supply the Haslingden workhouse with electricity, the Guardians have received a letter from the Rawtenstall Corporation, stating that they are prepared to supply the Board with electricity for lighting purposes at a flat rate of 3d. per unit, subject to a five years' agreement. They are also prepared to supply the Board with electricity for power purposes at the rate of 1d. per unit, subject to a five years' agreement—the Corporation to lay and maintain the necessary cables to the workhouse and new infirmary at their own expense. After discussion, it has been resolved unanimously to accept the terms offered.

Hanley.—At the last meeting of the Electricity Committee the engineer reported that in the month of April there had been connected six new lighting consumers taking 127 lamps, that extensions had been made on the premises of four consumers, equivalent to 71 lamps, and that two new and two extensions of power consumers had been coupled to the mains, equivalent to 3,573 lamps, and one new heating consumer, equivalent to 30 lamps, had been connected. The electrical engineer also presented a summary of the accounts for the March quarter, from which it appeared that the units sold exceeded by 34,667 the quantity disposed of in the corresponding period of 1908, the actual receipts showing an increase of £115. 12s. 9d.

Hastings.—The Electricity Committee have had before them a report from the borough electrical engineer intimating that he had recently gone carefully into the question of laying a high-tension main from the electricity works through Devonshire-road, Cornwallis-gardens, Prospect-place, and St. Margaret's-road to the existing substation in Shepherd-street, which would enable fully 100 per cent. more consumers than there were at present in the St. Leonards district to be supplied. He estimated the cost of the suggested new main and laying at £1,100. The committee recommended that the work be carried out, and that application be made to the Local Government Board for sanction to the borrowing of the estimated cost, to which course the Council have agreed.

York.—Alderman Meyer, in moving the adoption of the report of the Electricity Committee at the City Council meeting, pointed out that further money would be required for the cables of the new tramways, and to enable the electrical supply to be continued and extended to districts as required. The committee believed that the borrowing of further capital was necessary and commercially justifiable. Councillor Clarke seconded. Councillor Sessions asked Alderman Meyer to give the Council an assurance that the money would not be spent until the loan was granted, as they had got into hot water over that before. Alderman Meyer said that the Council might be perfectly easy about that. He then formally moved that the committee be empowered to apply to the Local Government Board for sanction to borrow £2,510. Councillor Clarke seconded, and it was carried.

Derby.—The Electric Lighting Committee have arranged with the Chloride Electrical Storage Co. to renew the tramway battery and to maintain it for 10 years upon the following terms—viz: the Corporation to pay the sum of £100 down and £100 per annum for six years; the Corporation to pay the sum of £70 during each of the 10 years, the company guaranteeing the battery to be in proper condition at the end of that period. Arrangements have been made to extend the mains to Gladstone-street, to the premises of Messrs. Haslam's Foundry Co. in City-road, and to the premises of Messrs. E. J. Axe and Co. in Bridge-street. The Council is recommended to apply for a provisional order extending the limits of supply of electricity to the following parishes—viz., Littleover, Markeaton, Darley Abbey,

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Broadsall, Chaddesden, Alvaston and Boulton, Normanton and Sinfin Moor.

Burnley.—The letting of a tender for the installation of electric lights in the new technical school excited considerable discussion at the monthly meeting of the Town Council. The quotation of £1,425 from a local firm of electrical engineers was accepted. Mr. Dan Irving during the consideration of the minutes of the Education Committee asked for an explanation as to why this particular contract had been accepted when there were several contracts lower. He also sought an explanation as to why the amount of the tender accepted was less than the amount of the original tender. Mr. S. Thornber and Alderman Keighley explained that the committee considered carefully the whole of the tenders before accepting the one in question. It would be unwise, they thought to give a small firm a large contract. Mr. H. Lees moved that the item be referred back, and Mr. Dan Irving seconded, but the amendment was defeated by an overwhelming majority.

Keighley.—At the last meeting of the Town Council the town clerk announced the receipt of a letter from the Local Government Board with reference to the application of the Corporation for borrowing powers for electricity extensions. The communication stated that the Board had decided to comply with the Corporation's application so far as it related to the sums of £2,110, £240, and £600 for prospective expenditure on mains, services, and motors respectively. The Board also assented to the allocation of the unexpended balance, amounting to £1,199. 6s. 5d. of loans previously sanctioned. The letter also referred to the proposals of the Town Council for the installation of high-tension alternating-current generating plant, and stated that the Board would be prepared to entertain an application for the sanction of a loan for this purpose, providing the Town Council were in a position to furnish evidence of a sufficient demand from prospective consumers to justify the expenditure.

Cleckheaton.—At the last meeting of the District Council the annual statement with reference to the electricity department was submitted, and showed that after transferring a sum of £250 for steam-raising purposes during a course of years, there remained a net profit of about £50. Mr. Atkinson, chairman of the committee, made some comments on the report, and offered suggestions as to how the capacity of the works might be better tested and the production increased. He criticised a statement which had been previously made to the effect that it would not be wise to advertise the electricity department, since it would perhaps interfere with the gasworks, which also belong to the Council, and which each year leave a very substantial margin of profit. The gasworks, he pointed out, were taxed to their utmost, and he thought it would be wise to push electricity more. Mr. Whiteley remarked that in the wards of Scholes and Oakenshaw there was considerable dissatisfaction with the price which Bradford charged for gas, and he suggested that if the electricity cables were taken forward to these villages Mr. Atkinson would secure some of that larger demand which he had asked for.

Hove.—The Lighting Committee's report, which is to be considered at the next meeting of the Council, contains a statement of the accounts of the Corporation electric lighting undertaking for Aldrington for the year ended March 31. The amount of loan owing at the end of the year was £8,159. 11s. 5d., a sum of £840 having been repaid. Sundry creditors account for £108, sums on capital and revenue account due to treasurer amount to £553. 14s. 10d., which, with a sum of £3. 12s. 5d. due to town clerk, bring the liabilities up to £9,665. 11s. 2d. The total receipts to March 31 "in the amount raised by loans" section make up a sum of £9,000. To this has to be added a balance of £20. 6s. 1d., £193 (current supplied), and other small items, leaving a debit balance of £452. 13s. 10d. The town clerk was instructed to write to Mr. F. R. Reeves, secretary of the Hove Electric Lighting Co., calling attention to the remarks of the Corporation auditors in reference to the company debiting to capital account their costs in connection with the recent Board of Trade inquiry, and protesting against their being so included. Mr. Reeves, in reply, said that the action was taken after the fullest consideration, with the approval of the auditors and with the consent of the company's solicitors.

Wigan.—The question of reorganising the Wigan electricity works in order to arrive at greater efficiency, and to prevent overlapping, has exercised the Corporation Electricity Committee for upwards of a year. The committee was called to consider specifications for the proposed extension of the works at Wigan, and the removal of the station from Pemberton to Wigan, and to convert the Pemberton premises into a sub-station only. The original scheme was brought before the committee in 1908 by the engineer, and reported on, on the instructions of the Council, by Mr. Wordingham. The reasons given were that by removing everything to Wigan would mean a great saving in the works cost, and the consequent increase in the available profit at the end of the year. The proposed scheme is, besides removal of the two 400-kw. sets from Pemberton, to have either a new 750-kw. reciprocating set, or a 1,000-kw. turbine, to deal with the increased load expected during the coming year. Tenders were also submitted last week, and six out of the nine sections were settled by the committee subject to the sanction of the Local Government Board. The three remaining section for the coal-conveying plant, engine, generator, and switchboard were held over, and a sub-committee was appointed and authorised to visit works where plant of a similar character is installed, and report to an early meeting of the Electricity Committee.

Gloucester.—Mr. Collett, in moving the adoption of the minutes of the Electricity Supply Committee at the Council meeting, reported that there were 47 installations of electrical illuminations in the city during the show week. The progress of the department reported at previous meetings had happily been continued. The electrical engineer reported an output of 105,542 units, as compared with 93,277 in the corresponding period of last year, and this meant an increase of £106. 10s. 3d. in revenue. At the same time the works costs, particularly in coal consumption, had been reduced by £76. 17s. 3d., and there were also savings in salaries, consequent on the recent vacancies and changes, bringing the total saving in expenditure up to £100. Thus the financial position on revenue and works cost had been improved by about £206 during the past month, but the complete overhauling of the traction sets, as a precaution in anticipation of the show-week traffic, entailed an additional £30 in the repairs cost. They had made considerable additions to the electric installations, equivalent to 717 8 c.p. lamps. Mr. Collett proceeded to say that they had had an inquiry from a foreign firm for a considerable supply of electricity, and that the load suggested would be of great advantage to the works. They had been able to quote at a low price, a price which it would have been impossible to quote a few months ago, and they would do all they could to meet the firm. Having regard to the other advantages which the city could offer, he confidently hoped a considerable industry would be established.

Bath.—The adjourned inquiry by the Local Government Board into the application of the Corporation for a loan for the purposes of electric lighting was resumed by Mr. H. R. Hooper on the 2nd inst. Originally the application was for £11,700, and the inquiry was adjourned in order that the total amount of excess expenditure up to March 31, 1909, might be ascertained. In the course of the proceedings the inspector suggested that certain items for which a loan was sought should be charged to revenue account. The amended application was not for £11,700, but for £9,470, and during the proceedings this amount was altered to £9,500. This sum was made up as follows: excess on previous sanctions, £2,223; machine tools, £125; new switchboard platform, £162; water-softening plant, £350; automatic stoker, £500; for extensions to mains, £4,000; house services, £1,500; transformers, £500; and meters, £140. The town clerk, in drawing attention to the amended application, informed the inspector that it had been simply brought out by looking through all the accounts, and by the suggestions of himself that they ought not to transfer to credit capital account an amount of £1,153. 19s. 7d., the value of sundry materials on hand; £940. 10s. 5d., sundry receipts from the sale of old plant; and £329, unexpected balances. These amounts reduced the gross excess capital expenditure on April 1 to £2,223. 8s. 1d., and this sum agreed with the balances of the printed accounts. The inspector then proceeded to run through the details of various amounts included in the aggregate for which a loan is applied, and he thanked the officials for furnishing him with such complete particulars.

Lewisham.—The Highways Committee of the Borough Council have considered letters from the South Metropolitan Electric Light and Power Co., giving notice of their intention, after the expiration of one month, to carry out the following works: To lay a low-tension concentric lead-covered cable from the existing main at the corner of Park-road and Church-road, Forest Hill, along the east side of Church-road to its junction with South-road, and across this latter thoroughfare, continuing along the south side in an easterly direction to the existing main outside "Tudor Hall." The cable to be placed in earthenware troughs filled in solid with refined pitch, and laid under the footways and roadways. To lay a low-tension concentric lead-covered cable on the south side of Tyson-road, Forest Hill, from the existing main at the corner of Honor Oak-road to its junction with Devonshire-road with service into No. 22. The cable to be placed in earthenware troughs filled in solid with refined pitch, and laid under the footways and roadways where possible. The committee have approved the proposals so far as the authority of the Council extends, subject to the reinstatement being carried out by the Council at the cost of the company, in accordance with the scale of charges adopted by the Council for such works, and to the trenches, where they are in tar paving being broken up, either to the forecourt line or to the kerb, whichever is the nearer, provided that the trench shall not be opened within 6 in. of the back line of the kerb, and to no part of the footways being kept open for more than one week, the Council reserving to themselves the right to fill in the ground and charge the company with the cost of the trenches if allowed to remain open for a longer period, and also subject to the cables being laid at a depth of at least 2½ ft. where crossing a roadway. The committee have also decided to inform the London County Council of the action taken.

Bridlington.—At the last meeting of the Electricity Committee the borough electrical engineer submitted the following report, which accompanied the presentation of his cost-sheet for the year ended March 31, 1909: "In presenting my cost sheet for the year 1908-9 I have pleasure in calling your attention to the fact that in spite of many difficulties the deficit for the year has been reduced from £275. 8s. 8d. in the previous year to £188 for this year, being a net improvement in the working of £87 odd. A most noticeable feature in this year's working is that for the first time since the undertaking commenced the revenue from private lighting and other sources has exceeded that of the public street-lighting, and that there has been an increased revenue of £387. 11s. 11d. for the year and an increase of 34,007 units sold. This, I trust, you will find satisfactory. During the year the working costs have been decreased by ·014d. per unit in spite of the fact that a cost of £136. 5s. 6d. over the previous year has been borne for repairs, chiefly on the battery. The standing charges costs have increased ·072d. due to the extra services of an additional clerk and also the increase in insurances and extra assessments and also the increased charge for renewals of public lighting, being an amount of £67. 11s. 11d. owing to giving the public a much improved and better light out of current expenses, and for which no additional charge has been made. During the year a Tirril regulator has been installed and contracts commenced for a condenser and a new boiler, the condenser primarily being put down to eliminate the atmospheric vibration which has caused annoyance to the residents in the vicinity of the works. This, although not yet completed, has almost entirely effected this desirable result. Several extensions to mains have also

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been put down during the year, and 52 new consumers connected, with an equivalent of 3,137 8-c.p. lamps. In conclusion, I would point out the undertaking has now been working four years, and stands at the present moment in the satisfactory position of having paid its way without any loss or call on the rates after having paid all capital charges."

Handsworth.—The Urban District Council having applied to the Local Government Board for sanction to borrow £4,400 for electric supply purposes and £310 in connection with the destructor works in Queen's Head-road, Mr. H. R. Hooper has held an inquiry into the application. Mr. Ernest Ward, the clerk to the Council, said there were really three applications, the third being in respect of £1,000 for free wiring, for which application was made on June 16 last year, but which was deferred. The amount authorised to be borrowed under the Act of 1901 was £49,050; additional loans sanctioned by the Local Government Board, £21,300; and the loan now applied for—making a total of £74,750. The £4,400 was required to cover the cost of extension work rendered necessary by the progress of the undertaking. The £310 was required for the extension of the cart-sheds and boundary wall at the destructor works. Referring to the free wiring of premises, Mr. Ward said he believed the system had been successfully in operation at Wolverhampton and other places. The Inspector said that with free wiring the Council had no asset. Any form of free wiring involved a liability. It was speculative. He took it that it would be less costly to allow it to remain than to remove it. Mr. Nixon, the electrical engineer, said the Council undertook to wire the premises of approved consumers and charge them the same price per unit for current consumed as other consumers in the district, the consumers undertaking to use the current for two years certain, and so long as they occupied premises, and pay a hiring rent for the wiring and fittings during that period. The Inspector stated that they might think the electric light more expensive than gas and revert to the latter. Assuming that they went away, what they left behind them in the houses would not be worth much. He thought it would be found that free wiring in other towns was deceased. Mr. Nixon said the undertaking was doing remarkably well, and they were anxious to open out a new field. Mr. Ward said, in reference to the hire purchase of the work, the payments would extend over a period of years. The Council would put in the fittings and the consumers would pay a quarter in advance, and the balance in from three to five years. The Inspector: These are public funds, and the carrying out of works with such funds should be properly secured and not speculative.

West Ham.—Mr. H. R. Hooper last week resumed the Local Government Board inquiry into the application of the Corporation for powers to borrow £74,600 for their electricity works. The proceedings on the first day lasted four hours, the whole of the time being spent in hearing the opposition of the India Rubber, Gutta Percha, and Telegraph Maintenance Co., who were represented by Mr. Elvy Robb. Mr. Hugh Seabrook, the consulting electrical engineer to the Corporation, was examined at great length, and maintained that power could be supplied at 0·37d. per unit, and declared the Corporation would be pleased to have other large consumers at the price. They had offered power at that price to other firms. The electricity accounts for 1908, excluding certain big contracts, suggested that current was sold at 0·36d., but that was not the price charged. West Ham had every facility to supply power, and it was to the distinct advantage of the whole of the consumers that this was done. All consumers were treated alike as to the capital expenditure charges. Where special capital expenditure was involved, such of that capital expenditure as was appropriated by the consumer was charged to him. The undertaking had been running 10 years, and the total capital expenditure up to the present was £138,000, of which £93,600 had been repaid. Mr. Elvy Robb said a very serious error was underlying the low estimate of 0·37d. per unit, and he asked, if the Local Government Board granted the loan, that they would make it a condition that no further contracts should be undertaken at unremunerative rates. They had found that the charge made for public lighting—1·53d. per unit—was excessive. The undertaking was underrated to the extent of about £4,000 a year, and from the rates £25,000 had been contributed to it. The transference of the sinking fund to the revenue account he regarded as a serious matter, and he hoped if the loan was granted it would be provided that it go to its proper channel. Mr. Stewart Russell and Mr. W. H. Patchell were called, and each declared that 0·37d. per unit was an unremunerative rate. It would yield a profit if the cost of the capital charges were ignored, but they each regarded it as unsound finance not to spread the whole capital charges over the whole business. After an adjournment until the following day, Mr. Morton dealt with the various points of the opposition. The suggestion that the Corporation had supplied cable with a false trade description was based on an error which appeared to have been made when the cable was ticketed when put in stock. Another allegation that the Corporation quoted cable at prices at which it could not be bought from the manufacturers was also baseless, for evidence had been given that the prices quoted gave a profit of 15 per cent. Even though the sales department did show a loss on its working, there was an asset that could not appear on any balance-sheet—its usefulness in arranging the sales of current. It was, in fact, a valuable adjunct of the electricity undertaking. The opposition of Mr. Elvy Robb was of a different character, but the climax of it came when Mr. Robb told the inspector that he did not really oppose the granting of the loans, but that he wanted the Local Government Board to make certain conditions. One of these was that no renewal of existing contracts at existing rates should be allowed and that no new contracts should be entered upon at the present unremunerative rates. The suggestion was that the present prices were unremunerative, and the main contest on that point centred on the question whether a proportion of the whole of the capital charges of the undertaking should be charged to the users of current for power. Power consumers were not all in one class, and the large consumers at Silvertown were not average consumers; the cost of the generation and distribution of their current was less, and the same observation applied to the capital charges. The Corporation were satisfied that their 0·37d per unit yielded them a profit, and that the supply at that rate was beneficial to the undertaking in general. It had developed progressively, and there was every reason to believe it would go on expanding. The low-priced power supply had and was attracting large manufacturers into the borough, and this could only result in a benefit to the ratepayers. In conclusion, Mr Morton submitted that the case for the loan had been made out, and that there were no good grounds for the imposition of any conditions. Mr. Hooper intimated that in due course he would report to the Local Government Board.

Stock Exchange.—Applications have been made to the committee to appoint special settling days in the Huelva Copper and Sulphur Mines' 368,437 shares of £1 each, fully paid, Nos. 1 to 7. 195,003 to 230,000, 300,001 to 325,457, and 328,458 to 516,487; the Pataling Rubber Estates Syndicate's 225,000 shares of 2s. each, fully paid, Nos. 1 to 225,000; and the Selangor Rubber Co.'s 300,000 shares of 2s. each, fully paid, Nos. 1 to 300,000. The committee has further been asked to allow the United Electric Tramways of Monte Video further issue of 12,800 ordinary shares of £5 each, fully paid, Nos. 147,201 to 160,000, and 2,777 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 76,501 to 79,277, to be quoted in the official list. The committee have appointed special settling days as follows: July 12—Inch Kenneth Rubber Estates' 15,000 shares of £1 each, fully paid, Nos. 15,001 to 30,000 (ex all dividends paid or declared up to and including July 12, 1909). July 13—Bukit Lintang Rubber Estates' 18,000 shares of £1 each, fully paid, Nos. 1 to 18,000, and a further issue of 6,000 shares of £1 each, 10s. paid, Nos. 18,001 to 24,000 (ex all dividends paid or declared up to and including July 13, 1909); Castlefield (Klang) Rubber Estates' 24,000 shares of £1 each, 17s. 6d. paid, Nos. 1 to 21,079 and 22,080 to 25,000, and 6,000 shares of £1 each, fully paid, Nos. 21,080 to 22,079 and 25,001 to 30,000 (ex all dividend paid or declared up to and including July 13, 1909); Ceylon (Para) Rubber Co.'s 35,000 shares of £1 each, fully paid, Nos. 1 to 35,000, and 15,000 shares of £1 each, 4s. paid, Nos. 35,001 to 50,000 (ex all dividends paid or declared up to and including July 13, 1909); Cicely Rubber Estates Co.'s 6,000 preference shares of £1 each, fully paid, Nos. 1 to 6,000, and 10,000 ordinary shares of £1 each, fully paid, Nos. 6,001 to 16,000 (ex all dividends paid or declared up to and including July 13, 1909); Golconda Malay Rubber Co.'s 70,000 shares of £1 each, fully paid, Nos. 1 to 70,000 (ex all dividends paid or declared up to and including July 13, 1909); Golden Hope Rubber Estate's 44,000 shares of £1 each, fully paid, Nos. 1 to 44,000 (ex all dividends paid or declared up to and including July 13, 1909); Inch Kenneth Rubber Estates 15,000 shares of £1 each, fully paid, Nos. 1 to 15,000 (ex all dividends paid or declared up to and including July 13, 1909); Kepong (Malay) Rubber Estates' 20,000 shares of £1 each, fully paid, Nos. 1 to 20,000 (ex all dividends paid or declared up to and including July 13, 1909); Kuala Selangor Rubber Co.'s 24,000 shares of £1 each, fully paid, Nos. 1 to 24,000 (ex all dividends paid or declared up to and including July 13, 1909); London Asiatic Rubber and Produce Co.'s further issue of 11,000 shares of £1 each, fully paid, Nos. 107,001 to 118,000; Monerakelle Rubber Estates' 21,349 shares of £1 each, fully paid, Nos. 1 to 21,349 (ex all dividends paid or declared up to and including July 13, 1909); Rubber Estates of Ceylon, 82,000 shares of £1 each, fully paid, Nos. 1 to 82,000, and 18,000 shares of £1 each, 10s. paid, Nos. 82,001 to 100,000 (ex all dividends paid or declared up to and including July 13, 1909); Shelford Rubber Estate's 65,000 shares of £1 each, fully paid, Nos. 1 to 65,000 (ex all dividends paid or declared up to and including July 13, 1909); Sungei Kapar Rubber Co.'s 100,000 shares of £1 each fully paid, Nos. 1 to 100,000 (ex all dividends paid or declared up to and including July 13, 1909; Tenom (Borneo) Rubber Co.'s 43,000 ordinary shares of £1 each, 17s 6d. paid, Nos. 1 to 43,000 (ex all dividends paid or declared up to and including July 13, 1909); Vallambrosa Rubber Co.'s 505,000 shares of 2s. each, fully paid, Nos 1 to 505,000 (ex all dividends paid or declared up to and including July 13, 1909); Zinc Corporation's further issue of 18,000 preference shares of £1 each, fully paid, Nos. 646,027 to 649,026 and 654,027 to 679,026. July 21—Johore Rubber Lands (Malay States) 120,000 shares of £1 each, 5s. paid, Nos. 60,001 to 180,000. The following securities are also ordered to be quoted in the official list: Mansfield and District Tramways, 60,000 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 60,000, and £70,000 4½ per cent. mortgage debenture stock; Rio de Janeiro Tramway Light and Power Co.'s further issue of £200,000 5 per cent. 50-year mortgage bonds of £100 each, Nos. B 12,001 to £14,000; South African Lighting Association's further issue of 1,000 shares of £10 each, fully paid, Nos. 8,001 to 9,000; West Kootenay Power and Light Co.'s £63,200 additional first mortgage 6 per cent. 35-year sinking fund gold bonds for £100 each, within Nos. 2,401 to 3,082.

TRACTION.

Brisbane Electric Tramways Co.—The traffic receipts for the month of June, 1909, amounted to £15,480, against £13,360 in the corresponding period last year.

Madras Electric Tramways—The traffic receipts for the fortnight ending June 30 amounted to Rs.17,776, against a total of Rs.16,644 for the corresponding period of 1908.

Torquay.—In its agreement with the tramway company, the Town Council is granted power to purchase the proposed extension of the tramway to Paignton, in the event of the Paignton authority not choosing to exercise the right.

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Cardiff.—The increased tram fares at Cardiff came into operation yesterday week. Although there was a slight decrease in the receipts, the tramway officials are satisfied that once the changes are thoroughly understood everything will work satisfactorily.

St. Pancras.—The Works Committee of the Borough Council recommend approval of plans submitted by the London County Council for continuing the Caledonian-road tramways at Pentonville to Gray's-inn-road, by means of the bridge to be erected over the Metropolitan Railway Co.'s King's Cross Station.

Lancaster.—On the 22nd ult. a letter was submitted from the Board of Trade to the Council, asking whether any steps had been taken in connection with the provision of speed indicators on the Corporation tramcars, as suggested in their letter of Jan. 13 last. The committee decided not to take any steps in the matter at present.

Sunderland.—The Tramways Committee of the Corporation have decided to approach the Electricity Committee with a view to getting the cost of electricity reduced. They have also considered suggestions that the District Tramways Co. should be given running powers over the borough system, but could not see their way to fall in with them.

Falkirk.—A start has now been made with the work in connection with the extension of Falkirk electric tramways to Laurieston. The new line connects with the present system at West Bridge-street, and extends to Mary-square, Laurieston. The line will be a mile and a half long, and it is expected to be open for traffic about the end of August.

Conciliation Boards for Tramway Men.—In response to an invitation from the Board of Trade to the tramway employés of the London County Council to assist in the formation of conciliation Boards, 4,734 voted in favour and 759 against. Steps will now be taken by the Board of Trade to conduct the elections of the employés' representatives for the four sectional Boards.

Leeds.—The Leeds Tramway Committee's minutes to be submitted to the Leeds City Council next week embrace a new scale of workmen's fares as follows: Any two consecutive ordinary penny stages on the same car for 1d.; any three such stages 1½d.; any four 2d; any five 2½d.; any six 3d.; any seven 3½d.; tickets to be issued at these rates to be available over the same section of route on date of issue after 12 noon if purchased at the same time as the outward ticket.

Rosyth.—A letter from Messrs. Deas and Co. was submitted to the Tramways Committee of the Edinburgh Town Council last week, asking whether the Council would favourably regard a scheme for connecting South Queensferry with the city. The necessity has arisen, it was pointed out, through the operations at Rosyth. The committee instructed the town clerk to reply that they looked on such suburban lines with favour, and would be glad to have particulars of the present proposal.

Stalybridge Joint Tramways.—At the last meeting of the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board it was reported that the borrowing powers had been exercised to the sum of £500,454, and loans amounting to £47,756 had been repaid out of sinking fund account, leaving the amount of loans outstanding at £452,698. The traffic receipts for the four weeks ended June 12 were reported to be £3,163, and the total receipts to that date from March 31 last £8,287.

Darlington.—Mr. Wooler submitted the minutes of the Electricity and Light Railways Committee at the last meeting of the Council, and remarked that other works were taking up electricity for power purposes and abandoning gas. With regard to the trams, he had anticipated some questions, and as the quarter ended at June it would be fitting, perhaps, that he should make some reference to the position. During the quarter they carried 71,792 more passengers, which was very gratifying, but turning to the receipts side the picture was rather gloomy, there being a decrease of £150. 2s. 5½d.

Aberdeen.—An arbitration between the Town Council and the Aberdeen Suburban Tramways Co. took place in the Palace Hotel, Aberdeen, on the 6th inst. for the purpose of fixing the price of the electrical energy to be supplied by the Town Council to the company and to arrange the period of the agreement. The arbitrator was Mr. W. H. Patchell. Mr. Charles Ruxton acted as clerk to the reference, Mr. Lachlan Mackinnon represented the Town Council, and Mr. George Duncan the Suburban Tramways Co. Parties were fully heard, and Mr. Patchell will issue his decision in due course.

Guiseley.—With the formal opening of the line of tramway from Yeadon to Guiseley, the extension to the latter place, which has been undertaken by the Leeds Corporation, is now complete. The extension from the city boundary at Kirkstall went first to Horsforth, and thence, at the request and with the financial co-operation of the Urban District Councils of Rawdon, Yeadon, and Guiseley, it has been taken to Guiseley, 9½ miles from Leeds. The line, which is a double one throughout, has cost over £50,000, and towards the cost the three Councils concerned have agreed to pay £400 a year for 11 years.

Light Railways Act, 1896.—In connection with the Crewkerne, South Petherton, and Martock light railway order the Light Railway Commissioners have submitted to the Board of Trade for confirmation, under the above-mentioned Act, an order made by them authorising the construction of a light railway in the county of Somerset, from Crewkerne to South Petherton and Martock. The Board of Trade have recently confirmed the Burry Port and Gwendreath Valley Railway (Light Railway) Order, 1909, authorising the reconstruction and working as a light railway of certain parts of the railways of the Burry Port and Gwendreath Valley Railway Co., in the county of Carmarthen.

Ventnor.—A hitch has occurred in connection with the proposed funicular railway from the esplanade to the downs at Ventnor, which it is not improbable may result in the abandonment of the scheme. On Friday the Light Railway Commissioners held an inquiry at Ventnor into the expediency of granting the application of the Urban District Council for powers to construct the proposed funicular railway. It was pointed out that there was opposition from the property owners affected by the proposed line of route, and an adjournment was granted to see if any arrangement could be come to with the representatives of the principal owner affected. The negotiations not resulting in a settlement, the inquiry was adjourned *sine die*.

South Shields.—The Town Council have refused the application of the Jarrow Tramway Co., which has running powers into South Shields, for permission to extend their service by running through cars into the borough on Sunday morning during the summer months as an experiment. A numerously signed petition from religious bodies in the town was read, urging the Council to discountenance Sunday labour. Councillor Edw. Smith believed that if Jarrow trams were allowed to run into the borough on Sunday morning, it would encourage drunkenness, as passengers would rank as *bona fide* travellers. Councillor Hall favoured the application, contending that it would give Jarrow people a chance of getting a breath of sea air. There was an overwhelming majority for refusal.

Redruth.—The Urban District Council have received a report from the Highways Committee relative to the proposed by-laws of the Camborne and Redruth tramways wherein they recommended the Council should reply to the Board of Trade that they see no objection to the substitution of longitudinal setts for the toothed setts, provided that the surface of the roadway maintainable by the company be put and maintained in a proper condition, but that the Council objects to the substitution of ordinary for tar macadam. The committee also observed that the granite sett paving is very badly worn, and in many cases so much below rail level as to be dangerous. Seeing that the tramway is on a county main road, such alterations as may be carried out by the company must be to the satisfaction of the county surveyor. The report was unanimously adopted.

Rochdale.—Councillor W. Dunning, chairman of the Tramways Committee, recently reported to the Town Council that an agreement had been effected between the Rochdale, Heywood, and Bury Corporations in the through running of trams. The points of the agreement are that through running should be adopted between the Rochdale centre and the Bury centre, each borough to take the earnings of its own district on the basis of the stage system. The working expenses in Heywood are to be ascertained on a basis agreed upon by the tramway managers of the three boroughs last year, with the addition of a payment of £200 a year to Bury and £100 to Rochdale in respect of sheds, etc. The mayor said that it seemed a pity that such an agreement could not have been arrived at without going to the expenditure of appearing before the parliamentary committee.

Derby.—The receipts of the Corporation tramways during the month ended June 26, 1909, amounted to £4,355. 2s. 10d., being a decrease of £246. 10s. 11d. as compared with the corresponding period of last year. The committee have, subject to the approval of the Council, agreed to accept an offer of the Bell Punch and Printing Co. to reduce the charge for punches to 10s. each per annum, and to supply tickets at 1½d. per thousand, which will effect a saving of £9. 15s. 8d. per annum. The committee recommend the Council to authorise the affixing of the common seal to a lease from Messrs. Jackson, Rohrs, and Co., for use as a messroom of a room with yard and outbuildings in Summer Hill-yard, at a rent of £20 per annum, and for the use of another room, if required, at a further rent of £15 per annum. The lease to be renewable at the option of the Corporation at the expiration of the term.

Newcastle.—At the half-yearly meeting of the Newcastle branch of the Amalgamated Association of Tramway and Vehicle Workers, the secretary (Mr. H. Goodhead) said that the six months just ended had been a successful period for the society. The income amounted to £81. 2s. 5d., and added to this was £2. 11s. 7d. in entrance fees. A member asked what was meant by the report in a local paper stating that Mr. Tate had said six of the men had to meet six of the Tramways Committee. In reply Mr. Goodhead read the official letter he had received, which stated that "the Tramways Committee at their meeting appointed a sub-committee to meet three representatives from the Amalgamated Society, along with three representatives from the Tramway Workers' Union, to discuss the grievances of the employés in this department. The date and time of meeting will be fixed later by the chairman of the Tramways Committee."

Reading.—The borough accountant's return relating to the traffic on the tramways, read at the last Council meeting, showed that the receipts from the commencement of the current financial year to June 10 amounted to £6,454; the receipts during the corresponding period of the last financial year to £6,333; the receipts from May 21 last to June 10 to £2,199; and the receipts during the corresponding period of last year to £2,051. The tramways manager submitted a report, in which he stated: During the four days on which the Royal Counties' Show was open the number of passengers carried by the cars was 116,309, and the receipts amounted to £563. The whole of the cars were in operation during the visit of the show, and additional car services were run on all routes, and a frequent service of special cars was maintained on the Bath-road route in addition to the ordinary service cars. The policy of the committee in raising the fare from 1d. to 2d. on the special cars proved very satisfactory.

Swinton.—According to instructions, the clerk to the Urban District Council has written to the Mexborough and Swinton Tramway Co. regarding the petition of the inhabitants of Swinton that halfpenny stages should be established in their area, and pointing out that the proposed alteration would be a benefit, not only to the passengers, but to the tramway company in the shape of increased revenue. Mr. Priestley, the manager of the company, in reply, points out that as the proposal involves serious loss to the company, he is not disposed to recommend its adoption, although anxious to meet the Council on all possible points. A later letter direct from the com-

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pany regretted its inability to fall in with the proposal, and remarked that disastrous results had attended the efforts of some undertakings to introduce the halfpenny stage. It was decided that a deputation, consisting of Mr. Bingham, Mr. Cooper, Mr. Ward, and Mr. Carr, wait upon the tramway company to make further representation.

Halesowen.—There is every prospect of the scheme for the construction of tramways within the Halesowen district being proceeded with in the immediate future, now that certain difficulties have been overcome. After a lengthy delay the District Council have succeeded in obtaining satisfaction from the Board of Trade with regard to the width of the track upon the various routes. A conference of representatives from the District Council, County Council, and promoters of the transfer order has recently taken place, as a result of which it was agreed that the promoters shall give to the District Council four months' notice of their intention to commence the construction of the railways, within which the District Council will acquire the land necessary for the widenings at Long-lane, Mucklow's-hill, and the Red Lion-hill, the County Council to contribute £100 towards the cost of acquiring the land, the promoters to pay the County Council £1,500 upon commencing the construction of the tramways, and the County Council to carry out the Long-lane widening within four months and the Mucklow's-hill and Red Lion-hill widenings within 10 weeks of the acquisition of the land. The promoters will now proceed to obtain further powers to connect up other outlying districts, and arrangements are being made for the commencement of the work.

Nottingham.—Sir John McCraith, moving the report of the Joint Committee of the Tramways and General Purposes Committee at the last City Council meeting with reference to obtaining parliamentary powers for an extension of the trams along Sneinton Dale, explained that inasmuch as applying for powers at the present moment would be an inexpensive procedure, they might as well obtain the necessary sanction, although the committee were not at all in favour of carrying out this extension. It would be a very unremunerative section of the system if it were instituted at the present time. If the district developed rapidly they could take advantage of the powers. Mr. Swain seconded, but differed from Sir John. He thought that very shortly after getting the Bill through they would find it very necessary to proceed with the work. A huge population would be tapped. Mr. Gregg said the district was increasing so rapidly that if the rate was maintained in two or three years the route would pay as well as the one they were constructing up Carlton-road. They were only proposing, he pointed out, to widen the road to 25 ft. to bear the traffic of a large residential district, while that morning they had determined to widen a road at Bulwell to 60 ft. He suggested an alternative scheme by which the road should be widened on the opposite side. Sir John Turney thought that in asking for powers they should carry the system beyond the suburban railway bridge to intersect Carlton-road somewhere at the top of the hill. The report was adopted.

Glasgow.—The Tramways Committee of the Corporation in their report for the year ended May 31, 1909, state that the ordinary income amounted to £892,750. 19s. 2d. and the working expenses to £505,617. 14s. 7d., thus leaving a gross balance of £387,133. 4s. 7d. The income of the previous year was £910,318. 8s. 5d. and the working expenses £509,894. 16s. 11d., leaving a gross balance of £400,423. 11s. 6d. The gross balance of £416,924. 15s. 9d., which includes interest on surplus revenue and rent of lines let to Dumbarton Burgh and County Tramway Co., has been applied as follows: rental of Govan and Ibrox tramways, £5,074. 13s. 3d., compared with £5,077. 4s. 7d. last year; proportion of traffic receipts due Paisley District Tramway Co., £4,659. 4s. 10d., compared with £4,783. 15s. 5d.; interest on capital, £63,349. 9s. 4d., compared with £53,152. 0s. 3d.; sinking fund, £71,323. 10s., compared with £68,804. 5s. 11d.; income tax, £10,444. 19s. 8d., compared with £9,435. 11s. 2d.; depreciation fund, £105,536. 10s. 5d., compared with £100.415. 15s. 5d.; permanent-way renewals fund, £90,261. 7s. 3d., compared with £88,187. 10s.; payment to common good, £50,000, compared with £35,000, making in all £400,649. 14s. 9d., and leaving a net balance of £16,275. 1s, which has been added to the general reserve fund. The gross revenue for the year shows a decrease of £17,567. 9s. 3d., compared with that of the previous year, and the average traffic revenue per car mile has been reduced from 10·488d. to 10·262d. The working expenses show a decrease per car mile of ·06d. The decrease in the revenue is mainly due to the general depression in trade during the year. The only item in the expenditure account which shows a large increase is the rates and taxes. It will also be observed that the amount expended on repairs and maintenance of permanent way was £16,127. 16s. 9d. less than in the preceding year. The expense of maintaining the electric equipment of the line also shows a considerable reduction.

Gloucester.—Mr. Ford, in submitting the minutes of the Tramways Committee at the last City Council meeting, gave the usual monthly returns, which showed for the four weeks ending June 16 increases of 11,898 in the passengers carried, 2,714 in the mileage, £24. 4s. 7d. in the receipts, £10. 15s. 9d. in the cost of current, and £10. 9s. in wages, and a decrease of 0·25d. in the receipts per car mile. The extra car mileage and cost of current was accounted for by the additional services on the Tuffley-Kingsholm and Westgate routes. Coming to the extraordinary traffic of the show week, Mr. Ford reported that on the five show days—Tuesday to Saturday inclusive—their receipts were £611. 1s. 10d., the car mileage 11,357, the passengers carried 100,632, and the average per car mile 12 91d. It was known to all of them that they ran a 10 minutes' service on all the routes at the ordinary fares, with the exception that transfer tickets were suspended throughout the week. They had in addition special cars from the railway stations, marked as such, upon which there was a uniform charge of 3d. a passenger, and the daily issues were as follows: Tuesday, 553, producing a revenue of £6. 18s. 3l.; Wednesday (the King's day), 4,269, £53. 7s. 3d.; Thursday, 4,271, £53. 7s. 9d. Friday, 5,063, £63. 5s. 9d.; and Saturday, 2,560, £32. The total amount taken on those special cars was £208. 19s. On the corresponding days of last year their revenue was £353. 10s. 2d., and this year the eight days yielded £792. 13s. 3d., giving an increase of £439, which he looked upon as attributable to the show and the King's visit. They had also to receive from the Bath Tramways Co. £38. 6s., by way of commission on motor-bus receipts, and fees for garaging, etc., and from the Great Western Co. £30, amounting to £68. 6s. The aggregate of additional traffic revenue due to the show was thus £507. 9s. 1d. It was due to the general manager and the whole staff to say that these results reflected the utmost credit upon them, and they were to be congratulated on conducting this heavy traffic without a single accident. Mr. C. G. Clark added his congratulations to those of the chairman, and at the same time complimented the chairman on the great amount of time and ability he had devoted to the service of the light railways. He (Mr. Clark) had heard in different places a great many expressions of admiration and appreciation as to the way in which the trams had been conducted in show week. Mr. Clark referred to the admirably decorated cars as an artistic monument to the work of the men.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Longport.—Tenders are invited for heating White Hall Works, Longport, by high or low pressure steam. Tenders to Messrs. Gaskell and Grocott, Longport.

Acton.—The Urban District Council invite tenders for the annual supply of lead-covered, paper-insulated cables. Particulars from Mr. M. Martin Blair, electrical engineer, 130, Churchfield-road, Acton, W. Tenders by July 12.

Long Eaton.—The Urban District Council invite tenders and schemes for the installation of a water-softening plant at the electricity works. Particulars from Mr. F. Worrall, engineer and manager. Tenders by July 20.

Skipton.—The Urban District Council invite tenders for setting, on the Poulton system, one Lancashire steam-boiler at the gasworks in Skipton. Tenders to Mr. J. H. Woodward, Gasworks, Skipton, by July 10.

St. Pancras.—The Borough Council invite tenders for the supply of arc lamp carbons. Particulars can be obtained upon application at the Electricity Department Offices, 57, Pratt-street, Camden Town, N.W. Tenders by July 10.

Aberystwyth (Wales).—Tenders are invited for the installation of a heating apparatus at the Alexandra Hall, Aberystwyth, for the University College of Wales. Plans and specifications can be inspected on application to the Registrar at the College.

Lauder (Scotland).—Tenders are invited for the installation of electric light and heating apparatus at the Lauder Technical School extension. Tenders must be sent to Mr. D. Gorrie, clerk to the School Board, 104, High-street, Dunfermline, by July 10.

Wallasey.—The Urban District Council invite tenders for the supply of a battery of accumulators, reversible booster, and switchboard. Specification from Mr. J. A. Crowther, electrical engineer, Offices, Sea View-road, Liscard. Tenders by July 12.

East Ardsley.—The District Education Committee invite tenders for supplying and fixing two radiators and new copper in heating chamber at the boys' school. Specifications from Mr. Alexander Angus, 128, Northgate, Wakefield. Tenders by July 15.

Shaftesbury.—Tenders are invited for supplying and fixing hot-water heating apparatus at the Westminster Cottage Hospital, Shaftesbury, where particulars can be obtained. Tenders must be sent to Mr. W. Lillington Chitty, hon. secretary, Shaftesbury, by July 14.

Edinburgh.—The School Board invite tenders for an electric light installation at Gorgie School. Specifications obtainable at the office of Mr. George Thomson, 11, Randolph-place. Tenders to Mr. G. W. Alexander, clerk to the Board, School Board Offices, Castle-terrace, Edinburgh, by July 12.

Sandbach (Cheshire).—The Congleton Rural District Council invite tenders for the supply of cast-iron pipes and specials. Specification and form of tender obtainable from the engineer, Mr. W. Woodley Wyatt, Whitchurch, Salop. Tenders to Mr. H. Ferrand, clerk, Sandbach, Cheshire, by July 20.

Sunderland.—Tenders are invited for the supply of mackintoshes for motormen to the Corporation (Tramways Department). Particulars obtainable of the General Manager, Tramways Offices, Monkwearmouth, Sunderland. Tenders to the Chairman of the Tramways Committee, Town Hall, Sunderland, by July 29.

Salford.—The Electricity Committee of the Corporation invite tenders for rewiring the Royal Technical Institute. Specification and forms of tender obtainable from Mr. V. A. H. M'Cowen, borough electrical engineer, Electricity Works, Frederick-road, Pendleton, upon payment of a deposit of £1. 1s. Tenders by July 12.

Ealing.—The Corporation invite tenders for the supply of cylinder oil, crank-chamber oil, bearing oil, paraffin, best rope waste, stoneware pipes, etc, to the electricity works. Particulars from Mr. J. Douglas Knight, borough electrical engineer and manager, Electricity Department, Town Hall, Ealing, W. Tenders by July 19.

Rotherham.—The Corporation invite tenders for the supply of a petrol-driven power wagon required by the tramways department. Particulars obtainable from the tramways manager, Mr. E. Cross, Tramways Office, Rotherham. Endorsed tenders must be sent to Mr. W. J. Board, town clerk, Town Hall, Rotherham, by July 10.

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Luton.—The Corporation invite tenders for the supply and erection at the electricity works of one 500-kw. steam-driven generator and condensing plant. Specification from Mr. W. H. Cooke, borough electrical engineer, to whom tenders must be sent by July 19.

Derby.—The Corporation invite offers for the privilege of placing advertisements on the electric tramcars of the Corporation. Particulars and forms of tender obtainable on application to the Tramway Manager, Tramway Offices, Victoria-street, Derby. Tenders to Mr. G. Trevelyan Lee, town clerk, 16, Tenant-street, Derby, by July 17.

Hull.—The Education Committee of the Corporation invite tenders for the installation of heating apparatus in New Cross School buildings. Tenders, with schemes, sealed and endorsed, addressed to the Chairman of the Finance and General Purposes (Education) Sub-Committee, must be sent to the Town Clerk's Office, Hull, by July 12.

London, E.C.—The Directors of the Burma Railways Co. invite tenders for the supply of miscellaneous tools and stores. Specifications and forms of tender obtainable at the Company's Office, 199, Gresham House, Old Broad-street, E.C. For each specification a fee of 20s. will be charged, which will not be returned. Tenders by July 16.

Altrincham.—The Education Committee invite tenders for the installation of heating, ventilating, electric lighting and wiring at the new higher elementary school, Queen's-road, Hale. Plans can be seen and specifications obtained, on deposit of £1. 1s. (returnable), at the office of Mr. Jos. Howarth, clerk, Education Department, Altrincham, Cheshire.

Whitehaven.—Tenders are invited for lighting the harbour, quays, etc., by electricity, gas, or other means for five years, or such other period as may be agreed upon, from Jan. 1, 1910, for the Harbour Commissioners. Application must be made to the Harbour Master for particulars. Tenders to Mr. John Tyson, clerk, Harbour Office, Whitehaven, by July 20.

London, S.W.—The Directors of the Madras and Southern Mahratta Railway Co. invite tenders for the supply of 32 pillar jib cranes, as per the specification, which can be seen at the offices of the Company. The charge for the specification is £1. 1s., which will not be returned. Tenders to Mr. H. Bonham-Carter, secretary, 91, York-street, Westminster, S.W., by July 13.

Paddington.—The London County Council invite tenders for an installation of electric lighting and fans at the extension of the Paddington Technical Institute, Saltram-crescent, W. Tenders to Mr. Maurice Fitzmaurice, C.M.G., the chief engineer of the Council, at the County Hall, Spring-gardens, S.W., by July 21. Full particulars in advertisement columns.

Bury.—The Corporation invite tenders for the supply and erection of three water-tube boilers, each capable of evaporating 25 000 lb. of water per hour. Copy of the specification and form of tender obtainable from Mr. S. J. Watson, M.I.E.E., engineer and manager, Electricity Works, Bury, on a deposit of £2. 2s. (returnable). Tenders to the Town Clerk, Bury, by Aug. 16.

Bridgwater.—The Rural District Council invite tenders for the laying of 1,489 yards, or thereabouts, of cast-iron pipes, 3 in. in diameter, and other works appertaining thereto, in accordance with the drawings, specifications, and instructions of the engineer, Mr. W. Alexander Collins, Binford-place, Bridgwater. Tenders to Mr. T. M. Reed, clerk, Bridgwater, by July 13.

Middleton.—The Corporation invite tenders for the supply of a Lancashire boiler. Particulars, specification, and form of tender, which will contain a fair wages clause, obtainable from Mr. C. F. Broadhead, gas engineer, Middleton. Tenders, addressed to the Chairman of the Gas Committee, must be sent to Mr. Frederick Entwistle, town clerk, Town Hall, Middleton, by July 14.

Manchester.—The Tramways Committee of the Corporation invite tenders for the supply of special (permanent way) track work. Specifications and forms of tender obtainable on application to Mr. J. M. McElroy, general manager, Corporation Tramways, 55, Piccadilly, Manchester, on deposit of £2. 2s. (returnable). Tenders to the Chairman of the Tramways Committee, 55, Piccadilly, Manchester, by July 13.

Aylesbury.—The Board of Guardians invite tenders for the supply to the Aylesbury union workhouse of a 3-n.h.p. high-class cross-tube vertical boiler by Messrs Marshall, Sons, and Co., of Gainsborough. The tender to include fitting and every expense. Particulars can be obtained and form of contract inspected on application to the Master of the Workhouse. Tenders to Mr. F. H. Parrott, clerk, Aylesbury, by July 10.

Edinburgh.—The Corporation invite tenders for the supply of new vertical steam-boiler and relative works at the disinfecting station, High School-yards. Plans and specification can be seen at the office of Mr. J. A. Williamson, Public Works Office, City Chambers, from whom also printed particulars and forms of tender can be obtained on personal application. Tenders to Mr. Thomas Hunter, W.S., town clerk, City Chambers, Edinburgh, by July 10.

Leeds.—The Street-Lighting Committee of the Corporation invite tenders for the annual supply of the following: copper lamps, lamp pillars, lamp furniture, pillar lamp irons and carriages, wall bracket irons, sheet copper and copper tops for lamps, glass for lamps. Particulars and forms of tender obtainable from the Superintendent of Street-Lighting, Springwell-street Depot. Tenders to Mr. Robert E. Fox, town clerk, Town Hall, Leeds, by July 14.

Whitehaven.—The Harbour Commissioners invite tenders for the supply of miscellaneous stores during the year ending July 31, 1910, including the following: iron castings, wrought iron, ironmongery, and tools; cement; lead, oils, paints, coal tar, etc.; rubber hose, washers, etc.; crane chains and wire rope; timber. Forms of tender obtainable from Mr. John Tyson, clerk, Harbour Offices, Queen's Dock Quay, Whitehaven, to whom tenders must be sent by July 19.

Wimbledon.—The Corporation invite schemes for the heating of the isolation hospital, Gap-road, and tenders for carrying out the work. On payment of £1. 1s. (returnable) general conditions and plans of the existing and proposed buildings will be supplied by the Borough Surveyor, Town Hall, Wimbledon. Tenders, addressed to the Chairman, Sanitary Committee, must be sent in by July 22.

Greenwich.—The London County Council invite tenders for the supply and delivery of about 130,000 tons of coal of the kind known as washed singles to the generating station, East Greenwich, from Aug. 1, 1909, to July 31, 1910. Tenders, upon the official forms, obtainable from Mr. G. L. Gomme, clerk, County Hall, Spring-gardens, S.W., upon payment to the Cashier of the Council of the sum of £1 for the specification, etc. (returnable), must be sent in by July 13.

Lanark.—The Corporation invite tenders for providing and delivering about 975 tons of cast-iron pipes, 9 in. in diameter, and the relative special castings in connection therewith. Copies of the specification and schedule can be obtained at the office of the engineer, Mr. M. Ratcliffe Barnett, C.E., 124, St. Vincent-street, Glasgow, on payment of £1. 1s. (returnable). Documents to be sent back. Tenders to Mr. James Annan, town clerk, Town Clerk's Office, Lanark, by July 12.

Pontypridd.—The Urban District Council invite tenders for the supply and delivery of an independent surface-condensing plant, together with circulating pump, air-pumps, pipework, etc., at the electric light and tramways department. Specification, general conditions, and form of tender obtainable from the Electrical Engineer and Manager upon payment of a deposit of £1. 1s. (returnable) to the Clerk. Tenders to Mr. J. Colenso Jones, clerk, Municipal Buildings, Pontypridd, by July 12.

London, E.C.—The Port of London Authority invite tenders for supplies of materials and stores, including carbons for electric lights and electric (incandescent) lamps. Specifications and forms of tender may be obtained on application at the Authority Stores Department, 106, Fenchurch-street, E.C., between the hours of 10 a.m. and 4 p.m. Tenders to Mr. Robert Philipson, secretary, Port of London Authority, 109, Leadenhall-street, London, E.C., by July 12. Full particulars in advertisement columns.

Leeds.—The Street-Lighting Committee of the Corporation invite tenders for the supply of the following materials during the ensuing year: copper lamps, lamp pillars, lamp furniture, pillar lamp irons and carriages, wall bracket irons, sheet copper and copper tops for lamps, glass for lamps. Particulars and forms of tender obtainable from the Superintendent of Street-Lighting, Springwell-street Depôt, between 9 and 11 a.m. daily. Tenders to the office of Mr. Robert E. Fox, town clerk, Town Hall, Leeds, by July 14.

Ringwood.—Persons desirous of tendering for the installation of low-pressure hot-water apparatus at the Ringwood new Council School (310 children), in the county of Southampton, can, on deposit of £2. 2s., see plans, specification, and general conditions of contract, and obtain all other information at the office of Mr. W. J. Taylor, county surveyor, The Castle, Winchester, during office hours. No information sent by post. A copy of the plans will be handed to contractors. Tenders by July 19.

Egremont (Cheshire).—The Wallasey Urban District Council invite tenders for the supply, delivery, and fixing of a battery of accumulators, reversible booster, and switchboard. Copies of the specification can be obtained on payment of £1. 1s. (returnable) from Mr. J. A. Crowther, Sea View road, Liscard. Tenders considered from makers only, and all material shall be as far as possible British manufacture. Tenders to the office of Mr. H. W. Cook, clerk, Public Offices, Egremont, Cheshire, by July 12.

Rotherham.—The Corporation invite tenders for the supply of electricity meters according to the requirements of the electric light department, between Aug. 1, 1909, and July 31, 1910. Ampere-hour meters of sizes for maximum currents of 2, 5, 10, 25 and 50 amperes. The supply pressure is 230 and 460 volts. Further particulars obtainable from the Borough Electrical Engineer. A contract containing the usual fair wages clause will be required to be entered into. Tenders to Mr. W. J. Board, town clerk, Rotherham, by July 13.

Manchester.—Tenders are invited for the supply of about 3,600 tons of welded steel pipes and collars, 44 in. and 40 in. diameter (Contract No. 9). Specification and form of tender obtainable from Messrs. G. H. Hill and Sons, civil engineers, Albert-chambers, Albert-square, Manchester, and 3, Victoria-street, Westminster, upon receipt of cheque for £2. 2s. (returnable). Documents to be sent back. Tenders, addressed to the Chairman of the Waterworks Committee, must be sent to the Secretary, Waterworks Offices, Town Hall, Manchester, by July 14.

West Ham.—The Borough Council invite tenders for the supply of six double deck electric tramcars, six trucks, and six complete electrical equipments. Specification, form of tender, and further particulars obtainable from Mr. H. E. Blain, tramways manager, Greengate-street, Plaistow, E., on the deposit of a £5 Bank of England note (returnable). A bond with two sureties for the due performance of the contract will be required to be entered into. Payment of wages and observance of hours of labour as are embodied in the schedule which will be part of the contract. Tenders to Mr. Fred. E. Hilleary, town clerk, Town Hall, Stratford, E., by July 16.

London, W.—The Metropolitan Water Board invite tenders for the supply and erection of coal transporter and appurtenant works at the Hammersmith pumping station. Contractors desirous of tendering can obtain forms of tender, conditions of contract, specification, drawings, etc., on application to the Engineer, Metropolitan Water Board, Western District, 41, Commercial-road, Pimlico, S.W., on the production of an official receipt for the sum of £10 (returnable), which sum must be deposited with the Accountant at Savoy-court, Strand, W.C. Documents to be sent back. Tenders to be sent

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to the Clerk, Metropolitan Water Board, Savoy-court, Strand, W.C., by July 19.

Eastleigh.—Persons desirous of tendering for the installation of low-pressure hot-water apparatus at the Eastleigh Derby-road Council School (1,200 children), in the county of Southampton, can, on deposit of £10. 10s., see plans, specification, and general conditions of contract, and obtain all other information at the office of Mr. W. J. Taylor, county surveyor, The Castle, Winchester, during office hours. No information sent by post. Deposits must be by cheque made payable to the Hants County Council and crossed "Bank of England." Endorsed tenders, on forms to be obtained from the County Surveyor, must be sent to Mr. H. Barber, clerk of the County Council, The Castle, Winchester, by July 12.

London, W.C.—Tenders are invited by the Postal Authorities for the supply of telegraph poles of (*a*) home-grown larch or fir; (*b*) Swedish, Norwegian, Finland, or Russian red fir. The poles are to be delivered at any one or more of the following ports as may be directed: London, Tilbury, Grimsby, Hull, West Hartlepool, North and South Shields, Ellesmere Port, Swansea, Cardiff, Newport, Southampton, Leven (Fifeshire), Ardrossan, Belfast. The poles to be felled during the winter of 1909-10, and to be delivered during the following summer. Butt sections, 2 in. thick, stamped with the shipper's or tenderer's mark from not fewer than three poles, to show the quality of the timber offered, must precede or accompany the tender of any person who has not already supplied the Postmaster-General with poles. Forms of tender, containing all particulars, obtainable from Mr. G. Morgan, controller of stores, Stores Department, G.P.O., 17-19, Bedford street, London, W.C. Tenders by Aug. 9.

Swansea.—Tenders are invited for the supply, etc., of the following to the Corporation Electricity Department: (Contract 30) supply, delivery, adjusting, and testing of continuous and alternating current enclosed-type arc lamps, resistances, choking coils, etc.; (31) supply and delivery of plain lead sheathed two-core conductor, fibre-insulated 660-volt cable (suitable for a draw in system), also rubber-insulated and braided single-conductor arc lamp cable for a working pressure of 550 volts; (32) supply, delivery, adjusting, and testing of arc lamp raising and lowering gear, winches, wire rope, arc lamp pillars and brackets together with all required clamps, straps, bolts and nuts, etc.; (33) supply and delivery of arc lamp feeder pillars, complete with switch and fuse gear, time switches, 'bus bars, sweating sockets, connections, and accessories, also cable joint boxes, complete with fittings, glands, bonds, compound, etc. Copies of the general conditions, specifications, and forms of tender obtainable from Mr. O. A. L. Prusmann, borough electrical engineer, Swansea, on payment of £1. 1s. for each of the specifications, etc. (returnable). Additional copies can be obtained on payment of 10s. per copy, which amount will not be returned. Contractors may tender for all or any of the contracts. Tenders to be sent to the office of Mr. Jno. Thomas, town clerk, Guildhall, Swansea, by July 7 for Contracts 30 and 31, and July 14 for Contracts 32 and 33.

COLONIAL AND FOREIGN.

Cologne.—The Municipality invite tenders for the supply of four electrically-driven lifts. Tenders by July 15.

Rome.—The Italian State Railways Department invite tenders for the supply of two lathes. Tenders by July 20.

Sofia.—The District Finance Commission invite tenders for the supply of iron bars and wire. Tenders by July 23.

Victoria.—The Postmaster-General invites tenders for the supply of 5,000 telephones complete. Tenders by Aug. 10.

Vernon.—The Municipality invite tenders for the provision of two gas motors. Particulars from the Maire. Tenders by July 27.

New South Wales.—The Postmaster-General invites tenders for the supply of 10 switchboards for 100 metallic circuits. Tenders by Sept. 10.

Prahran.—The Prahran and Malvern Tramways Trust invite tenders for the supply complete of 12 electric tramcar bodies. Tenders by Aug. 27.

Brussels.—The Belgian State Railways Department invite tenders for the construction of a section of the Schaerbeck-Hal line. Tenders by Aug. 14.

Besancon.—Tenders are invited for the construction of a railway, estimated to cost £6,000. Particulars from the Prefecture du Doubs. Tenders by July 10.

Wilhelmshaven.—Tenders are invited for the supply of broad-gauge ammunition railway wagons to the Marine Artillery Depôt. Tenders by July 31.

Toulon.—Tenders are invited for the supply of copper wire required at the Arsenal. Particulars from the Ministère de la Marine, Paris. Tenders by July 22.

Brescia.—Tenders are invited for the supply of cast-steel bars and wire to the artillery depôt. Particulars from the Direction d'Artillerie. Tenders by July 12.

Madrid.—Tenders are invited by the Public Works Department for the construction and working of a railway from Villajoyoso to Denia. Tenders by July 31.

Paris.—Tenders are invited for the supply of machine tools, bolts, etc., to the Colonial Office. Particulars from Galerie d'Orleans, Palais Royal. Tenders by July 20.

Dortmund.—The Prussian State Railway Department invite tenders for the supply of an 80-ton locomotive transporter to be electrically worked. Tenders by July 12.

Bukarest.—The Roumanian State Railways Department invite tenders for the supply of copper tubes for locomotive and tender funnels. Tenders by Aug. 19.

Cologne.—The Prussian State Railways Department invite tenders for the supply of galvanised iron cable. Particulars from Eisenbahn-direction. Tenders by July 14.

Emden.—Tenders are invited for the supply of two electrically-driven dredgers. Particulars can be obtained from K. Maschinen-bau-inspection. Tenders by July 20.

Bukarest.—Tenders are invited for the supply of brass rods, copper tubes, and lead bars to the Arsenal. Particulars from the Direction de l'Arsenal. Tenders by July 19.

Stanislaw.—The Austrian State Railways Department invite tenders for the supply of a tubular boiler. Particulars from K. K. Staats-Eisenbahn. Tenders by July 15.

Naples.—Tenders are invited for the supply of iron and steel materials required at the arsenal. Particulars from the Ministero della Marina, Rome. Tenders by July 12.

Bar le-Duc.—Tenders are invited for the construction of a railway from Verdun to Montpellier. Particulars can be obtained at the Prefecture de la Meuse. Tenders by July 20.

Rockhampton (Australia).—The City Council invite tenders for the provision of low-lift pumping plant. Specifications from the town clerk, Mr. T. V. Nobbs. Tenders by July 14.

Paris.—Tenders are invited for a three years' supply of bolts, nuts, and rivets required for the French Colonies. Particulars from Galerie d'Orleans, Palais Royal. Tenders by July 20.

Sofia.—Tenders are invited by the Bulgarian State Railways Department for the supply of bolts and rivets. Particulars from the District Finance Commission. Tenders by July 9.

The Hague.—Tenders are invited for the supply of copper wire and sheets, brass wire and bars, aluminium sheets, etc. Particulars from Van Cleef Freres, Colonial Office. Tenders by July 14.

Bukarest.—Tenders are invited by the Roumanian State Railways Department for the supply of tubes for train heating, copper sheets, tin, and parts for Westinghouse brakes. Tenders by July 16.

Koslow.—The Tambow Government invite tenders for the equipment of the central electric station for distribution purposes. Particulars from Govodskaja Uprawe, Koslow. Tenders by July 16.

Tongres.—The Municipality invite tenders for the extension of the electric lighting supply to the suburbs. Specifications can be obtained from the Hotel de Ville, price 6s. 6d. Tenders by July 11.

Buenos Ayres.—Tenders are invited for the supply of seven locomotives for use on the Patagonian railways. Particulars from the Direccion General de Vias y Communicaciones. Tenders by Aug. 21.

Brussels.—Tenders are invited for the supply of tirefonds, bolts, and nuts to the Belgian State Railways Department. Specification No. 237 can be obtained from 11, Rue de Louvain. Tenders by Aug. 4.

Robida.—The Public Works Department, Madrid, invite tenders for the construction of a railway to Robida. Particulars from the Direccion de Obras Publicas, Ministerio de Fomento. Tenders by Aug. 20.

Rome.—Tenders are invited for the supply of electric cable to the Italian Government Railways Department. Particulars from Ferrovie dello Stato Segretariato Generale, Seziono Contratti. Tenders by Aug. 10.

Victoria.—The Postmaster-General invites tenders for the supply and delivery at the post office, Hawthorn, of eight sections of a common-battery switchboard and subscribers' apparatus. Tenders by Sept. 14.

Santa Croce.—The Municipality of Santa Croce, Tenerifa, invite tenders for the provision of suction dredger and pontoon with steam-engine. Particulars from the Junta de Obras del Puerto. Tenders by Aug. 27.

Santiago.—Tenders are invited by the Chilian Railways Department for the supply of rails, fishplates, dog-spikes, and bolts. Particulars from the Direccion-General de Obras Publicas. Tenders by Sept. 1.

Wevelghem.—Tenders are invited by the Vicinal Railways Department, Brussels, for the construction of a line to Wevelghem. Specification, price 10d., can be obtained from 14, Rue de la Science. Tenders by Aug. 4.

Bukarest.—The Roumanian State Railways Department invite tenders for the supply of tin, copper bars, weldless copper tubes and rivets. Particulars from the Direction des Chemins de fer Roumains. Tenders by July 13.

Bukarest.—Tenders are invited for the supply of copper bars, copper plates for fire-boxes, Martin steel tyres for goods wagons, and tin. Particulars from the Roumanian State Railways Department. Tenders by July 19.

Saarbruckon.—Tenders are invited for the supply of seven travelling cranes, one fixed crane, and the provision of a transporter bridge. Particulars from the Preussischen Staats-Eisenbahnen. Tenders by July 19.

Sydney (N.S.W.).—The Postmaster-General invites tenders for the supply and delivery at departmental stores, Sydney, of 150 relays non-polar W.E. Co.'s type 12,505 wound to 250 ohms to schedule. Tenders by July 21.

Brussels.—Tenders are invited by the Société Nationale des Chemins de fer Vicinaux for the equipment of a sub-station in connection with the Spa to Verviers line—alternating current to direct current. Tenders by July 14.

Bukarest.—Tenders are invited for the supply of steel, antimony, copper, brass, rivets, and drills for steelwork required by the War

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Department. Particulars from the Ministere de la Guerre, Section Pyrotechnic. Tenders by July 13.

Paris.—The Municipality invite tenders for the provision of a steam motor and dynamo. Particulars from the Ingenieur-en-Chef, Chef du Service Technique des Eaux et de l'Assainissement, 9, Place de l'Hôtel de Ville. Tenders by July 15.

New South Wales.—The Postmaster-General invites tenders for the supply, delivery, and erection of a branching multiple-magneto switchboard at the Edgecliffe telephone exchange in accordance with Specification No. 247. Tenders by Sept. 29.

Barcelona.—The Public Works Department, Madrid, invite tenders for the construction and exploitation of electric tramways in Barcelona. Particulars from the Direccion-General de Obras Publicas, Ministerio de Fomento. Tenders by Aug. 27.

Paris.—Tenders are invited by the Post and Telegraph Department for the construction of telephone lines at Levallois-Perrat and Fontenay-aux-Roses. Particulars from Sous-Secrétariat d'Etat des postes et des télégraphes, 103, Rue de Grenelle.

Scheveningen.—Tenders are invited by the Post and Telegraph Department, The Hague, for the provision of a radio-telegraph station at Scheveningen. Particulars from the Administration Superieure des Postes et Télégraphes. Tenders by July 15.

Rome.—The Italian State Railways Department invite tenders for carrying out various works of railway construction in connection with the Bivio-Sciacca-Bivio Greci Porto Empedocle line. Particulars from the Direzzione Generale, Ferrovie dello Stato. Tenders by July 20.

Madrid.—The Public Works Department invite tenders for the construction and exploitation of an electric tramway between Monarhil and the suburbs of Gabia Grande, Granada. Particulars can be obtained from the Commercial Intelligence Department of the Board of Trade. Tenders by Aug 26.

Melbourne.—The Corporation invite tenders for the supply of one direct-current steam-driven generating set. Tender form, conditions of tender, specification, and plans can be obtained on application to Messrs. McIlwraith, McEacharn, and Co., Ppty., Billiter-square-buildings, London, E.C., agents for Melbourne City Council. Tenders to the Town Clerk, Town Hall, Melbourne, by July 14.

Adelaide.—The Municipal Tramways Trust invite tenders for the erection of buildings for power station on the site of Ocean Steamers' Wharf, Port Adelaide. The sum of 10 guineas will be charged per copy of specification, which will only be refunded on receipt of *bona fide* tender and return of specification. Particulars from Mr. H. C. Mais, 31, Queen-street, Melbourne. Tenders to Mr. W. G. T. Goodman, chief engineer and general manager, 8, King William-street, Adelaide, by July 27.

Melbourne (Australia).—The Corporation invite tenders for the supply of one overhead travelling crane. Tender form, conditions of tendering, specification, and plans, etc., can be obtained on application to Messrs. McIlwraith, McEacharn, and Co., Billiter-square-buildings, London, E.C., agents for Melbourne City Council. by depositing the sum of £1. 1s., which amount will be returned on receipt of a *bona fide* tender. Tenders to the Chairman, Electrical Supply Committee, Town Hall, Melbourne, by 2 p.m. on Aug. 4.

Brisbane (Australia).—The Board of Waterworks invite tenders for the supply of 42-in. and 48 in. steel pipes, or alternatively 42 in. and 48-in. wrought-iron pipes or 42 in. and 48-in. cast-iron pipes. The whole of the material to be used in the manufacture of the pipes must be the product of the United Kingdom or of the Commonwealth of Australia. Specifications and drawings can be obtained on application at the office of the Engineer to the Agent-General for Queensland, 409 and 410, Strand, London, W.C., on payment of a fee of £3. 3s Tenders must be sent to the Secretary, Brisbane Board of Waterworks, Brisbane, Queensland, by Sept. 1.

Ladysmith (Natal).—The Corporation invite tenders for the manufacture, supply, and delivery f.o.r. at the port of Durban, Natal, of the following—viz.: (*a*) about 740 tons of 12-in. cast-iron pipes and special castings, certain sluice and air valves, and surface boxes and pipe cutter; (*b*) 435 cwt. of soft pig lead and 24 cwt. of tar rope, ½ in. diameter, for pipe jointing. Specifications, with schedule of quantities for the cast-iron pipes, sluice valves, etc., obtainable on deposit of £2. 2s. (returnable) from the London Agents. No deposit required for particulars of the lead and tar rope. Tenders must be sent to Messrs. Webster, Steel, and Co., London agents, 5, East India-avenue, Leadenhall-street, London, E.C., by July 13.

Christiania (Norway).—Tenders are invited by the Norwegian State Railways for the supply of a number of axles and wheels. Tenders, marked "Hjul," must be sent to the Styrelsen for Statsbanernes Expeditionskontor, by July 16. Copies of the specifications and conditions of tender, together with drawings, can be inspected by British makers on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C. It should be noted that in all Norwegian Government contracts a preference of from 10 to 15 per cent. (apart from customs duties) is given to Norwegian manufacturers, and that it is obligatory that a resident agent (not necessarily a Norwegian firm) should act for tenderers not residing in Norway.

Copenhagen (Denmark).—The Commercial Intelligence Branch of the Board of Trade have been notified by his Majesty's consul at Copenhagen (Mr. L. C. Liddell, M.V.O.) that tenders are invited by the Copenhagen Lighting Corporation for the supply of (1) a quantity of continuous-current cable; and (2) 800 electric meters for alternating currents. The period of delivery, in both cases, is to extend from Aug. 1, 1909, to Aug. 1, 1910. Tenders, marked "Tilbud paa Jaevnstroms Kabler" in the case of (1) and "Tilbud paa Vekselstromsmaalere" in the case of (2), should reach Directoren for Belysningsvaesenet, Raadhuset, Copenhagen, by 12 noon on July 19 and 17 respectively. Copies of the specifications and conditions of tenders can be seen by British makers interested on application at the Commercial Intelligence Branch of the Board of Trade.

Rome (Italy).—The Rome *Gazzetta Ufficiale* of June 17 announces that tenders are invited for the construction of the Ostiglia-Negara section of the Bologna-Verona Railway, nine miles long, and of various junctions. The upset price is placed at 3,650,000 lire (£146,000), and the competition will turn on the percentage of reduction offered thereon. To qualify any tender a deposit of 182,000 lire (£7,280) will be required, to be increased by the successful tenderer to 365,000 lire (£14,600). Tenders must be enclosed in sealed envelopes, marked on the outside "Offerta per Asta: tronco Ostiglia-Nogara," and addressed to Direzzione-Generale delle Ferrovie dello Stato (servizio 1, ufficio contratti), *via* Ludovisi 4, Rome, where they will be opened on July 31. Tenderers will be required to furnish certificates of competency. The award in respect of this competition will no doubt involve the purchase of a substantial quantity of permanent-way material, which may have to be obtained wholly or in part out of Italy. The *Gazzetta*, containing further particulars, can be seen by British firms interested on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall street, London, E.C.

Winnipeg (Canada).—The Board of Control invite tenders for the manufacture, delivery, and erection of the hydraulic, electric, and auxiliary equipment of the municipal generating station at Point du Bois, on the Winnipeg River. Specifications and plans will be on exhibit at the offices of the following: *Engineering*, London, England; *Engineering News*, New York City; Smith, Kerry, and Chace, Toronto; Wm. Kennedy jun., Y.M.C.A. Building, Montreal; and Smith, Kerry, and Chace, Winnipeg. Copies of the instructions to bidders, of the plans, specifications, and form of tender can be obtained from the Power Engineer's Office, Carnegie Library Building, Winnipeg; and at the office of *Engineering*, London, England; but the application for these must be accompanied by deposit, as listed below, for each section applied for. This deposit will be returned to the applicant only upon the return to the Power Engineer's Office of the plans and specifications in good order. Each tender must be accompanied by a certified cheque payable to the City Treasurer for the sum called for in the corresponding instructions to tenderers, which cheque will become forfeit to the Corporation in the event of the successful tenderer refusing or neglecting to execute a satisfactory contract when called upon so to do. Tenders will be received upon the following sections: (A) Specifications Nos. 5 and 6—five 5,200-h.p. turbines and two 450-h.p turbines; deposit, 250 dol. This tender returnable Aug. 2, 1909. (B) Specifications Nos. 7, 8, and 11—five 3,000 kw. generators, two 250-kw. generators, and switching and accessory apparatus; deposit, 250 dol. (C) Specification No. 10—six step-up transformers; deposit, 100 dol. (D) Specification No. 12—light, heat, and power systems; deposit, 50 dol. (E) Specification No. 23—protective apparatus; deposit, 50 dol. (F) Specification No. 25—three electric travelling cranes; deposit, 50 dol. (G) Specification No. 27—auxiliary apparatus; deposit, 100 dol. As an alternative, tenderers may include or group together one or more of the above sections, providing that they have also tendered for the individual sections of such grouping. Tenders, addressed to the Chairman of the Board of Control, must be sent to the office of Mr. M. Peterson, secretary, Office of the Board of Control, Winnipeg, Canada, by Aug. 2 and 16.

RESULTS OF TENDERS.

Margate.—The Town Council have accepted the tender of Stuart and Moore, at £68, for the supply of electrical fire-alarm apparatus.

Cheltenham.—The Corporation have accepted the tender of Pates and Co. for the annual supply of coal for use at the electricity works.

Rochford.—The Guardians have accepted the tender of Rosser and Russell, at £22. 15s., for the provision of a radiator in the attendants' room.

Plymouth.—The Corporation have accepted the tender of Cory Bros. and Co., Cardiff, for the supply of coal for use at the electricity works.

Rugby.—The Urban District Council have accepted the tender of W. T. Henley and Co., amounting to £78, for the supply of service cable.

Swansea.—The Electric Lighting Committee have accepted the tender of Brook, Hirst, and Co., at £70, for the supply of a starting switch.

Stirling.—The tender of the Sloan Electric Co., amounting to £41. 9s., has been accepted by the Town Council for the supply of carbons.

Birkenhead.—The Corporation have accepted the tender of Dennis Bros., Onslow-street, Guildford, for the supply of a motor fire-engine for £980.

Tunstall.—The Education Committee have accepted the tender of Truswell and Son for the provision of an additional boiler at Chell school for £36.

Toronto (Canada).—The tender of C. W. Dill, of Toronto, amounting to about £100,000, has been accepted for the erection of filtration plant.

Deptford.—The Borough Council have accepted the tender of Cooper and White, 1, Napier-street, for repairs to heating apparatus at the town hall.

Windsor.—The Town Council have accepted the tender of Crossley and Sons, Manchester, for the erection of a gas suction plant for the sum of £344. 10s.

Gloucester.—The County Council have accepted the tender of Woodward and Co. at £36. 10s. for the erection of two wrought-iron boilers at Over Hospital.

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Southampton.—The Town Council have accepted the tender of P. Brotherhood, Limited, at £60, for the provision of an air compressor for the tramways department.

Newark.—The Urban District Council have accepted the offer of H. Widdowson, of Nottingham, to purchase for £36 the old engine and dynamo at the Farnsfield works.

Lancaster.—The Town Council have accepted the tender of Saunders and Taylor, amounting to £91. 10s., for the supply and fixing of a boiler at Storey's Institute.

Burnley.—The Education Committee have accepted the tender of Simpson Bros., Burnley, for the electrical installation at the new technical school for the sum of £1,425.

Dundee.—The offer of Kelvin and White, Glasgow, has been accepted for the supply of the main switchboard required at the new technical institute for the sum of £300.

Longton.—The Electricity Committee of the Town Council have accepted the tender of Tompkinson and Bettelley, at £452. 17s., for the extension of the electricity generating station.

Erith.—The Electricity Committee recommend the acceptance of the tender of Beadle Bros., Erith, for the supply of about 5,500 tons of Longhurst rough small coal at 11s. 1d. per ton.

London.—The London County Council are recommended to accept the tender of the Easton Lift Co., at £245, for the supply and fitting of a new lift in the chief station of the fire brigade.

Birmingham.—The Corporation have accepted the tender of the Phœnix Dynamo Co. the supply for two years of 250 motors, ranging from 1 h.p. to 5 h.p., to the electricity department.

Gillingham.—The Electric Light Committee have accepted the tender of the Electrical Construction Co., amounting to £2,420, for the supply of one 135-140-kw. Mirrlees-Diesel E.C.C. set.

Penwithick.—The St. Austell Rural District Council have accepted the tender of Tangyes, Birmingham, for the provision of two horizontal suction gas-engines and two pumps at the waterworks for £541.

Derby.—The Electricity Committee have accepted the tenders of the Derby Coal Co., T. and G. Walker, and Parsons Bros. and Snape for the supply of coal for use at the electricity generating station.

Heston and Isleworth.—The District Council have accepted the tender of Babcock and Wilcox to supply and fix a mechanical chain-grate stoker to boiler No. 3 at the electricity works for the inclusive sum of £310.

Wednesfield.—The Staffordshire Education Committee have accepted the tender of C. Manton, Walsall, for the installation of low-pressure hot-water heating apparatus in the Council school for the sum of £210.

Stepney.—The Borough Council have accepted the tender of the Reason Manufacturing Co., amounting to £563. 5s., for the supply of demand indicators for the ensuing two years, and that of Venner and Co. for time switches.

Western Australia.—The Postmaster-General has accepted the tender of W. T. Henley's Telegraph Works, Melbourne, for the supply of three miles cable, 52 pairs, at £186. 10s. per mile; ditto, 26 pairs, at £141 per mile.

Peckham.—The tender of R. Bridger and Co., at £135. 8s., is recommended to the London County Council for acceptance for installing electric lighting in connection with the enlargement of the "Oliver Goldsmith" School, Peckham.

Leamington.—The D.P. Battery Co., of Bakewell, have received an order from the Midland Electric Light and Power Co., of Leamington, to install and maintain for 10 years a storage battery of their LS-17 type, in replacement of two batteries of another make.

Wishaw.—The Corporation Electricity Department have accepted the following tenders: British Westinghouse Co., one 100-kw. rotary converter; Oliver and Co., Woolwich, 12 9-ampere magazine flame lamps; London Electric Firm, 12 sets of raising and lowering gears.

Leyton.—The Urban District Council have accepted the tender of Siemens Bros. Dynamo Works for the installation of an electric motor at the baths for £13. 7s. 6d.; that of H. Grimshaw and Sons for wiring, etc., at £7. 7s.; and that of Venner and Co. for the annual supply of meters.

Warminster.—The Urban District Council have accepted the tender of J. W. Pitt, Woodcock Ironworks, for the supply and erection of a Tangye 35-b.h.p. gas-engine and suction gas-producer plant and a Daniel's high-speed vertical three-throw pump at the Crockerton pumping station for the sum of £8,601.

Bushbury (Staffs).—The Staffs Education Committee have accepted the following tenders for work at the Council school: J. Caddick, Wolverhampton, painting, constructing heating chamber, etc., £166. 10s.; W. H. Manley and Co., Wolverhampton, providing and fixing new boiler, etc., £40.

Spennymoor.—The Urban District Council have resolved to accept the tender of the Northern Counties Electricity Supply Co. for the public lighting for the ensuing season. The installation will include the provision of 34 lamps of 120 c.p. per lamp, 238 lamps of 50 c.p., and 28 lamps of 36 c.p., or a total of 310 lamps at £2. 10s. per lamp for the season of 10 months.

Grimsby.—On the recommendation of the Electric Lighting Committee, the Town Council have accepted the tenders of Sykes and Sugden, and that of W. Lucy and Co., for the supply of service boxes for the ensuing two years, also that of the British Insulated and Helsby Cables, Limited, at £108. 12s. 3d. for a two years' supply of fuse-boxes, and the tender of John Wilson and Co. at £145 for pipe-work.

London.—The London County Council have received the following tenders for the supply of 362 moulded plough bases for electric cars and stores vehicles: J. G. Ingram and Son, Hackney Wick, 45s. each (recommended for acceptance); India Rubber, Gutta Percha, and Telegraph Works Co., Cannon-street, E.C., 47s. 6d. (less 2½ per cent. discount); Avon India Rubber Co., Melksham, Wilts, 55s.; Dermatine Co., Camberwell, 59s. 6d.

London.—The London County Council have received the following tenders for the supply of (1) 150 outside stringers; (2) 150 inside stringers, and (3) 1,200 galvanised risers for electric cars: G. A. Harvey, Limited, Lewisham, (1) 3s. 4d., (2) 3s. 1d., and (3) 7d. each, less 2½ per cent. discount (recommended for acceptance); E. Le Bas and Co., Billiter-street, E.C., 6s. 6d., 6s. 6d., and 8½d. each; F. Braby and Co., Euston-road, N.W., 7s. 3d., 7s., and 10½d. each, less 2½ per cent. discount.

Victoria.—The States Railways Department have accepted the following tenders: Dorman, Long, and Co. for the manufacture, supply, and delivery of rolled-steel joists, angle braces, etc., for superstructure of Brougham-place subway, Geelong; F. Ziegeler, manufacture, erection, and maintenance, etc., of a four-dial tower clock and all connecting mechanism complete in tower of new station, Flinders-street, Melbourne, £750; and that of the Acme Bolt and Nut Co., 1-in. steel fishbolts and nuts for 80-lb. and 100-lb. rails, £19. 9s. 9d. per ton.

London, W.—The London County Council have received the following tenders for the supply of fittings and the execution of the wiring for an electric light installation at the Great Marlborough-street Fire Station:

G. E. Taylor and Co., 8, Bush-lane, E.C.*	£169 0 0
Pinching and Walton, 52, Cannon-street, E.C.	169 7 6
Tredegar and Co., 56, Victoria-street, S.W.	182 0 9
W. J. Fryer and Co., Bravington Works, Paddington	194 0 0
A. Hawkins and Sons, 125-8, London-road, Southwark	210 0 0

Chief engineer's estimate, £207. *Recommended for acceptance.

Woolwich.—The following tenders have been accepted by the Electricity Committee for the supply of 2,000 yards of three-core ·025 E.H.T. cable, required in connection with the extension of mains to New Eltham:

Callender's Cable and Construction Co.	£396 10 0
Johnson and Phillips	396 0 0
W. T. Glover and Co.	393 0 0
Siemens Bros.	391 0 0
Henley's Telegraph Works Co. (accepted)	384 10 0
Western Electric Co.	383 0 0

Western Australia.—The States Railways Department have accepted the following tenders: Agent-General, 1,000 bars round spring steel ⅜ in. diameter £13. 19s. 9d. per ton, ditto 1⅛ in. diameter £12. 19s. 9d. per ton; Dunlop Rubber Co. of Australasia, 500 vacuum hose washers 25s. per 100, 198 21-in. piston rolling rings 4s. each; McLean Bros. and Rigg, one Cradley boiler, 6 h.p., £84. 10s.; Harris, Scarfe, and Co., 3,207 sq. ft. spark arrester wire, 36 in. by 6 mesh by 16 gauge, 5½d. per square foot; Saunders and Stuart, 3 tons 15 cwt. 21 lb. mild steel, £11. 10s. per ton; J. Martin and Co., 27 cwt. 1 qr. of steel castings, 34s. per cwt.; J. and W. Bateman, 68 cwt. 3 qr. car iron, 4 by 1, £11. 5s. per ton.

Greenwich.—The London County Council have received the following tenders for the supply and erection of the condenser water piping, valves, etc., required for the final portion of the Greenwich generating station:

Foster Bros., Wednesbury	£2,617 0 0
Railway and General Engineering Co., Nottingham*	2 986 14 6
Staveley Coal and Iron Co., Chesterfield	3.024 15 4
J. Spencer, Wednesbury	3,064 5 8
J. Oakes and Co., Alfreton	3,092 18 0
J. Wilson and Co., Lime-street, E.C.	3,183 18 2
S. Russell and Sons, Leicester	3,236 18 0

Chief officer of tramways' estimate, £3,500. *Recommended for acceptance.

Kingston-on-Thames.—The Council have received the following tenders for the supply of two motor fire-engines:

Shand, Mason, and Co.	£1,295
H. Simonis and Co.	1,200
Ditto, alternative	1,025
Argylls, Limited	1,125
Merryweather and Sons	1,045
Ditto, alternative	920
Leyland Motor	1,070
Ditto, alternative	1,025
Halley's Industrial Motors	975
Dennis Bros.*	870

*Recommended for acceptance.

London, S.E.—The London County Council have received the following tenders for the supply and erection at the Greenwich generating station of steam, exhaust, feed, and drain piping, valves, water-tanks, etc., required for the final portion of the station:

Staveley Coal and Iron Co., Chesterfield*	£7,066 7 2
Ditto (alternative)	7,566 7 2
Railway and General Engineering Co., Nottingham	7,342 13 1
Shelby Manufacturing Co., Peckham	7,733 13 3
S. Russell and Sons, Leicester	7,954 9 6
J. Oakes and Co., Alfreton	8,002 19 0
Foster Bros., Wednesbury	8,168 12 0
Stewarts and Lloyds, Glasgow	8,232 9 8
J. Spencer, Limited, Wednesbury	8,291 7 11
Babcock and Wilcox, Farringdon-street, E.C.	8,400 0 0
E. Le Bas and Co., Billiter-street, E.C.	8,495 2 5

Chief officer of tramways' estimate, £9,000. *Recommended for acceptance, with permission to sublet the following portions of the work—viz.: Stewarts and Lloyds, J. Spencer, Limited, or J. Russell and Sons, the steel piping; Newton, Chambers, and Co., the water-tanks; Cresswell's Asbestos Co., the pipe covering.

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Wandsworth.—The Board of Guardians have received the following tenders for retubing four heaters at the infirmary, St. John's-hill, S.W.:

J. and F. May, 33, Whetstone-park, Lincoln's-inn-fields (accepted)	£287	10	0
Z. D. Berry and Sons, Albion Works, Regency-street	289	10	0
Kennington Engineering Works, Lower Kennington-lane, S.E.	293	0	0
Rosser and Russell, Queen's Wharf, Hammersmith	325	0	0
H. and C. Davis and Co., 1, The Pavement, Clapham	373	9	6
A. Goodwin and Son, Sumner-street, Southwark Bridge	422	0	0

PROVISIONAL PATENTS, 1909.

JUNE 24.

14790. Improvements in iron-clad electric switches. Charles Hellyer Pearson, 18, Southampton-buildings, London.

14799. Electric indicator for skittle grounds. Hermann Schlüter, 20, High Holborn, London.

14803. Improvements in and relating to electric searchlights. Siemens Bros. and Co., Limited, and John Harold Bradley, Caxton House, Tothill-street, Westminster. (Complete specification.)

14826. Improvements in electric signalling. Reginald Aubrey Fessenden, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, July 30, 1908, being date of application in United States.) (Complete specification.)

14833. Improvements in or relating to electric switches. Robert Pickersgill Howgrave-Graham, 11, Hatton-garden, London.

JUNE 26.

14858. Improvements in or relating to electric furnace electrodes. Charles Bingham, 8, Breams-buildings, London.

14873. Improvements in or relating to electric clocks. Frank Holden, 83, Cannon-street, London.

14898. New or improved manhole cover for sewers, electrical conduits, and similar purposes. Richard Ames, 72, Ranelagh-road, Ealing, London.

14899. Improvements in electric quantity indicators. Rankin Kennedy, 96, Byres road, Partick, Glasgow.

14911. Improvements in or connected with telegraphic apparatus for use on road vehicles and the like. William Chadburn, Tower-building, Water-street, Liverpool.

14934. Improvements in and relating to electric reflector lamps. Charles Clare Regnart, 29, Anson-road, Cricklewood, London.

14937. Improvements in electrical induction furnaces. Carl Grunwald, 33, Chancery-lane, London. (Application for patent of addition to No. 3,599/09. Date applied for under Section 91 of the Act, Oct. 2, 1908, being date of application in Germany.) (Complete specification.)

14952. Improved method of detecting faulty insulators in high-tension conductors. Richard Greiner, 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, July 20, 1908, being date of application in Germany.) (Complete specification.)

14965. Improved apparatus for avoiding the dangers resulting from excess voltages in distributing mains. Vittorio Arcioni, 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, June 27, 1908, being date of application in Italy.) (Complete specification.)

14972. Improvements connected with the raising and lowering of arc lamps and the like. Adolph Wunderlich and Gwylim Anwyl Hughes, 18, Southampton-buildings London. (Application for patent of addition to No. 25398/07.) (Complete specification.)

14980. Improvements relating to the rectification of alternating electric currents and to devices for use therein. Ernst Fässler, 322, High Holborn, London.

JUNE 28

15006. Improved terminals for shunts and other electrical apparatus. Kelvin and James White, Limited, William Tuxford Evans, and Samuel Biggart Wilson, 65, Chancery-lane, London.

15032. Improvements in third-rail electric railway systems. Charles Kozesnik, 33, Chancery-lane, London. (Complete specification.)

15075. Improvements in circuit-closing contacts. John William Mackenzie, 40, Chancery-lane, London. (Sundh Electric Company, United States.) (Complete specification.)

15081. Improvements in and relating to electric dynamos and motors. Herman Bernard Van Daalen, 18, Southbuildings, London. (Complete specification.)

15086. Improvements in apparatus for automatically establishing and cutting off the supply of electricity, gas, or other fluid. John Hansford and John Frederick Wright, Birkbeck Bank-chambers, Southampton-buildings, London.

15115. Improvements in and relating to electric reflector lamps. Charles Clare Regnart, 29, Anson-road, Cricklewood, London. (Complete specification.)

JUNE 29.

15151. Improved contact finger for electrical controllers, switches, and the like. Robert Crawford Lyness, Prudential-buildings, Mosley-street, Newcastle-on-Tyne.

15158. New or improved method of eliminating or reducing electrostatic electromagnetic induction between contact wires of electric traction systems and adjacent telegraph and/or telephone circuits. Josiah Sayers, Imperial-chambers, Albert-street, Derby.

15167. Improvements in telegraphy. Louis Maxwell Potts, 55, Chancery-lane, London. (Complete specification.)

15182. Improvements in and relating to flame arc lamps. Francis Smith and Francis Victor Smith, 60, Queen Victoria-street, London.

15192. Improvements in the manufacture of metallic filaments for incandescent electric lamps. Société Française d'Incandescence par le Gaz (Système Auer), 24, Southampton-buildings, London. (Date applied for under Section 91 of the Act, July 18, 1908, being date of application in France.) (Complete specification.)

15193. Improvements in the preparation of filaments suitable for incandescent electric lamps. Société Française d'Incandescence par le Gaz (Système Auer), 24, Southampton-buildings, London. (Date applied for under Section 91 of the Act, July 18, 1908, being date of application in France.) (Complete specification.)

15194. Improvements in primary batteries. Wilhelm Alexander Felix Bleeck, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

15203. Improvements in and relating to the actuation of controllers and the like for electric machinery. Herman Bernard van Daalen, 18, Southampton-buildings, London. (Complete specification.)

15210. Improved method for attaching the filaments of incandescent lamps. Jean Canello, 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, July 22, 1908, being date of application in France.) (Complete specification.)

15211. Improvements in electric switches. Walter Herbert Flood, 4, South-street, Finsbury, London.

15217. Improvements in brush-holders for dynamo-electric machines. John Somerville Highfield, 322, High Holborn, London.

JUNE 30.

15270. Improvements relating to time-limit or retarding devices for use in connection with circuit breakers. Electric and Ordnance Accessories Company, Limited, Joseph Richardson Gardner, and Norman Collins, 24, Temple-row, Birmingham. (Complete specification.)

15282. Improvements in or relating to driving mechanism for petrol electric apparatus. Felten und Guilleaume Lahmeyerwerke Akt.-Ges., 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, July 1, 1908, being date of application in Germany.) (Complete specification.)

15287. Improvements in magazine electric arc lamps. Johnson and Phillips, Limited, and James Brockie, Birkbeck Bank-chambers, Southampton-buildings, London.

15298. Improved electric shunt arrangement for watt measurement. Charles Edouard Joules O'Keenan, 70, Chancery-lane, London. (Date applied for under Section 91 of the Act, July 17, 1908, being date of application in France.) (Complete specification.)

15317. Improved electric motor. Carl Heinrich Prött, 231, Strand, London. (Complete specification.)

15319. Improvements relating to dynamo-electric machines constructed with commutators. Robert Pohl and Phœnix Dynamo Manufacturing Company, Limited, 322, High Holborn, London.

15323. Means for diminishing the field excitation of variable-speed electric generators in proportion to their speed of rotation. Henry Leitner, 4, South-street, Finsbury, London.

15326. Improvements in the production of constant-potential electric circuits. Henry Leitner, 4, South-street, Finsbury, London.

JULY 1.

15312 Improvements in or appertaining to electric terminals or binding screws. George Whitley Micklethwait, 9, Tempest Hey, Liverpool.

15345. Improvements in voltage regulators for dynamo-electric machines. Thomas Ferguson, 1, The Mount, Altrincham, Cheshire.

15351. Incandescent electric lamp filament packing or transit box. Francis Harrison, 142, Duke's-avenue, Muswell Hill, London.

15371. Improvements in collector shoes or skates for electric traction systems. Reginald James Houghton, Peter Allman, and William Turnbull Gray, 37, Moorfields, Liverpool. (Date applied for under Rule 13, June 2, 1909. An invention comprised in application No. 12937, dated June 2, 1909.)

15380. Improvements in or connected with high-tension magneto-electric machines. Frederick Richard Simms and Simms Manufacturing Company, Limited, 4, South-street, Finsbury, London.

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15373. Process for preventing the dropping of active material in alkaline accumulators. Leon Marseille and Paul Gouin, 70, Chancery-lane, London. (Date applied for under Section 91 of the Act, July 4, 1908, being date of application in France.) (Complete specification.)

15381. Improvements in or connected with magneto-electric machines. Frederick Richard Simms and Simms Manufacturing Company, Limited, 4, South-street, Finsbury, London.

15385. Improvements in or relating to electric telegraphy. Sidney George Brown, 7, Southampton-buildings, London.

15389. Improvements in electric ignition apparatus for internal-combustion engines. Leonard Albert Hindley, Harold Douglas Hindley, and William Stanford, Boulton, Dorset.

15412. Improvements in and connected with magnetic ore separators. Henry William Buddicom, 18, Southampton-buildings, London.

15413. Improvements in and relating to the jointing of electrical conductors. Charles Vernier, 18, Southampton-buildings, London. (Complete specifications.)

15421. Improvements in and relating to current-collecting devices for dynamo-electric machines. British Thomson-Houston Company, Limited, and William Francis Dawson, 83, Cannon-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on July 15.)

1908.

9800. Electric batteries. Richmond. (Post-dated, Nov. 9, 1908.)

13185. Devices for operating automatic switches applicable for use with electric transformers. Sunderland and Pillinger.

13327. Electromagnetic switch. Venner, Griesbach, and Morris.

13504. Rotors of dynamo-electric machines. Lancashire Dynamo and Motor Company and McLeod.

13520. Control of electric motors. Hartenheim.

13788. Electric meters. British Thomson-Houston Company and Martin.

14773. Switches for supplying electric power. Cooper and Sharp.

15388. Electric accumulators. Van Raden and Co. and Metz.

15523. Transformation of electric currents. Taylor.

17143. Electric telegraphs. Tyer and Dobson.

17161. Means for indicating and recording current leakage in electric circuits or motors. Ashington Coal Company and McKie.

19757. Construction of regulating switch. Gott.

21936. Direct-current dynamo-electric machinery. Midgley and Vandervell.

21938. Direct-current dynamo-electric machinery. Midgley and Vandervell.

23070. Supply and regulation of the electric energy employed in the operation of arc lamps used in searchlights and like apparatus. British Thomson-Houston Company and Pollock. (Application for patent of addition to No. 4379/05.)

23489. High-potential rectifying switch. Snook. (Date applied for under International Convention, July 20, 1907. Originally included in No. 13354/08.)

23908. Electrical apparatus for working planing machines and other reciprocating tools. Vickers, Sons, and Maxim, Limited, and Williamson.

26918. Printer for a multiplex printing telegraph system. Murray.

27343. Alternating-current meters. Siemens-Schuckertwerke Ges. (Date applied for under International Convention, Dec. 17, 1907.)

28271. Single-phase alternating-current meters. H. Aron Elektricitäts Zählerfabrik Ges. (Date applied for under International Convention, Oct. 9, 1908.)

1909.

335. Magnetic separating machines. Rapid Magnetting Machine Company, Thompson, and Davies. (Date applied for under Rule 13, July 14, 1908.)

1345. Aluminium electrolytic cells. British Thomson-Houston Company. (General Electric Company.) (Date applied for under Rule 13, Sept. 4, 1908.)

3831. Armature windings for dynamo-electric machines. Storer. (Date applied for under International Convention, March 2, 1908.)

4863. Magnetic locking device for locking railway-carriage doors, safes, or for other purposes. Fairless and Dixon.

5119. Electric motor-generator sets. British Thomson-Houston Company. (General Electric Company.)

6105. Means for use in connection with the electric ignition gear of motor road vehicles to prevent starting of the vehicle by unauthorised persons. Hay.

6646. Device for converting a series of electrical contacts of short duration into a contact of longer duration. Plato.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos 1-70,000	1	–	½-⅝
—— Ord., 1,125,000	1	–	½-⅝
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	⅜-½
—— Ordinary, Nos. 1-125,000	1	–	11/32-15/32xd
British Aluminium Co., Ordinary, 2,001-40,000	5	–	¾-1
—— 7 per cent. Cum. Pref., 1-40,000	5	–	1½-2½
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	–	2⅞-3⅛
—— 4 per cent. Funding Certificates, 1-20,000	5	–	3-4
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	83-88
—— 5½ per cent. Loch Leven Deb. (Reg.), Red., 1-3,000	100	–	94-99
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	7⅜-7½
—— 6 per cent. Cum. Pref., 1-100,000	5	–	6⅞-6⅞
—— 4½ per cent. Mortgage Debentures	100	–	103 106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	91-96
British Westinghouse Elec. and Manuf. 10 per cent. Pref. 275,001-475,000	3	–	3/16-7/16
—— 4 per cent. Mortgage Debenture Stock	100	–	40-45
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	–	0-¼
—— Non. Cum., 6 per cent., Pref.	2	–	0-¼
—— 4½ per cent. 1st Debenture Stock	100	–	45-48
—— 4½ per cent. 2nd Debenture Stock	100	–	27-31
Callender's Cable, Debentures	100	–	105-107
—— Ordinary	5	–	9½-10½ xd
—— 5 per cent. Pref.	5	–	5⅛-5½
Consolidated Electrical Co., Ordinary, 1-110,000	1	–	7/16-9/16
Crompton and Co., Nos. 1-85,000	3	..	1-1¼
—— 5 per cent. 1st Mort. Reg. Debs., Nos. 1-900 of £100, and 901-1,100 of £50, Red.	—	..	91½-94½ xd
Dick, Kerr, and Co., Ordinary, 1,260,000	1	–	1 1/16-1⅛
—— 6 per cent. Cum. Pref., 1-305,000	1	–	1 3/32-1 7/32
—— 4½ per cent. Debenture Stock, Red.	100	–	99-102 xd
Edison and Swan United, "A" Shares, 1-99,261	5	–	¼-½
—— "A" Shares, 01-017,139	5	–	14-¼
—— 5 per cent. Debentures	100	–	68-73
—— 4 per cent. Deb. Stock, Red.	100	..	93-96
Electric Construction, Nos. 1 to 112,100	2	–	7/16-½
—— 7 per cent. Cumulative Pref.	2	–	1 7/16-1 11/16
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	59-63
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	71-77
General Electric Company (1900) 5 per cent. Cum. Pref.	10	–	7⅛-7½ xd
—— 4 per cent. 1st Mort. Deb. Stock	100	–	85-88
W. T. Henley's Telegraph Works, Ordinary	5	..	11½-12½
—— 4½ per cent. Preference	5	..	5-5½
—— 4½ per cent. Debentures	100	–	105-107
India Rubber, Gutta Percha, and Telegraph Works	10	–	14½-15½
—— 4 per cent. Debentures	100	..	99-101
National Electric Construction Co., 1-170,000	1	–	⅛-¼
Telegraph Construction and Maintenance	12	–	3[illegible]-3½
—— 4 per cent. Bonds	100	–	99-101
White, J. G., and Co., 5 per cent. Cum. Pref., 1-15,000	10	–	9½-10½ xd

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	–	5½-5⅝
Bournemouth and Poole, Ordinary	10	–	9½-10
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9⅝-10⅛
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	10¼-10½
—— 4½ per cent. Debenture Stock, Red.	100	–	99-103 xd
Bromley (Kent) Electric Light and Power Co.	5	–	4½-5
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	93-96
Brompton and Kensington, Ordinary	5	–	8-8½
—— 7 per cent. Preference	5	–	8-8½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-100,000	5	–	5½-6
Cambridge Electric Supply Company, £10 Ord.	8	–	12½-13½
Canadian General Electric Co., Common Shares	$100	–	117-120 xd
—— 7 per cent. Cum. Pref. Stock	$100	–	120-122
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	–	97-100
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	–	3⅞-4⅛
—— 4½ per cent. Cum. Pref., 1-80,000	5	–	4⅛-4⅜
—— 4 per cent. Debenture Stock, Red.	100	..	96-99 xd
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000	5	..	3⅞-4⅛ xd
Chelsea Electricity Supply	5	–	3⅞-4
—— 4½ per cent. Debentures	100	–	100-103 xd
City of London, Ordinary	10	–	10½-11
—— 6 per cent. Cumulative Pref.	10	–	11½-12⅝
—— 5 per cent. Debenture Stock	100	–	120-123 xd
—— 4½ per cent. 2nd Deb. Stk., Red.	100	–	99-102 xd
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	–	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	–	2⅜-2½
—— 5 per cent. Preference, 1-50,000	5	–	3½-3⅝
County of London Elec. Supply, Ordinary	10	..	8⅛-8⅜
—— 6 per cent. Cum. Pref.	10	..	10⅝-11⅛
—— 4½ per cent. Debentures Prov. Certs. All pd., Rd.	100	..	104-107
—— 4½ per cent. 2nd Debentures Prov. Certs	100	..	100-103
Edmundson's Electricity Corporation, Ordinary, 1-80,000	5	..	3/16-5/16
—— 6 per cent. Cum. Pref.	5	..	⅜-½
—— 4½ per cent. First Mort. Deb.	100	..	60-63
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	—	..	86-88 p.c.
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	–	85½ 87½ xd
Folkestone Electric Supply, Ord., Nos. 1-10,000	5	–	4½-5
—— 5 per cent. Cum. Pref., Nos. 1-10,000	5	–	5-5½
—— 4½ per cent. First Deb. Stock, Red.	100	–	98-101
Hove Electric Lighting, Ord., 1-13,000	5	–	7⅛-7
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	5	–	1½-2
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100	–	74-78
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	–	25/32-¾
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5	–	6½-7
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red	100	–	98-101

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Name.	Amount paid. £	Last price. £
London Electric Ordinary	5	1⅞-2⅛
—— 6 per cent. Pref.	5	5⅛-5⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red	100	92-96
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	76-80
Metropolitan Ordinary, 190,001-300,000	5	4⅛-4⅜
—— 4½ per cent. First Mortgage Debenture Stock	100	103-108 xd
—— 4½ per cent. Cum. Pref.	5	4⅜-5⅛
—— 3½ per cent. Mortgage Debenture Red.	100	83⅛-8⅜
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,000 ($500) M 1-4,400 ($1,000) ($500) 4,001-14,000 ($1,000)	—	82-84 p.c. 87-89
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	92-96
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-87,500	5	4⅜-5⅛
—— do. 87,501-137,500 (issued at 21 prem.). All paid (Prov. Certs.)	5	4⅜-5⅛
—— do., 5 per cent. Pref., 1-87,500 (Prov Certs.)	2	4⅜-5⅛
—— 5 per cent. Pref., 87,501-137,500 (Prov. Certs.)	4	4⅜-5⅛
Notting Hill Electric Lighting	10	11⅛-12⅛
Oxford Electric, Ordinary, 1-96 and 40-14,510	5	6-6⅛
—— 4 per cent. Debenture Stock	100	94-97
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,597	1	1⅛-1⅛
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	1 1/32-1 5/32
—— 5 per cent. Debenture Stock, Red	100	102-106 xd
Rosario Electric Co., 5 per cent. Cum. Pref., 1-20,000	5	5 5/16-5 9/16
—— 5 per cent. Cum. 2nd Pref., 1-15,000	5	5⅜ 6
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	102-104
Shawinigan Water and Power. Co., 5 p.c. Cons. 1st Mt. Bds.	—	106-108 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	9/16-13/16
South London, Ordinary	4	⅜-⅝
South Metropolitan Electric Light and Power, Ord.	1	5/16-7/16
—— 7 per cent. Cum. Pref.	1	1 5/16-1 5/16
—— 4½ per cent. 1st. Mort. Deb.	100	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5	8⅜-9⅛
—— 7 per cent. Pref.	5	7-7⅛
—— 3½ per cent. Deb.	100	84-88
Urban Electric Supply Co., Ordinary, 8-30,007	5	⅜-1
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	1⅜-2⅛
—— 4½ per cent. First Mort. Debenture Stock, Red.	100	80-84
Westminster, Ordinary	5	8⅜-9⅛
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	5-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine, 6 per cent. Cum. Pref., 1-250,007	5	5⅛-5⅜
—— 10 per cent. Non-Cum. 2nd Pref., 250,008-280,007	5	9⅛-9⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	137-142
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	101-103
Bath Elec. Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	⅛-¼
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1	19/32-23/32
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	87-90
Blackpool and Fleetwood Tramroad	10	13⅜-13⅝
Bombay Elec. Supply and Trams Co., 5 per cent. Cum. Pref.	10	9⅛-10
—— 4½ per cent. Deb. Stock, Red.	100	93-95
Brisbane Tramway Invest., Ord., 1-75,000	5	5⅛-5⅜
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	5-5⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	100½-104½
British Columbia Electric Railway Co., Ord. Def.	100	142-146
—— Ord. Pref.	100	121-124
—— 5 per cent. Cum. Perpetual Pref. Stock	100	110-113
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	102-104
—— 4½ per cent. Vancouver Power Deb.	100	102-105
British Electric Traction, Ord. 1-30,000 & 60,001-90,000	10	⅛-¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	2⅜-2⅝
—— 5 per cent. Perpetual Debenture Stock	100	88-92
—— 4½ per cent. 2nd Deb. Stock	100	68-72
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	81-86
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	103-107
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	103-106
Buenos Ayres Lacrose Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	93-101
Calcutta Tramways Ord., Nos. 1-137,610	5	4⅜-4⅝
—— 5 per cent. Cum. Pref., Nos. 1-30,000	5	4⅜-5
—— 4½ per cent. 1st Deb. Stock, Red.	100	97½-100½
Cape Electric Tramways, Nos. 1-480,000	1	⅛-¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	4⅜-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	97-101
City of Buenos Ayres Trams. Co. (1904), 1-243,000	5	5⅜-5⅝
—— 4 per cent. Deb. Stock, Red. (1935)	100	98-101 xd
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	98-101
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum. Pref.	10	12⅜-13⅜
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	12½-13½
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	90-95
Hastings and Dist. Elec Tram. Co., 4½ p.c. Deb. Stk., Red.	100	80-85
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000	93-96
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	⅝-1⅛ xd
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	58-63
Kalgoorlie Electric Tramways, 1-250,000	1	1/32-3/32
—— 5 per cent. "A" Deb. Stock	100	88-91
—— 6 per cent. "B" Deb. Stock	100	63-67
Kidderminster and District Lighting and Traction, Pref.	5	9 15/16-10 3/16
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	82½ 80½
—— £236,500 2nd Mort. Deb. Stock	—	—
—— £33,350 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-534,135	1	15/16-1 1/16
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1	15/16-1 3/16
—— 5 per cent. Mort. Deb., 1-5,000, Red.	100	94-98

Name.	Amount paid. £	Last price. £
London United Trys. (1901) 5 per cent. Cum. Pref.	10	1⅛-2⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	63-67
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	90½-93½
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	94-96
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5	4⅛-5
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	86-91
Metropolitan Elec. Trams., Defd., 1,000,001-1 314,016	1	1/32-5/32
—— 5 per cent. Cum. Pref., 600,001-1,000,000	1	23/32-27/32
—— 4½ per cent. Deb. Stock, Red.	100	96½-98½
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	92-94 p.c
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort. Bonds (1926) 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922)	100	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	⅛-¼
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mort. Deb. Stk.	100	100½-103½
Potteries Electric Traction, Ordinary, 1-245,000	1	3/16-7/16
—— 5 per cent. Cum. Pref., 300,001-545,000	1	⅛-¼
—— 4½ per cent. Debenture Stock	100	86-89
Provincial Tramways Co., Ordinary, 1-24,912	10	4-4½
—— 6 per cent. Cum. Pref., 1-10,000	10	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	5⅛-5⅜
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	98-100
Sao Paulo Tramway, Light, and Power Co.	$100	149-150
—— 5 per cent. 1st Mort. Deb., Red. (1929) 1-12,000	$500	97½-99½ p.c
South Metropolitan Electric Tramways and Lighting Co. 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅛-¼
—— 4 per cent. Deb. Stock, Red. (1940)	100	70-74
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red, 1-1,600	100	82-86
Yorkshire (West Riding) Elect. Tram. Co., Ord., 70,001-110,000	5	⅛-¼
—— 6 per cent. Cum. Pref., 1-46,261	5	1⅜-2⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	81-83

Electric Railways.—

Name.	Amount paid. £	Last price £
Central London, Ordinary	100	62-64
—— 4 per cent. Pref.	100	83-85
—— " " deferred	100	45-47
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	101-103
City and South London, Consolidated Ordinary	100	30½-31½
—— 4 per cent. Debenture Stock	100	99-101
—— 5 per cent. Pref. Stock '91	100	110-113
—— " " " '96	100	106-109
—— " " " '01	100	102-105
—— " " " '03	100	93-95
Liverpool Overhead, 5 per cent. Pref.	10	10-10⅛
—— Ordinary, 1-50,000	10	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	102½-103½

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price £
Amason Telegraph Co., 1-25,000	10	2⅜-3⅛
—— 5 per cent. Debs., Red., within 1-1,069	100	92-96
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	97-99
Anglo-American Telegraph Co., Ordinary	100	57-59
—— 6 per cent. Preferred Ordinary	100	100-101
—— Deferred Ordinary	100	15⅜-16
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	102-104
Chili Telephone Co., 1-44,000	5	8-8⅜
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	89-91
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	8⅛-8⅜
—— 10 per cent. Preference, 1-6,000	10	17-18
Direct Spanish Telegraph Co., Ordinary	5	2⅞-3⅛
—— 10 per cent. Cum. Preference	5	8⅛-8⅜
—— 4½ per cent. Debs., 1-600	50	99-101
Direct United States Cable Co.	20	12⅜-13⅛
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	98-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000 (1909)	100	100-102
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy) 1-8 000 (1913)	25	102-104
Eastern Extension, Australasia and China, 1-300,000	10	11½-12
—— 4 per cent. Mort. Deb. Stock, Perp.	100	102½-104½
Eastern Telegraph Co., Ordinary Stock	100	127-130
—— 3½ per cent. Preference Stock	100	—
—— 4 per cent. Mortgage Debenture Stock	100	104½-106½
Great Northern Telegraph Co. (of Copenhagen)	10	25½-26½
Halifax and Bermudas Cable Co., 4½ per cent. 1st. Mort. Debs., within 1-1,200, Red.	100	98-101
Indo-European Telegraph Co.	25	51½-53½
Marconi's Wireless Telegraph Co., Nos. 256,128-384,190	1	25/32-27/32
Monte Video Telephone Co., Ordinary, 1-72,680	1	⅛-¼
—— 5 per cent. Preference, 1-86,432	1	13/16-15/16
National Telephone, Preferred	100	107-109
—— Deferred Stock	100	122-124
—— 6 per cent. Cum. First Pref.	10	10½-11
—— 6 per cent. Cum. Second Pref.	10	10-10⅛
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100	97-99
—— 4 per cent. Deb. Stock, Red.	100	98-101
Oriental Telephone and Electric Company	1	1 5/16-1 7/16
—— 6 per cent. Cum. Pref.	1	1 1/16-1 3/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	98-101
United River Plate Tele. Co., Ordinary, 1-100,000	—	6⅜-7⅛
—— 5 per cent. Cum. Pref., 1-40,000	5	4⅛-5⅛
—— 4½ per cent. Debenture Stock, Red.	100	102-103½
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	98½-100½
West African Telegraph Co.	10	12⅜ 13⅜
West Coast of America, 1-30,000 and 53,001-53,008	8½	1⅛-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	98-101
West India and Panama Telegraph Co., Ordinary	10	9/16-1 1/16
—— 6 per cent. Cum. 1st Preference	10	8⅛-8
—— 6 per cent. Cum. 2nd Preference	10	8-9
—— 5 per cent. Debs., Red., 1-500	100	100½-102½
Western Telegraph Co., 1-207,930	10	13⅛-13⅝
—— 4 per cent. Debenture Stock, Red.	00	93-96

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns week. Ending	1909.	1908	Increase or decrease. Week.	Current year.	Miles of track open. 1909.	1908.	Accounts for past year. Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Mile of track. Passenger	Car mile.	Mile of track.	Cost per car mile.
		£	£	£	£				£						
Aberdeen Corporation	June 20	1,338	1,397	- 259	- 703	87½	87½	May 31	71,930	17,517,304	1,566,119	98	11·02	4,940	5·95
Ayr Corporation	July 3	200	378	- 78	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	,, 3	3 2'0	2,970	+ 240	+ 7,710	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 4	1,232	1,218	+ 14	- 440	23·63	23·63	—	—	—	—	—	—	—	
Birmingham Corporation	June 26	6,480	6,266	+ 214	—	56 782	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 20	1,063	1,295	- 232	- 468	28 3	28 3	—	—	—	—	—	—	—	—
Blackpool Corporation	July 1	1,516	1,831	- 315	+ 773	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Aug. 8	2,304	2,329	- 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	July 4	2,546	2,693	- 147	- 703	42	42	March 31	117,799	25 492 902	2,492,147	1·1	11 34	2.804	6·50
Bournemouth Corporation	June 30	1,507	1,625	- 118	+ 118	29¼	29½	,, 31	86,225	13,991,328	1,766,068	1 47	11·71	2,912	7·22
Bradford Corporation	,, 26	4,742	5,133	- 391	+ 962	98½	98½	,, 31	235,258	47,839,569	5,331,007	1 17	10·59	2,378	—
Brighton Corporation	July 4	1,023	1,018	+ 5	+ 703	—	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	,, 2	5,876	5,601	+ 275	—	57	51½	Dec. 31	265,362	46 652 389	5,756 842	—	—	—	—
Burnley Corporation	,, 3	1,245	1,420	- 75	—	19½	19½	March 31	64,261	12 355,958	1,202,330	1·23	12·83	5,971	7·98
Burton Corporation	,, 4	268	286	- 18	- 84	10	10	,, 31	14,9 8	3,221,596	430,915	1·04	8 30	1,460	5 85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	,, 31	109,979	25,058,146	2,497,169	—	10 57	—	—
Carlisle Tramways Company	June 19	170	175	- 5	- 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	July 3	5,645	7,003	-1,358	-18,554	6 32	5·77	Dec. 31	350,150	41,896,373	1,476,781	2·01	5·769	55,404	30 2·6
Charing X, Baston, & Hamp. Ry	,, 3	3 8'0	3,380	+ 500	+16 450	—	—	—	—	—	—	—	—	—	—
City and South London Railway	,, 4	3,2.7	3,102	+ 155	+ 1,514	—	—	—	—	—	—	—	—	—	—
Colchester Corporation	May 26	176	190	- 14	—	8	—	March 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6 56
Cork E. T. and L. Company	July 1	537	585	- 48	- 985	—	—	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4 45
Croydon Corporation	June 25	1,422	—	—	—	11½	—	March 31	74,132	16,277,418	1,884,137	1 06	9 56	3,703	7 109
Darwen Corporation	,, 18	253	233	+ 20	- 78	7·23	7·23	,, 31	13,194	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	,, 26	199	227	- 28	- 168	7	—	,, 31	11,593	2,697,672	316,764	·98	8 78	—	—
Dublin and Lucan Electric Ry.	,, 30	115	116	- 1	+ 252A	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	July 2	5,834	6,632	- 798	- 343	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	June 20	1,202	1,301	- 89	- 360	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7 46
East Ham Corporation	July 3	987	891	+ 96	+ 2,022	15	15	March 31	47,430	15,355,703	1,091,586	·73	10 26	—	6 96
Glasgow Corporation	June 26	17,389	19,135	-1,746	+ 320	185½	179	May 31	907,494	226,948,290	20,766,722	·96	10 49	5,08	5 89
Gloucester Corporation	,, 30	545	262	+ 283	+ 584	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton.	July 3	5,650	5,250	+ 400	+ 9,775	—	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	March 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	June 26	1,565	1,668	- 103	+ 666	28½	28½	,, 31	84 704	16,200,020	1,960,329	1·29	10 37	2,421	5 10
Hull Corporation	July 4	2,562	2,406	+ 155	+ 317	26	26	,, 31	128,722	30,964,254	3,022,844	1	10·22	—	6·04
Ilford Corporation	June 26	488	478	+ 10	+ 565	10	10½	,, 31	25,378	6,385,466	634,446	·87	9 58	2 066	6·42
Ilkeston Corporation	,, 20	140	148	- 8	- 144	4	4	,, 31	7,214	1,968,850	198,415	9 1	7·9	1 803	7·04
Kirkcaldy Corporation	,, 20	244	265	- 21	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	,, 30	1,463	1,802	- 339	- 449	39	39	Dec. 31	68,904	12,551,593	2,244,344	—	—	—	—
Leeds Corporation	,, 26	6,810	6,919	- 119	+ 2,903	96½	96½	March 31	340,768	75,734,083	7,694,989	1·06	10 62	3,527	5·51
Leicester Corporation	July 3	2,304	2,344	- 40	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	June 26	10,879	11,129	- 360	- 3,208	104	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	July 4	1,539	1,493	+ 46	—	6 65	2 40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	,, 6	36,655	35,632	+ 663	+20,355	121	115½	March 31	1274,660	279,166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	June 26	177	209	- 32	- 633	3½	—	Sept. 30	11,399	2,645,206	370,39	1·03	7·36	3,279	6·12
Maidstone Corporation	,, 26	171	202	- 31	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 26	14,658	15,975	-1,313	- 862	181	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	July 3	10,343	9,188	+1,155	+25,066	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	June 27	17,416	16,905	+ 511	+13,512	24½	24½	June 30	680,357	99 846,735	—	1·46	—	—	—
Nelson Corporation	July 3	112	149	- 18	- 94	2½	2½	March 31	7,362	2,060,712	204,7..	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	,, 3	3,546	5,232	- 1 685	- 1,412	60½	59½	,, 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·38
Newport (Mon.) Corporation	June 26	615	667	- 52	- 197	14½	14½	,, 31	35,531	8,174,003	798,029	1·04	9 89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	- 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	March 31	97,741	21,247,048	2,309,479	1·10	10·15	—	
Reading Corporation	July 1	624	676	- 52	+ 112	13½	13½	,, 31	32,769	7,933,672	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	,, 31	56,558	10,196,148	1,252,925	1·32	10 83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	- 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	June 28	4,378	5,137	- 759	- 2229	78	74½	March 31	244,065	45,771,511	5,486,150	1 25	10·67	3,185	
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Sheffield Corporation	,, 27	5,692	5,723	- 31	- 1,219	68½	66½	March 25	289,745	17,568,686	7,065 380	·856	9 842	4,225	5·09
Southampton Corporation	,, 20	1,058	1,170	- 112	- 447	18	18	,, 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	,, 30	500	488	+ 12	+ 901	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	March 31	52,004	9,155,172	1,335,911	1 34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	- 26	- 7,584	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	June 30	133	150	- 17	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	July 1	305	340	- 35	—	5·16	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	June 26	920	957	- 37	+ 373	12 68	12·45	March 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	,, 24	2,460	2,385	+ 65	+ 1,831	14·7	14·7	March 31	122,881	35,502,836	2,566,854	·789	10·96	4,417	6·79
Wolverhampton Corporation	,, 30	770	857	- 87	—	20½		,, 31	44,432	3,440,369	975,714	—	10·929	2,190	6·309

a Train mile. b Half-year's figures.

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THE

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DOMESTIC ELECTRIC HEATING AND THE CENTRAL STATIONS.

There can be no doubt that the cost of wiring premises has retarded the expansion of electricity supply in this country. Persons of limited means have been unwilling to incur the expense, whilst others, holding premises on short agreements, even though possessed of means, have objected to bear the cost of wiring the premises. It is in order to meet circumstances such as these that many electricity supply undertakers have themselves adopted a house-wiring scheme, taking their remuneration in the shape of quarterly rentals, purchase instalments, cash payments, or whatever the case may be. Without entering upon a discussion of this policy, which, notwithstanding all that has been urged against it, has added remunerative consumers of electricity who would not otherwise be reached, we may ask whether its extension so as to include electric heating and cooking devices would not be an advantage? At all events, no one can gainsay the general advantage which would accrue if the central stations were brought more into touch with the users of these appliances. This seems to be the policy in America, where we learn from an interesting article by Mr. W. H. Wissing, which appears in the *Electrical World*, that the sale and hire of electrical devices for domestic purposes is undertaken by many central stations on sound commercial lines, and with satisfactory results. Mr. Wissing is connected with the supply company in St. Louis, and his article in our contemporary is a strong endorsement of the practice of the central station company in that city of selling electric heating appliances with a guarantee by which the company assumes all responsibility of replacing defective devices. The prices charged are somewhat higher than usual rates—24s. for a 6 lb. iron, and other prices in proportion. With this, however, the company practically assumes the responsibility of maintaining these appliances in good condition indefinitely. It appears that irons have been sold at a considerably less price by St. Louis department stores, but without any guarantee. The policy of maintaining irons and heating appliances is somewhat akin to the policy of free lamp renewals so far as the central-station company is concerned. Both policies ensure good service to the consumer. It is no advantage to a central-station company to have a lot of electric irons and other devices in its consumers' houses which are not in use on account of small defects. Many central-station companies have practically assumed the maintenance of electric irons and cords without so guaranteeing at the time of sale, as they have felt that to charge for repairs of this kind would be to discourage the business in its beginnings. Then with regard to electric radiators, the policy of the St. Louis company in advising the users as to the best purpose which this apparatus is designed to serve, is also a wise one. The company issue a notice which begins with the warning that the 750-watt radiator will cost 4½d. per hour to operate, and the 1,500-watt 9d. per hour; that to attempt to use it for general heating is at present absurd, but that for temporary use in the morning while dressing, for additional heat in the bathroom or nursery, it is ideal and not expensive. The customer thus prepared does not come back with complaints about excessive operating costs. He uses them for the purpose intended, likes them, and commends them to others. This is a much sounder policy than the indiscriminate "pushing" of domestic electric devices, of which we come across numerous examples in this country. Central-station managers have something to learn from their gas friends in this matter. The latter not only interest the public in gas cooking apparatus, but they recommend the best makes to customers,

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maintain the apparatus in their houses in good condition and repair, and do everything else in their power to inspire public confidence in gas cooking. It would be well to acknowledge that at present there are limits to electric heating and cooking, that under certain conditions it is not wholly advantageous. Much more would be done towards advancing the domestic uses of electricity if the central stations were brought into closer touch with users, so that the latter could rely upon the central-station engineer to advise them that the type of apparatus they were about to adopt was the most reliable, and that the purpose for which it was intended the best.

THE ELECTRIC LIGHTING BILL.

The letter which appears in our correspondence columns from the pen of Mr. E. Garcke directs attention to the shortcomings of the Electric Lighting Acts (Amendment) Bill now before a Standing Committee of the House of Commons. Now that there is at least a reasonable hope for the passing of the Electricity Bill which has been introduced every session during the past few years under the auspices of the Board of Trade (only to be included each time in the massacre of the innocents at the end of the session), it is a thousand pities that it should appear in a form which is objectionable to those connected with the industry. The Government, or their advisers in this matter, must be entirely out of touch with the movement for reform which has been going on for some years within the industry, or else they are determined to show a singular disregard to the voice of those who will be most affected by their Bill, for their entire policy seems to be carried on without regard to the interests of the electrical supply industry. The Bill will fail to ameliorate the onerous conditions imposed upon supply undertakers, and it will, moreover, fail to remove one of the greatest obstacles to progress—viz., the hostility between local authorities and companies, which has been brought about simply by the imperfections in the laws controlling electrical enterprises. When the Bill came before the House of Commons it was hoped that the Government would accept a motion that the Bill would be referred to a Select Committee, so as to give the industry an opportunity of obtaining amendments on clauses. This was not to be, however, and the Bill has been referred to a Standing Committee, which will preclude the views of the industry being put forward. This is but one more incident which emphasises still further the need for an influential and representative organisation to look after the interests of the electrical industry. The shrinkage which is shown alike in the business of electrical manufacturing, electric traction, and electric supply is in a large measure due to the disjointed condition of the operating branches of electrical enterprises, and in order to maintain the vigour of the industry as a whole, organisation is an urgent necessity.

COAL TRADE CRISIS.

The crisis in the coal trade, which we thought had been passed with the settlement of the dispute in South Wales, has broken out afresh in Scotland, and at the moment of writing the news to hand gives little encouragement to hope of a peaceful solution. Into the merits of the dispute we need not enter, nor need we emphasise the fact that a disastrous blow will be dealt to the engineering centres of Scotland if a strike is not averted. It is sufficient simply to draw attention to the serious position of those electricity works which are dependent upon an uninterrupted supply of coal. The question of alternative stand-by plant in large central stations serving important industrial areas is once more brought prominently forward by recent events in mining circles, and it deserves the consideration of electrical engineers, who are liable to be heavily handicapped by labour disputes in the coal mining industry. The Scottish Miners' Federation have taken up a very militant attitude on this occasion, and the executive committee have made preparations for calling all the men out on the 26th of this month, when the reduction announced by the masters becomes operative. Of course, a conflict may yet be averted, but the present situation should serve as a warning to electrical engineers to make preparations in order to meet contingencies raised by a stoppage of their coal supplies.

IS CENTRAL-STATION WORK PLAYED OUT?

BY S. L.

Is central-station work—as a calling—played out? An observer of the progress of the electrical supply industry during the past few years cannot fail to have noticed the rapidly increasing growth of a certain type of individual that, for want of a better name, we will call "assistant." He enters the profession in various ways, sometimes as "junior assistant"; frequently as "improver," but in the majority of cases as a pupil, usually premium. In the first and second cases, occasionally a small salary is offered. The premium in the latter may take quite a variety of forms, and not always without a dash of novelty attaching to it. It has even been announced to aspiring Edisons or the guardians of same that a trifle in the way of a motor cycle would be accepted, which is, by the way, to say the least of it, a very modest charge for "a thorough training in all branches" when compared to the hundreds of pounds required by some firms for the privilege of passing through their works, with perhaps the not very remote chance of enabling the "premium" to qualify ultimately for entry in the central-station world as "assistant" (on the usual "training for service" terms) who has been through the shops.

At the present day there are hundreds of men in central stations whose only qualification was the premium paid for their entry therein. Instances are not wanting of men well out of their teens having abandoned good positions and callings to enter this branch of the electrical engineering profession after hearing some "know-all" dilating at length on the glorious prospects in that profession, which is still, and, judging from what the man in the street says, is ever likely to remain in its infancy. These misguided worshippers of Electra have been known to leave lucrative posts for entry into a central station at nothing per week except, perhaps, what is popularly known as the chance of a promise. In many cases such changes of vocation have received the full sanction of the young aspirant's parent or guardian. It seems somewhat strange why an otherwise cute business man should be a party to a change of such momentous importance in the career of his son, yet it often happens. It may be that the seeds of discontent are first sown in the mind of the would-be engineer by the perusal of a speciously-worded advertisement, or may be that otherwise well-meaning individual who finds access to all our family circles, and who always seems *au fait* with the latest scientific discoveries and improvements, may fire up young hopeful with glowing stories (in more than one sense) of how Edison and other such geniuses rose. One finds this class of raw, untrained individual in a surprisingly large number of stations. What his prospects are, goodness knows! Oftener than not he is allowed to simply wander about the works as he pleases, which, perhaps, would be as well were it not for the undoubted bad influence such slack discipline has on the employés whom he comes in contact with. Another and, perhaps, more serious phase of the question is, what happens when the pupilage period is up? Far too frequently an unwritten promise is given to the premium pupil's guardians that a salaried opening on the regular staff will be offered the young man on the completion of his term. This may take the form of a few

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shillings per week, or may even mean the replacing of an employé by the pupil at a fraction of the former's wages. A case in point was that of a pupil of a little over 12 months' standing who was pushed into the vacancy caused by the resignation of a shift engineer, at considerably less than half the latter's salary. The other shift engineers naturally, of course, made an indignant protest, particularly against an arrangement whereby the late pupil was to take regularly the day watch, which was the lightest duty, until the new man "got used to the running," but the only consolation they received was, "Take it or leave it." In this case the pupil was one of a batch of four who were literally pitchforked into the station, the cash premiums paid for their entry, which were considerable, being the perquisites of the chief engineer. The fact that the chief contemplated a move may have had some bearing on the lucky pupil's rise. Anyway, he (the chief) left shortly afterwards, his committee having declined to allow him the privilege of restocking the works with further premium pupils. Before leaving the chief presented his four protégés with long glowing testimonials describing each as "junior assistant." The lads—they were little more—entered the station in question raw from school, and received as great a written mis statement as was ever put on paper, representing something like a spell of 18 months' idleness.

There are hundreds of this type of man turned out every year, ready and eager to take anything in the way of an opening (salary immaterial) in central-station work. The past few years has seen a steady decline in the rate of pay for station workers, particularly shift operators, until now, at the present time, it is almost useless for a really competent man to apply for a job vacant at a decent living wage. If further proof were needed of this fact, the advertisement columns of not only the technical journals but those of the lay Press would furnish it. The smaller stations mostly seem to harbour this kind of labour, usually on the score of economy (?). And in some cases the heads cut down wages in this manner to help on non-paying works, or to augment the meagre salary of their own under-paid selves. Is it not time a halt were called in this mad rush for entry into an already vastly overcrowded and poorly-paid calling, which offers little or no prospects to the really ambitious and conscientious worker?

THE ENGINEERING OF ORDNANCE.

At the anniversary meeting last week of the Junior Institution of Engineers, Lieutenant A. Trevor Dawson delivered the Gustave Canet lecture on "The Engineering of Ordnance." The lecture was a lucid exposition of the enormous development which modern ordnance has undergone in the last 20 years. It is not possible, however, to do more than note here one or two of the applications of electricity connected with the manipulation of the gun, which the author touches upon in that section of his paper showing the influence of mechanics on ordnance. The breech mechanism of the gun designed by the late M. Canet can be operated either by percussion or electricity. In the electric firing arrangement no contact is obtained before the gun is closed, so that the gun cannot be fired prematurely; when it is fired by percussion the gear has to be held by a spring "catch." In the case of the "Elswick" single-motion breech mechanism for a quick-firing gun, the firing gear is of the combined electrical and percussion type. The breech mechanism of the Vickers gun is arranged so that it may be operated either by electric or hydraulic gear.

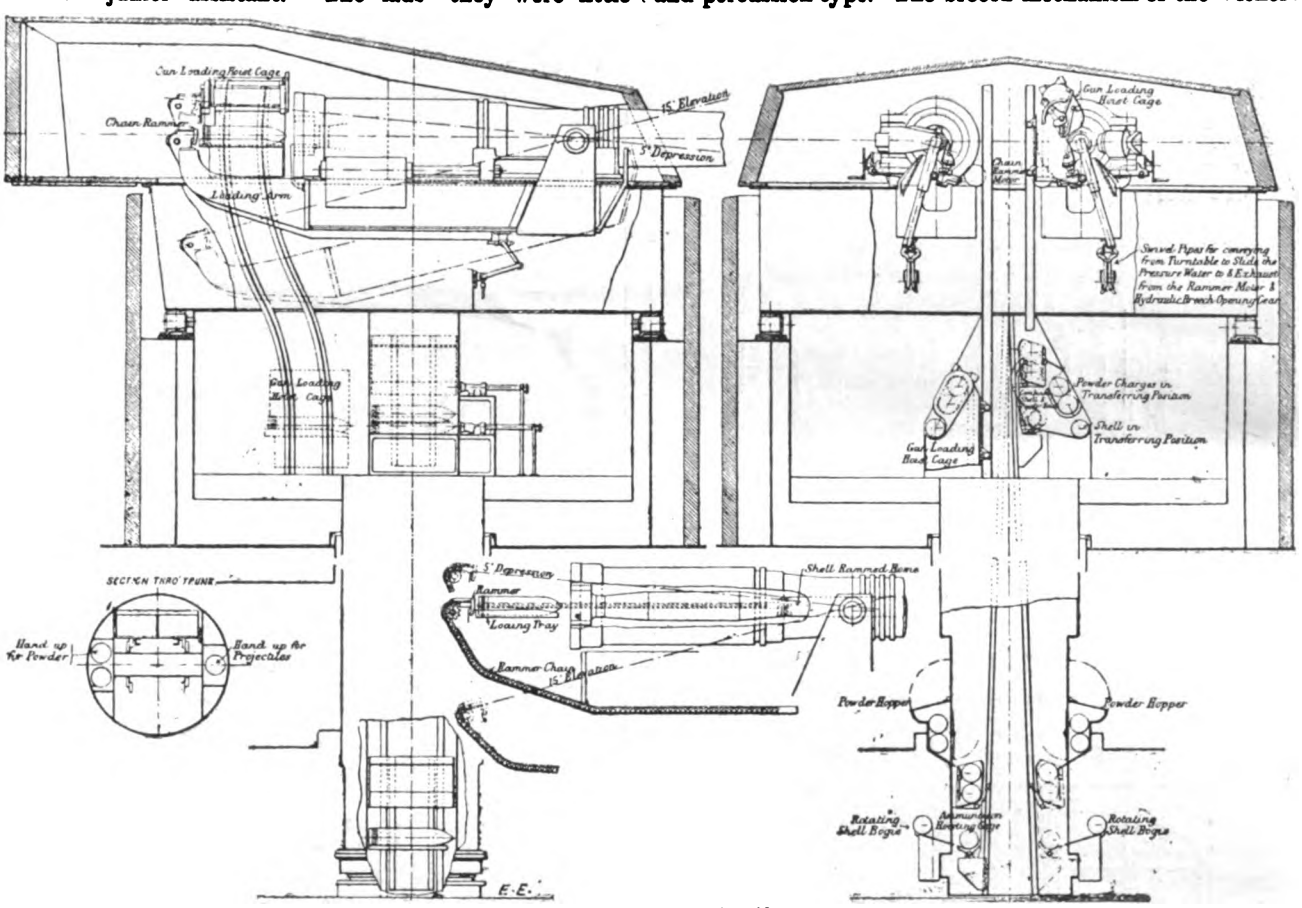

FIG. 1.—Hydraulic Mounting for Two 12-in. Guns.

Lieutenant Dawson discussed the comparative merits of hydraulic or electric power for working heavy ordnance after describing their application. Fig. 1 illustrates one of the latest examples of hydraulic mounting. We need not draw attention to the details of this illustration, which are self-evident. The training of the turret is effected by hydraulic motors. Electric motors are sometimes fitted as a provision against complete breakdown, but they are only intended to turn the turret at a slower speed—at from 1 deg. to 2 deg. per second. In Fig. 2 there is illustrated an electrically controlled mounting, which, in its main features, differs from the hydraulic mounting only in the nature of the motive power used for the various operations. The supports of the gun, the turn-table, working chamber, and hoist trunks are generally similar in structure, but the hydraulic engine is substituted by an electric motor with a special controller and frictional attachments to prevent undue straining. The motors for training the guns are arranged to turn the turret at a speed of 3 deg. to 4 deg. of arc per second when the ship is inclined to 8 deg. In the absence of hydraulic power the gun is returned

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to the firing position by springs or compressed-air cylinders, air pressure being always available from the torpedo department. In the mounting illustrated (Fig. 2) four sets of springs are provided with sufficient power to hold the gun in the firing position at the maximum angle of elevation—35 deg. in this case. The elevating of the gun is also accomplished by electric motors with worm gearing. There is also in the working chamber hand gear, which is interlocked with the motors so that both cannot be in operation simultaneously. This hand gear also rotates a worm actuating a pinion in gear with a curved tooth rack on the underside of the gun-slide frames. The ammunition elevators have electric and hand winches, and the rammer is also worked by an electric motor with worm gearing instead of by an hydraulic engine.

Discussing the relative advantages of hydraulic and electric mountings, Lieutenant Dawson said: "Although the hydraulic system has many qualities which make it preferable

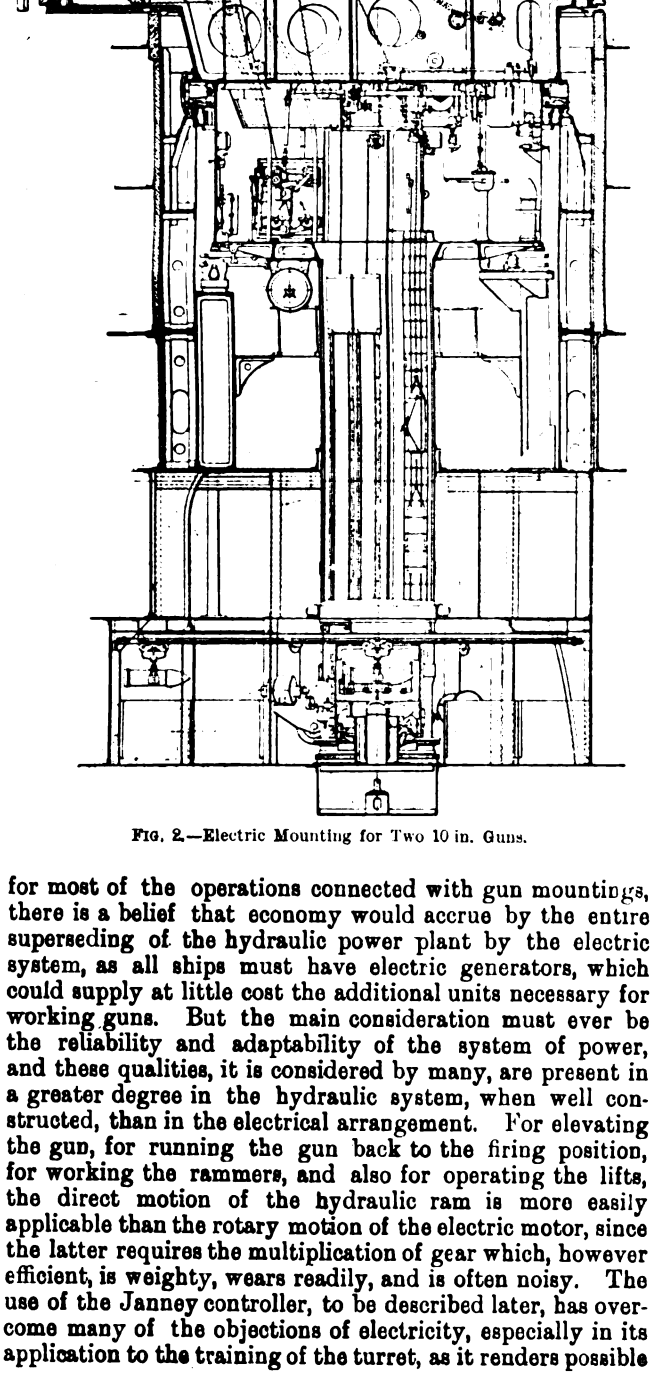

FIG. 2.—Electric Mounting for Two 10 in. Guns.

for most of the operations connected with gun mountings, there is a belief that economy would accrue by the entire superseding of the hydraulic power plant by the electric system, as all ships must have electric generators, which could supply at little cost the additional units necessary for working guns. But the main consideration must ever be the reliability and adaptability of the system of power, and these qualities, it is considered by many, are present in a greater degree in the hydraulic system, when well constructed, than in the electrical arrangement. For elevating the gun, for running the gun back to the firing position, for working the rammers, and also for operating the lifts, the direct motion of the hydraulic ram is more easily applicable than the rotary motion of the electric motor, since the latter requires the multiplication of gear which, however efficient, is weighty, wears readily, and is often noisy. The use of the Janney controller, to be described later, has overcome many of the objections of electricity, especially in its application to the training of the turret, as it renders possible the high precision of movement obtainable with the hydraulic motor. From the point of view of safety there is much to be said in favour of hydraulic power. Damage is at once located, and is easily repaired, whereas short-circuiting might seriously affect the working of the turret and fusing might cause ignition of explosives. As regards weight, neither of the systems appears to have any advantage over the other, when there is reckoned against the hydraulic power the water-tanks, pipes, and the reserve supply of water. But in the case of hydraulic mountings the weights are carried lower down in the ship than those of the electric system; this affects stability advantageously."

A machine of special interest in connection with electrically-operated turrets is the Janney controller, illustrated in Fig. 3. Electric motors are not very successful under conditions where large variation of speeds and frequent reversal of action are required. This is pre-eminently the case with the training of turrets or moving the gun in elevation. It can readily be imagined how continually the operations of a motor for elevating would be varied when the gun is being kept on the "object" during the rolling of a ship in a seaway. The Janney controller gets over all the difficulties in the electric motor in respect of varying speeds and frequent reversals. It permits the motor to run at constant speed and in the same direction—

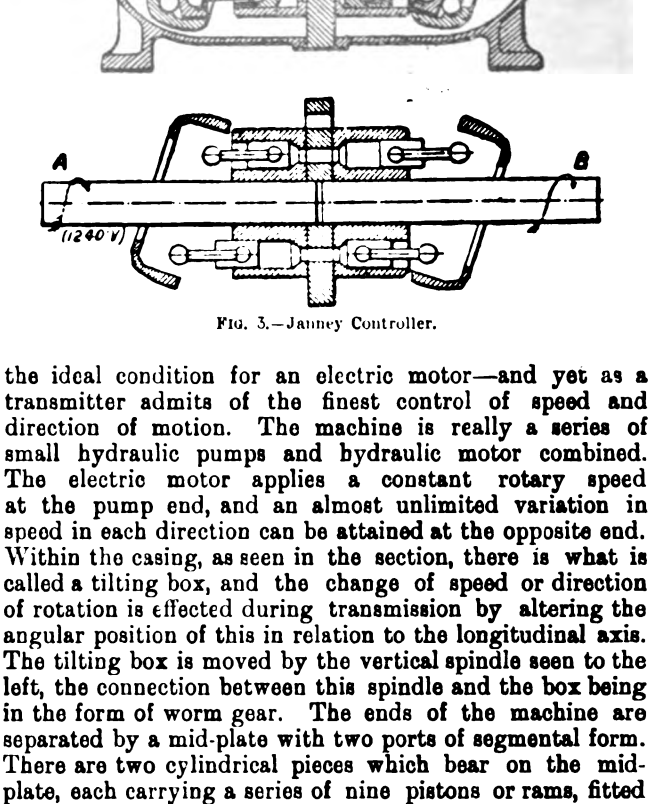

FIG. 3.—Janney Controller.

the ideal condition for an electric motor—and yet as a transmitter admits of the finest control of speed and direction of motion. The machine is really a series of small hydraulic pumps and hydraulic motor combined. The electric motor applies a constant rotary speed at the pump end, and an almost unlimited variation in speed in each direction can be attained at the opposite end. Within the casing, as seen in the section, there is what is called a tilting box, and the change of speed or direction of rotation is effected during transmission by altering the angular position of this in relation to the longitudinal axis. The tilting box is moved by the vertical spindle seen to the left, the connection between this spindle and the box being in the form of worm gear. The ends of the machine are separated by a mid-plate with two ports of segmental form. There are two cylindrical pieces which bear on the mid-plate, each carrying a series of nine pistons or rams, fitted with connecting rods with ball ends. The outer ends of the connecting rods engage a ring or disc carried on a ball race. That at the driven end, generally called the A end, is supported in the tilting box; while in the other end, known as the B end, the ball race is supported in a suitable bearing piece set at a permanent angle. The cylindrical pieces carrying the pistons, as also the bearing rings, are keyed or otherwise secured to their respective shafts, so as to rotate together. The function of the end A is to deliver oil under pressure to the end B. After doing useful work in causing rotation of the

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B end shaft, it is received back again in the A end. There is thus a continuous oil circulation so long as the A end is running, the quantity of oil so circulated depending on the angle of the tilting box. The action of the plungers of the A end is identical to that obtaining in any pump. There is the pumping or pressure stroke and the suction stroke for each revolution of the shaft; about half the number of plungers are pumping the oil while the remainder are acting in suction. Similarly in the B end about half the number of the pistons are receiving pressure at each half revolution, while the others are exhausting. By tilting the box in the opposite direction to that shown on the illustration, the periods of delivery and exhaust are reversed, and thereby a corresponding reverse rotation will take place in the B end of the shaft.

There is almost no limit to the scope of such a transmission and controlling gear, because of the great range in the control and direction of rotation, and there can be no doubt that it will be a great factor in the development of electric mountings for guns. Hitherto the training of the turret by electrical means has involved the use of special motor-generators and complicated electric leads for varying the voltage at the operating motor terminals, in order to obtain a large variation of speed. In this new device no reversing of the electric motor is necessary to obtain a reverse direction of rotation, and any speed can be obtained from zero up to the maximum in either direction. The apparatus is very simple, and the effort required for control is small; with the driving motor running at maximum speed it can work so slowly that the movement of the turret, for instance, is imperceptible, and associated with this low speed is a greatly increased turning effort.

TELEPHONE EXCHANGE FIRES.

Mr. D. H. Kennedy, A.M.I.E.E., contributes a most interesting article to the July issue of the *Post Office Electrical Engineer's Journal* on "The Paris Fires and After." It describes the details of the central telephone exchange in Paris which was burned out on Sept. 20 last year, and shows how the construction of the same helped the fire to spread. The firemen attempted to enter the basement, where the fire appears to have originated, but in spite of their masks they were unable to do so; and this can be readily understood when it is stated that half a million yards of paraffined jumper wire was aflame on the distribution frame. Unfortunately, the cable shafts leading from the basement to the first, second, third, and fourth floors were not blocked. They, therefore, formed chimneys up which the flames rushed. On each floor, except the first, the shafts communicated with the false floors of the switchrooms. It was due to this fact that one hour after the fire began the first and second floors were burning, and an hour later the third floor was also ablaze. The immediate consequence of the fire was the throwing out of service of 18,000 subscribers' lines (out of a total of 43,000 in Paris); 10,000 junction lines and 450 trunk lines, together with the distribution frame connecting the cross-town junction between the other offices. It can thus easily be realised that on the following day Paris was thrown back into the pre-telephone age, and business men felt that the nation had sustained a serious disaster.

The author describes the prompt measures adopted for the construction of a temporary exchange, which commenced to give partial service early in November. By Dec. 5 the service had practically been restored. The cause of the fire is still under investigation, but the fact that the main frames had neither fuses, lightning protectors, nor heat coils, points to an electric cause for the ignition of the wires.

The author points out that the same lack of protective devices is found on the temporary main frame now in use. He concludes his article by stating the measures in connection with fire prevention which, at the present time, are regarded as desirable in connection with large exchanges

1. *Measures to Prevent Outbreak of Fire.*—(*a*) Limitation of voltages to low values; (*b*) provision of conductors of suitable diameter for current density; (*c*) efficient protection of main frames (heat coils, fuses, and lightning protectors); (*d*) use of efficient flameproof wire; (*e*) interposition of resistances in circuits to limit values of outgoing currents.

2. *Measures to Prevent the Spread of Fire.*—(*a*) Use of uralite under flameproof jumpers; (*b*) fireproof sections with metal separating shelves; (*c*) vertical and horizontal channels blocked at intervals to prevent through draughts; (*d*) fireproof building with steel bulkhead doors for isolating sections of the building; (*e*) use of wired glass for windows and partitions.

3. *Measures for Fire Extinction.*—(*a*) A trained fireman in constant attendance who is technically acquainted with the building and plant. (*b*) Male employés trained to act as a fire brigade. (*c*) An efficient system of fire-alarms. (*d*) Asbestos cloths a yard square, in red tin cases, should be provided on a liberal scale and in conspicuous positions, with instructions as to their use for smothering flames. (*e*) Ample provision of sand, with instructions as to its use in preference to water. This should be in buckets, not too large, and there should be not less than six at any given point. Such buckets should be numbered conspicuously, so that the absence of one will be at once evident. (*f*) Small chemical extincteurs may be provided, or small hand pumps for use only in extreme emergency. (*g*) A high-pressure fire-main of at least 3 in. diameter, with hydrants fixed at points where they can be safely operated without danger to life. A nozzle and a long length of hose should always be connected, and the hose should be doubled back on itself, so that it would only be necessary to turn the wheel, take down the nozzle, and run to the fire. The hose should unwind automatically, assisted by the pressure of the water. (*h*) With a view to preventing loss of human life, regular fire drills of the operating staff should take place. (*i*) All doors should open outwards, and all doors and corridors and stairways should be of ample width, and should be kept clear of obstructions. For high buildings iron emergency outside stairs should be provided.

ELECTRIC COOKING BY "SILUNDUM."

One of the greatest drawbacks in connection with cooking by electricity is the rapid deterioration of much of the apparatus used and the consequent costliness of electric cooking. The British Prometheus Company, Limited, Salop street Works, Highgate, Birmingham, have been experimenting for some time past with a heating element which would not deteriorate so rapidly as most of those in use, and they have now introduced a new system of incandescent cooking using this new metal—"Silundum." This material is a product of the electric furnace, and among its many extremely valuable properties we would point out that it can be heated in air to a temperature of approximately 3,000 deg. F. without entering into combination with the oxygen or other gases of the air. The manufacturers assert that skilfully conducted experiments have demonstrated that Silundum cannot be melted, and is, therefore, a truly refractory material, and, moreover, it will withstand the attacks of acids. The process of manufacture permits the production of Silundum rods especially applicable for electric cooking apparatus, and, therefore, such apparatus may be worked at incandescent temperatures without oxidisation. If practical experience should bear out this claim, electric cooking will have made an immense advance, for there has hitherto been no satisfactory system of working electrical resistances at a high temperature.

After years of experimenting, the British Prometheus Company, Limited, have succeeded in producing cooking utensils on a commercial scale, which seem to embody a a highly satisfactory method of high-temperature electric heating. The system may be described briefly as follows: For practical purposes the rods are assembled in units, free from self-induction, and are protected from mechanical injury by a grid or grating. The Silundum units will not in any way be damaged by the spilling of water or grease, and this highly important advantage of Silundum grills and hot-plates is one that will appeal to all electrical engineers who have had experience in the use of electric cooking

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apparatus. Silundum enables the concentration of a higher loading on a given area than heretofore, and thus makes it possible to carry out cooking operations in ordinary utensils; the clean and efficient electric fire replacing the fume-emitting coal or gas fire. It may be pointed out that useful sets of cooking apparatus may now be employed by the use of, say, a Silundum oven and grill in conjunction with separately heated utensils, constructed on the Prometheus strip system. Experience has shown that for heating large quantities of liquid the Prometheus strip system attains in many cases an over-all efficiency of approximately 97 per cent., and is, therefore, to be recommended for such purposes.

Ovens, breakfast cookers, grills, toasters, and hot-plates, each of which works at a glowing red heat, are now manufactured on this system. The miniature incandescent

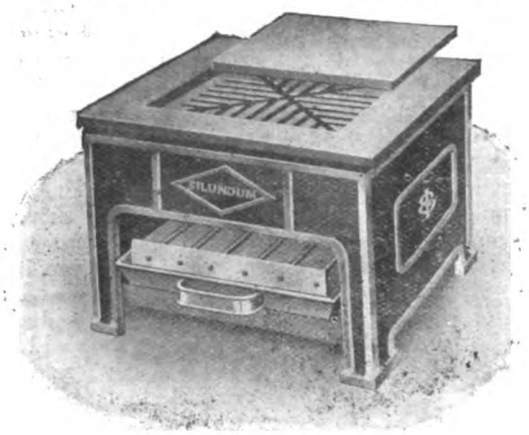

FIG. 1.—Silundum Miniature Range.

cooking range (shown in Fig. 1) is specially useful for the preparation of breakfasts. The 1,500-watt size will boil two pints of water in 20 minutes, and at the same time the grill underneath may be employed for grilling or other purposes, thus enabling a complete breakfast to be prepared at a very small cost indeed. The cover plate will be found

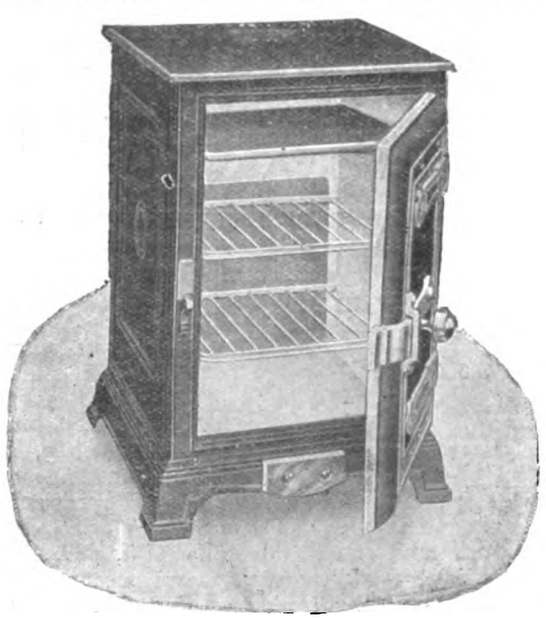

FIG. 2.—Silundum Oven.

useful to reduce the temperature of the top, when it is desired to keep liquids simmering, or to concentrate the heat to the grill or under portion of the range. In the cast-iron oven (illustrated in Fig. 2) the heat is concentrated in a most advantageous position. For purposes of regulation two or more units are employed, and, working as they do at a bright red heat, all the advantages of radiated and convected heat are obtained. These ovens are constructed with open Silundum elements, which possess a small capacity for heat, and, therefore, the oven begins to heat up immediately on being switched in circuit, thus attaining a very high over-all efficiency. With the high efficiencies attained we are confident that the "Silundum" system will have a great influence in increasing the popularity of electric cooking apparatus, and so bring a welcome addition to the load of the central stations.

NEW-PATTERN REFLECTOR LAMP.

A new-pattern metallic-filament lamp—the "Metaflect"—has been designed by Mr. S. Horvath, and is being

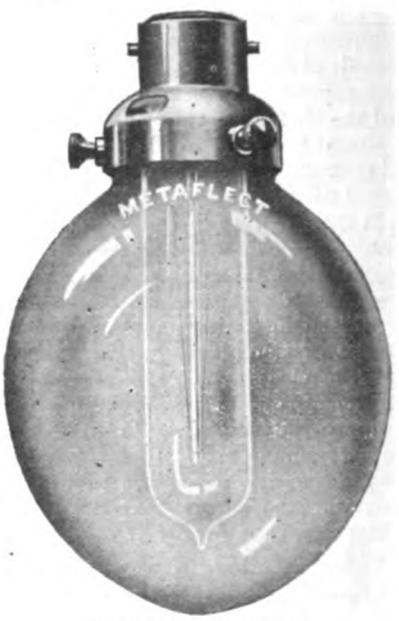

FIG. 1.—"Metaflect" Lamp.

manufactured by him at his factory, 51, Standen-road, Southfields, S.W. This will shortly be put on the market by Messrs. Krupki and Jacobi, 11, Queen Victoria-

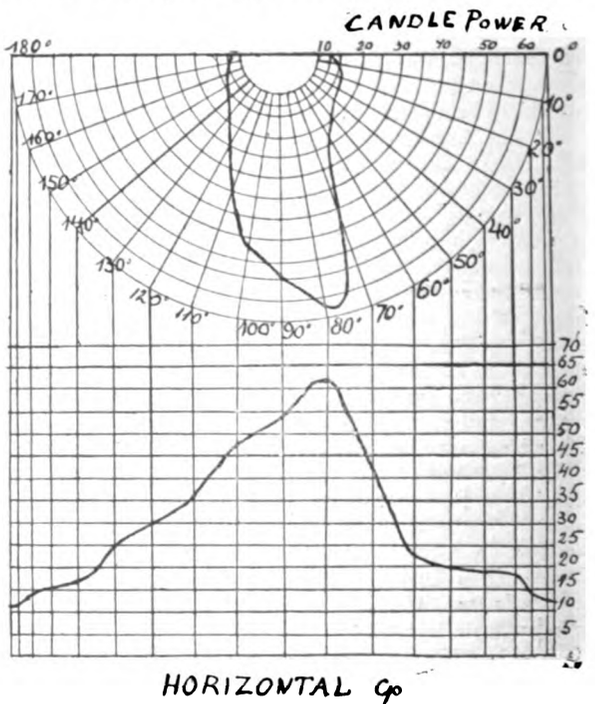

FIG. 2.—Horizontal C.P. Curve.

street, E C, who have undertaken the sole agency for the United Kingdom.

The lamp consists of an elongated tubular-shaped bulb fitted with a special cap with three little thumbscrews and three ventilation holes, as shown in Fig. 1. The tubular lamp is inserted in spherical concave and convex-shaped glass bulb, of which one flattened side is silvered in such a way that it cannot oxidise or tarnish. The peculiar design of the outer bulb possesses a distinct advantage, as by inserting the elongated tube in the reflector it brings the lamp so near to the inner surface of the reflector that a total reflection takes place with a most extraordinary uniform distribution, as the curve of the

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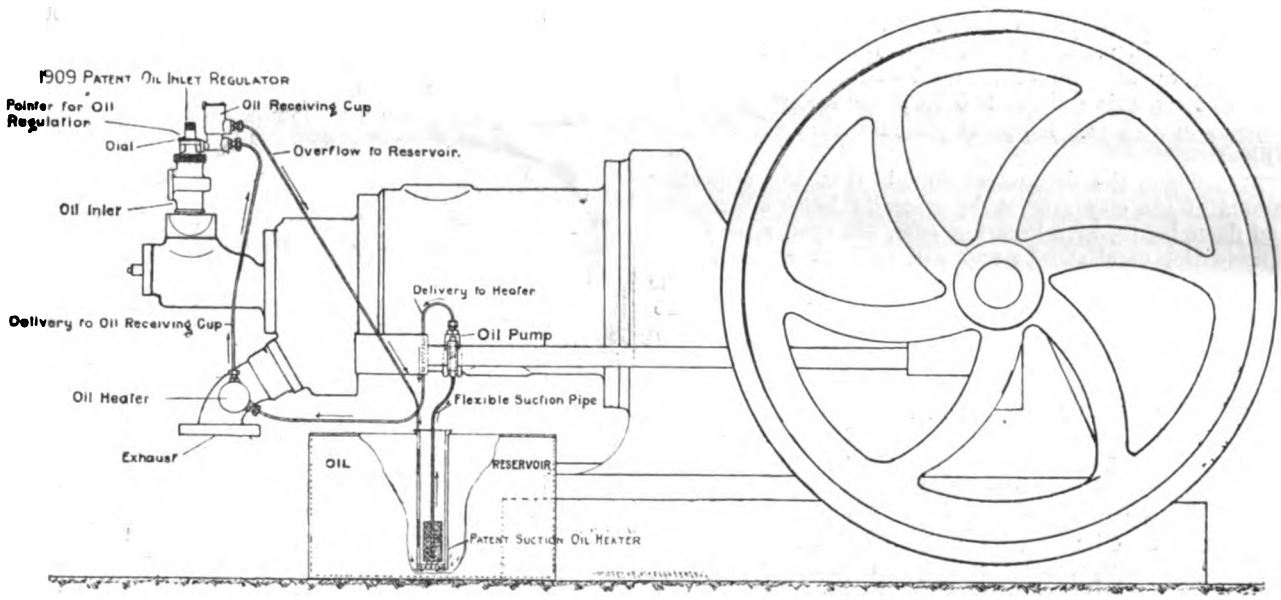
National Physical Laboratory (Fig. 2) shows the vertical and horizontal candle-power from 0 deg. to 180 deg. The lamps are made in 25 and 50 volts, and mounted on a flexible nickel-plated conduit tube. With eight lamps at a distance of 8 in. apart the whole system is equal to a high-voltage lamp, with the exception that the "Metaflect" is divided in a long range with a perfect distribution, and totally different to a single high-voltage lamp, where the light is concentrated in small areas. The "Metaflect" system is fixed on the window frame, and the source of light is directed on the contents of the window, which brings the objects into prominence without offending the eye. The whole arrangement is very simple to fit, and the light can be concentrated in any direction by simply moving the reflecting globe.

THE "PETTER" PATENT OIL ENGINE.

The low cost of crude petroleums, approximately about half that of the usual refined oils, makes it an attractive fuel for use in engines for agricultural and other purposes. The makers of the Petter oil engine (Messrs. James B. Petter and Sons, Limited, Yeovil) have for several years been experimenting with every possible variety of crude and residual petroleums, and are now able to offer an engine with which all kinds of petroleum—crude and refined—can be used without any other alteration than that of a simple adjustment of the oil inlet, which can be made while the engine is working. Difficulties in the use of crude petroleums arise partly on account of the varying consistency or thickness of the oil, which in winter will often be too thick to be conveniently pumped or to flow through any regulating device, and partly on account of the high flash-point, usually over 200 deg. F. To meet the difficulty arising from the thickness of these crude or residual oils, a special heating arrangement is provided which warms the oil on its passage to the engine. Experiments showed that while it took 5 minutes 35 seconds for half a pint of oil to flow through $\frac{3}{16}$-in. hole when at 56 deg. F., it took only 43 seconds under similar conditions when the temperature was raised to 110 deg. F.

The pump is constructed to raise a larger quantity of oil than is required by the engine, and the overflow of heated oil is returned to the oil supply tank through the patent suction oil heater, so that while the bulk of the oil in the tank may be so thick that it cannot be pumped, that small quantity which is immediately around the suction pipe of the pump is heated and flows readily to the pump. Further, the heating of the oil before it passes to the vaporiser assists vaporisation, and ensures the more complete combustion of the fuel. Another feature of the design is the patent dial feed arrangement on the oil inlet, which enables the oil feed to be immediately adjusted to the correct position for dealing with oils of varying thicknesses. This engine, which has been well tested during the past winter both in this country and in colder climates, has been found entirely satisfactory, the difficulties referred to in the use of thick crude oils being entirely removed.



Petter Oil Engine (Side Elevation), showing Arrangement for Use of Crude Oil.

FREIGHT LOCOMOTIVES FOR THE NEW YORK, NEW HAVEN, AND HARTFORD RAILROAD.

The New York, New Haven, and Hartford Railroad has placed an order with the Westinghouse Electric and Manufacturing Company for two freight locomotives to be employed on its main line. One of these locomotives is to be equipped with side rods and the other is to be of the geared type. It is understood that tests will be made with these locomotives to determine (1) the relative performance of electric and steam locomotives for freight service and (2) the relative advantages of the two types of locomotives which are to be employed.

In view of the many conflicting reports that have appeared in regard to the proposed extension of the New Haven electrification, it is of interest to turn to the statement of the facts which is given in the *Electric Railway Journal* of New York. The performance of the present electrical system is very satisfactory, and the number of engine miles per failure is far larger than with steam operation. During the month of May it amounted to 7,345. The engineers of the company have made a very careful investigation as to the cost of electrifying the company's six-track Harlem River branch and the four tracks of the main line from Stamford to New Haven, inclusive of the necessary power-houses, looking to the handling of passenger and freight trains. The investigation also covers the trackage incident to the electrification of freight and passenger yards. These estimates have been filed with the directors of the company, but no definite action has been taken by them with regard to immediate extension of the system.

It is proposed, however, during the next few months to extend the present electrification from Stamford for the distance of one mile for experimental purposes. The overhead construction will differ somewhat in regard to the form of steel bents and arrangements of overhead wires from those previously used, but these changes are incident only to the improvements in forms of construction and reductions in cost. The main features in the present form of construction, including a steel contact wire suspended every 10 ft. by clips of the present design from an overhead copper conductor, will be retained.

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PUBLIC LIGHTING IN THE CITY OF LONDON.

Still another report has been issued on the question of the public lighting of the city of London. A deputation, consisting of the chairman of the Streets Committee (Mr. Charles Alfred Teuten), Mr. Deputy Turner, and Messrs. John Stopher, Josiah Gunton, and G. Gordon Stanham, visited Brussels, Cologne, Düsseldorf, Berlin, Dresden, Vienna, Munich, and Paris in March last, and they have now submitted their report, together with particulars of the different systems of lighting inspected, from which it will be seen that in each city gas as well as electricity is used.

In Brussels the main thoroughfares, squares, and market places are lighted by means of electric arc lamps, with an ordinary incandescent gas burner on each side. The arc lamps are turned off at midnight, after which time the lighting is supplied by gas. The side streets are lit with incandescent gas. The total number of electric arc lamps in use is 238, supplied by direct current, consuming energy at the rate of 440 watts, and fixed upon columns. The distance (not diagonal) between the open lamps is 98 ft. to 115 ft., the average height of the lamps being about 20 ft. The width of the streets in which open lamps are used varies from 82 ft. to 98 ft. The cost per lamp per annum (half night only), including interest, depreciation, and all other charges, is £14. 9s. 7d. There are only two centrally-suspended electric arc lamps, and these are fixed in the "Grand Place," from the Hotel de Ville across the market place (the lamps taking 1,100 watts each), at an altitude of about 70 ft.—the width of the market place being about 200 ft.; the lowering gear in connection with the lamps is placed within the Hotel de Ville.

In Cologne the deputation found that the important streets of the city are let by centrally hung electric arc and flame lamps, with lowering gear, the open spaces by a combination of electricity and gas, and the minor streets mainly by incandescent gas lamps upon standards. The total number of electric arc lamps in Cologne is 426, supplied by alternating current, both open and flame lamps being used. One-half of the lamps are centrally hung, the others being fixed upon standards. The distance between the open lamps is 88 ft. to 115 ft., and between the flame lamps 121 ft. to 148 ft. The lamps are fixed at a height of from 26 ft. to 33 ft. in streets from 23 ft. to 148 ft. wide. The cost per annum per lamp, including interest on capital outlay, depreciation, and all other charges, is for open lamps £11. 5s. 6d. each; for flame lamps £9. 6s. 3d. each. The centrally-suspended arc lamps are fixed about 30 ft. above the roadway, 110 ft. apart, and give a light equal to about 1,300 candles each. The apparatus used for lowering the lamps is contained in a box 12 in. high, 8 in. wide, attached to the houses about 4 ft. from the pavement level. By a simple arrangement the lamps are drawn aside over the pavement and lowered for trimming, etc., and on being replaced are lighted by automatic contact with the main wire. Owing to the daily examination during the trimming of the lamps the danger to the public from defective wires is reduced to a minimum, only one accident having been reported since the lamps were fixed. One hundred and seventeen electric incandescent lamps are used in the streets, of which 30 are carbon-filament lamps and 87 metal-filament lamps. These carbon-filament lamps are of 14 c.p, and take about 50 watts each; the metal-filament lamps are 28 c.p., and take 32 watts. The lamps are fixed in groups upon columns about 100 ft. apart, at an average height of 11 ft. 6 in. The cost per annum per lamp, including interest on capital expenditure, depreciation, and all other charges, is: for carbon-filament lamps, £2. 14s.; metal-filament lamps, £2. 4s. 2d.

Next Düsseldorf was visited, where the lighting is in a somewhat similar manner to Cologne, arc lamps centrally hung and upon standards, and by incandescent gas. The total cost per annum per lamp, including interest on capital outlay, depreciation, and all other charges, is £17. 13s. Electric incandescent lamps are also used; there are 120 carbon-filament lamps of 14 c.p. and 22 c.p., taking about 50 and 75 watts respectively, and 111 metal-filament lamps of 22 c.p. and 90 c.p., taking 25 and 100 watts respectively. Incandescent gas lighting cost £3. 8s. 3d. per lamp (all night).

In Berlin the general arrangement for lighting is by means of electric arc lamps, centrally hung and upon standards, electric incandescent lamps, and high-pressure incandescent gas lamps with inverted mantles. Gas is manufactured by the municipality, but electricity is purchased in bulk from a private company. The total number of electric arc lamps (open and flame) in Berlin is 864, supplied by direct current. Six hundred and sixty-four of these lamps are fixed upon standards, and 200 are suspended across the streets centrally hung. The distance between the open lamps is from 100 ft. to 130 ft. and 98 ft. between the flame lamps. The open and flame lamps are fixed at heights of 26 ft. to 31 ft., a few flame lamps being 52 ft. high; one-half of the lamps are extinguished at midnight. Two hundred and twelve electric incandescent lamps are used in the city, 177 being of the Nernst type, 14 carbon-filament lamps, and 21 metal-filament lamps, the carbon-filament lamps giving a light of 14 candles and taking 57 watts per lamp, the metal-filament lamps being of 440 c.p, and taking 440 watts per lamp. The deputation was informed that the Berlin authorities have decided to spend seven million marks (£350,000) in installing the latest patterns of high-pressure gas lamps with inverted burners in lieu of the existing gas and electric lamps. Expenditure in this direction has been going on for two years at the rate of one million marks (£50,000) a year, and will be continued at the same rate for the next five years. The lamps used are graded according to the importance of the thoroughfares—at junctions of main streets, lamps of 4,000 c.p; in main thoroughfares, lamps of 2,000 c.p.; and in other streets, lamps of 1,000, 600, 400, and 200 c.p., the 400-c.p. and 200-c.p. lamps being on low pressure. So far as gas is concerned, four-fifths of the city is lighted by the municipal authority and the remaining one-fifth by the Imperial Continental Gas Association. In some streets where the municipal authority and association meet, the latter are putting in the same kind of burner as the former.

In Dresden, electric arc lamps of the open and flame type are used, a considerable number being suspended across the centre of the streets, with side lowering gear. Electric incandescent lamps are also used. The side streets are lit with low-pressure incandescent gas lamps. The electric arc lamps are switched off at midnight, leaving incandescent gas lighting only. The total number of electric arc lamps in use is 425, supplied by alternating current, the type of lamps used being: open (124), flame (301), the open lamps taking 500 and 375 watts, the flame lamps taking 350 watts; 238 lamps are fixed upon side posts, 187 being suspended across the centre of the streets, with side lowering gear. The average distance between open lamps is about 148 ft, and flame lamps 180 ft. The lamps are fixed at a height of about 26 ft. in streets having an average width of 65 ft. The average cost per annum per lamp, including interest on capital outlay, depreciation, and all other charges, is about £26. Electric incandescent lamps are largely used in the streets, and are fixed upon standards and brackets, and also centrally hung. Seventy-two carbon-filament lamps are of 14 c.p. and 22 c.p, and take 55 and 87 watts respectively; 437 metal-filament lamps are of 22, 44, and 260 c.p., and take 30, 60, and 330 watts respectively. The lamps are fixed about 100 ft. apart at a height of 16 ft, and cost £2 14s. per lamp per annum.

In Vienna the general arrangement for lighting is by means of electric lamps upon columns with incandescent gas lamps fixed upon brackets below, the electricity being switched off at midnight. The total number of electric arc lamps in Vienna is 1,155, of which 1,139 are supplied by direct current, 16 only being by alternating current. There are no flame arc lamps used in Vienna for street lighting. There are but five centrally hung electric lamps in this city. Up to the present there have been three cases in which arc lamps have fallen owing to breakage of the wire, but without causing injury to passers-by. The open lamps take about 660 watts, and are fixed upon standards at a distance of about 115 ft., at a height of 25 ft. to 40 ft. The average width of streets in Vienna is nearly 100 ft. The cost per annum per lamp, including interest on capital outlay, depreciation and all other charges, varies from £16 to £35, according to the hours

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of lighting. There are 686 electric incandescent lamps in use for street lighting and 148 for the three bridges over the Danube: (1) the Reichsbrucke Bridge with 100 carbon-filament lamps of 25 c.p.; (2) the Marienbrucke Bridge with 28 metal-filament lamps (tantalum) at 50 c.p.; (3) the Brigittabrucke Bridge with 20 metal-filament lamps (tantalum) of 50 c.p. The electric incandescent lamps are fixed at a height of about 10 ft. At points where the traffic is heavy, as at street crossings, etc., two lateral arms, each with one carbon-filament lamp of 25 c.p, are fixed to the arc lamp columns. These incandescent lamps are not switched on until 12 o'clock at night, when the arc lamps are extinguished. The annual cost of those burning all night is £6. 12s. 6d. per lamp, including interest and renewal of lamps, £3. 11s. 9d. per lamp being the estimated cost of running the half-night carbon-filament lamps.

The deputation next visited Munich. The number of electric arc lamps installed here is about 900, supplied by direct current. Open lamps of the Alba Carbon type are generally used, taking 450 and 270 watts. There are also 78 flame lamps taking 300 watts. About one-half of the lamps are fixed upon standards at distances of about 200 ft. apart, the lamps being about 33 ft. above the pavement level in streets about 80 ft. wide. The flame lamps are placed at average distances of 160 ft., at a height of 33 ft., in streets about 70 ft. wide. Centrally hung lamps are fitted with lowering gear, and in some of the widest streets as many as three arc lamps are suspended across the road on a single line. The cost per annum per lamp for electric arc lamps, including interest on capital outlay, depreciation, and all other charges, was stated to be—for open lamps about £29, flame lamps £27, the current being supplied by the municipal authority. Of electric incandescent lamps there are 96 in use, metal-filament lamps being generally adopted of 28 c.p, taking 55 watts. They are fixed on central posts (three in each lantern) and also on brackets, the distances between the lamps being about 162 ft, at a height of 13 ft. in streets about 33 ft. wide. The cost per annum per lamp, including capital expenditure, depreciation, and all other charges, for metal filament lamps is £3. 8s. 8d. High-pressure incandescent gas lamps are not at present installed in Munich. In the low-pressure gas lamps Welsbach upright incandescent burners are used, consuming about 3½ cubic feet per hour. The illuminating power was stated to be 72 c.p., the lamps being fixed about 11½ ft. above the roadway at distances of about 60 ft. The cost of these low-pressure incandescent gas lamps, including interest on capital expenditure, depreciation, and all other charges, is £4. 4s. 4d. per annum.

The general arrangement for lighting the streets of Paris is much the same as in London, electric lamps upon columns being generally used. The total number of electric arc lamps in Paris is 1,899, of which 559 are supplied by alternating current and 1,340 by direct current. The lamps are fixed about 100 ft. apart at about 14 ft. to 18 ft. high, the main streets of Paris being 70 ft. to 100 ft. wide. A large number of these lamps are extinguished at 1 o'clock a.m.

In an appendix to their report the deputation give some particulars concerning lighting in the city of London.

The total number of electric arc lamps in the City is 450; 380 open arc lamps and 20 flame lamps are fixed upon columns and brackets; the average distance between the open lamps is 126 ft., the average height of the lamps being about 18½ ft. The cost of each of the open lamps is £26 per annum and of each flame lamp £17. 10s. In accordance with the resolution of the Court of Common Council of July 25, 1907, permitting the two electric lighting companies having statutory powers in the City to experiment with the newest form of electric lamps for street lighting in the thoroughfares of Holborn, Holborn-viaduct, Old Bailey (part of), the lamps being placed about 20 ft. from the ground, Cannon-street (between St. Paul's-churchyard and Dowgate-hill) at a height of 28 ft., and Farringdon-street at a height of 14 ft., the Charing Cross and Strand Electricity Supply Company proceeded with the lighting of their portion—viz, Cannon-street—by erecting 11 Oliver magazine flame arc lamps, centrally hung, and suspended over the roadway by wires attached to the buildings on either side. The lamps were put into lighting in November, 1907, and £17. 10s. per lamp is the price paid for the experimental running. This is the price quoted by the company for a contract for not less than 250 of such lamps. The City of London Electric Lighting Company also proceeded with the carrying out of their experiment by substituting 21 Oliver flame arcs for a similar number of the original open arcs, adapting the existing standards in Holborn, Holborn-viaduct, and part of Old Bailey; whilst in Farringdon-street 18 enclosed arcs of the Reason type were fitted up on special short columns in lieu of the 12 original open arc lamps and columns in that thoroughfare. The installation of this area was completed in November, 1907. The cost of the Oliver flame arcs in the Holborn area is £17. 10s. each per annum, being equivalent to the charge for similar lamps in Cannon-street. The cost of the enclosed arcs in Farringdon-street is £12. 10s. each per annum. The Oliver flame arc lamps at Ludgate-circus and Ludgate-hill, put into lighting this year, are fixed at a height of 18 5 ft. above the roadway, as against 20·5 with the experimental lamps of the same type at Holborn.

After having very carefully considered the various systems, the deputation are of opinion that the public lighting in the city of London can be materially improved, and they have come to the following conclusions: (1) That, wherever possible, streets should be lighted by means of centrally hung lamps with lowering gear. This they think particularly important in the city of London, where the number of obstructions upon the footways in the form of lamp-posts, bins, letter-boxes, etc, is so large. (2) That open spaces should be lighted by means of lamps upon standards, fitted with lowering gear. (3) That high-pressure incandescent gas lamps with inverted burners should be adopted as the illuminant, but where gas is impracticable electricity with open arc and flame arc lamps should be installed. They think, however, before suggesting any drastic alterations in the general lighting of the City, that the Streets Committee should be authorised to arrange for some further experimental lighting of the City thoroughfares, and they recommend accordingly.

ELECTRICITY SUPPLY TARIFFS.

A system of rates for residence consumers employed by the Detroit Edison Company for several years is beginning to find favour with several smaller companies, and has certain features of interest to which but little attention has been called in articles and discussions on the rate question. The Detroit plan is to charge 8d. per kilowatt-hour up to a point where the customer's consumption equals two kilowatt-hours per month for each of the rooms in the house, which are counted, and 2d. per kilowatt-hour for all electricity used in excess of that amount. The characteristic or peculiar feature of this system is that it is based on the theory that a consumer's maximum demand is in proportion to the number of rooms in the house rather than in proportion to the number of lamps actually connected. In determining the amount which must be used before the lower rate is secured by the Detroit system, only the principal rooms of a house are counted. Two kilowatt-hours per month is the equivalent of 60 hours' use per month of 33 watts per room, or 30 hours' use per month of 66 watts per room counted. As a basis for the rate all of the rooms of the house are included except the kitchen, laundry, storeroom, and three bedrooms. The advantage claimed for the Detroit system is that it does not put an unjust penalty on the use of as many convenient sockets as the consumer desires. It is based on the broad assumption that the consumer's maximum demand is approximately proportional to the number of regularly occupied rooms in the house. The argument against it is sometimes advanced that in some houses with very large rooms the number of lamps per room is greater than in a small house. While this is true, on the other hand, the large house is likely to have more of its rooms unoccupied at one time than is the small house. This tends to keep the ratio of maximum demand to rooms about the same for the different houses.—*Electrical World.*

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SOME ELEMENTARY CONSIDERATIONS OF HIGH-TENSION SWITCHGEAR.

BY J. H S.

A few years ago the design and location of switchgear in a central station was a matter of secondary importance, whereas to-day the selection and lay-outs of switchgear are as carefully considered as any other part of the system. This is partly due to the increase in pressures now employed, and to the experience gained in the construction and maintenance of the panel or flat-back type of board.

The predominating design to-day is the cellular construction, which was, no doubt, suggested to designers by Mr. Ferranti's backless cellular gear, and which can to-day be seen working in many central stations of moderate size. This switchgear is fitted with both plain quick-break knife switches and with a similar switch in which the final break takes place in oil. The fuses also are provided with oil-baths, the fuse carrier disappearing into the oil when the fuse wire melts.

The modern oil switch is evolved from the above type, and its principal good features are as follows: The contacts being all enclosed and the switch itself being generally at a distance from the operator, there is no danger to life or limb whatever happens to the switch. Again, should something untoward happen causing a burn-out, the attendant will not have to consider his own safety, as

FIG. 1.

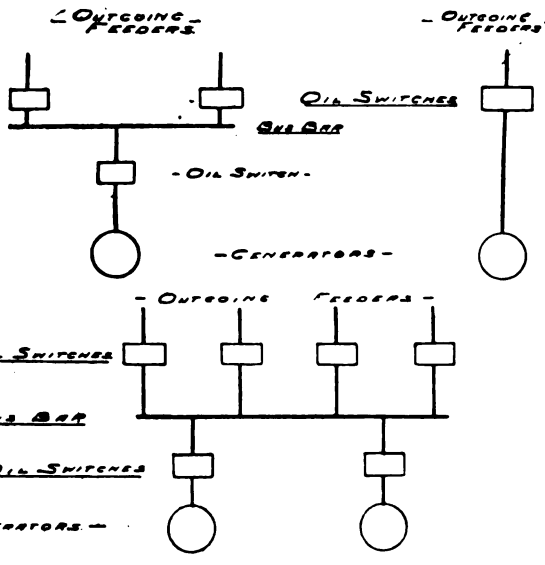

FIG. 2.

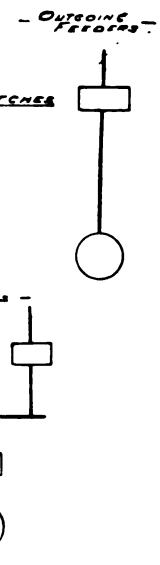

FIG. 3.

possibly the only indication he gets will be the abnormal behaviour of the instrument pointers, and the operator is able to concentrate all his energies to the manipulation of the switchgear, thus possibly avoiding a total shutdown. A further advantage is that, due to the oil, the circuit is actually broken at zero current, the oil allowing the current to flow for the incredibly small space of time between when the switch mechanism commences to move and the time of zero current.

With these few points in mind when considering the installation or redesign of high-tension switchgear, it will not be difficult to decide whether to install oil or air break switches, but an engineer's real difficulties commence in attempting to select a suitable switch from the many makes that are in the market; and it was with an idea of giving assistance on this question that these notes were attempted.

There are a large number of firms in the United Kingdom manufacturing thoroughly reliable oil switches, some of those makers having designed and supplied switches for abnormal duties, and the behaviour of these switches is entirely satisfactory even when called upon to break many thousands of kilowatts.

Before the size and type of switch can be decided it is necessary to lay out the scheme and determine the main connections. For small stations or sub-stations with a working pressure not exceeding 3,000 volts, and where the generator capacity is small, or, owing to the connections, the switches will not be called upon to break an excessive current, a switch mounted on the back of the panel makes a compact and economical arrangement. But if the space can be arranged for, it is always advisable to construct cubicles and erect the gear so as to isolate each section. This apparent refinement will eventually appear as a necessity when alterations and additions are being carried out, and it is remarkable how a small amount of time and money judiciously expended in the design and construction of these cubicles will save both time and money, and, perhaps, life, when extensions are being added.

The next question, whether to install mechanically or electrically operated switches, can be summed up as follows: in a mechanically-operated switch the only reason for non-operation is the failure of the man in charge, whereas the electrically-operated switch may fail due to two or more causes—the man in charge and the operating circuit. Thus electrical control introduces another possible risk of failure, and providing the rods and cranks for mechanical operation are not too long and complicated, this type of switch is to be preferred. The determination of the correct size of switch to install is a more complicated problem, and will depend upon the size, governing, short-circuit current, and connections of the machines.

A polyphase generator is popularly supposed to be only capable of giving about three times its normal full-load current on short-circuit, whereas oscillograph records have proved that momentarily the current may reach 20 times the normal, the current gradually dying away as the duration of the short-circuit is prolonged. From this it will be seen that the size or breaking capacity of an oil switch depends upon the time between the commencement of a short and the moment of breaking circuit, and that the shorter the time element allowed the more severe are the

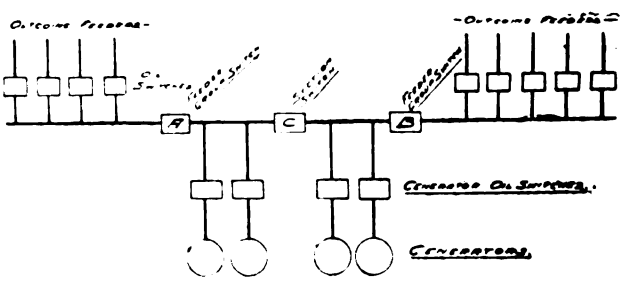

FIG. 4.

conditions imposed on the switch. As previously mentioned, the size and type of switch is materially affected by the connections, the simplest possible cases being illustrated in Figs. 1 and 2, where in each case the feeder switch may be called upon to rupture the total short-circuit current of one generator. In Fig. 3 each feeder switch must be capable of breaking the short-circuit current of two machines, but the machine or generator switches need only be large enough to rupture the current of one machine. In an installation connected up as shown in Fig. 4, with three or more machines, the feeder switches need only be designed in proportion to the load on the feeder, and should be fitted with time element overload relays. The section or group switches, A and B, must be liberally designed, each being capable of rupturing the total short-circuit current of the station. They should be automatic and fitted with time overload relays, the relays being set to operate at a given overload, but with considerably less time lag than the feeder switches. The section switch, C, should be capable of breaking the short-circuit current of two machines, or the current from as many machines that are on each half of the 'bus bar. There is no reason for fitting this switch with automatic devices.

The machine switches must be large enough to break the short-circuit current of the total number of machines minus one, and should be fitted with reverse-current relays only. A guarantee should be obtained from the relay manufacturers giving the percentage of normal working pressure that the instruments will operate at when a specified reverse current is flowing.

The amount of current that can safely be interrupted by an oil switch is proportional to the length of break and the head of oil above the stationary contacts. Various manu-

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facturers offer further advantages, some by shaping the lining of the oil-box round the contacts, and thus reducing the amount of oil for a given length of stroke. Others leave an oil space between the wooden lining and the oil-tank, by this means obtaining a high dielectric strength and also providing a reservoir of cool oil to assist in damping out any tendency to arcing. A very decided advantage is to keep each pole or phases in a separate oil-tank; all leading manufacturers do this in the larger switches, and some carry this principle down to the smallest size. On any oil switch these separate small oil-boxes are much easier to handle than one large box, and, in addition, there is the obvious advantage of isolating the phases.

All the insulating material used in the construction of an oil switch should be of the best quality glazed porcelain, except the plunger rods, where a high-class quality of cane is occasionally used. Plain insulators are to be preferred to corrugated on account of the dirt adhering to the corrugations; flaws and cracks are more easily distinguished in plain insulators and they are easier to keep clean. All toggles, knuckles, catches, etc, should be so arranged that they are outside the actual oil-switch cell with a stout concrete, stone, or brick partition between them and the high-tension rods or cables. An oil switch with the leading-in conductors above the oil level is preferable to those fitted with stationary contacts at the bottom of the oil-tank. It is almost impossible to maintain the latter type oiltight, and any repairs or replacements necessary are tiresome jobs. When purchasing oil for high-tension switches it is advisable to obtain it either from the switch manufacturers or from a firm recommended by them.

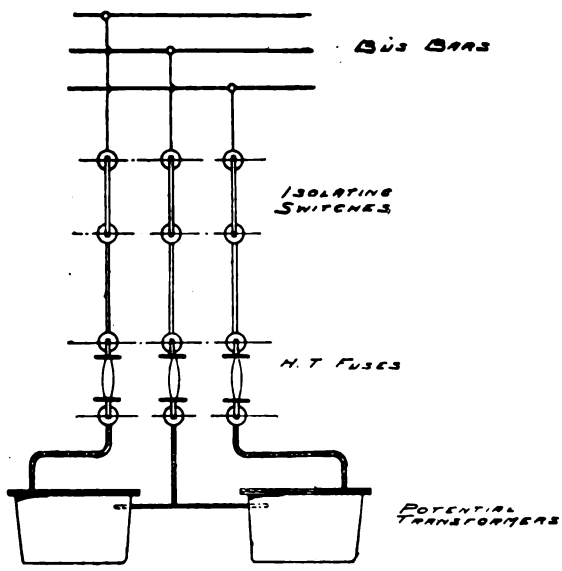


FIG. b.

Apparently simple but important parts of high-tension switchgear are instrument transformers. These transformers are now standardised by nearly all electrical instrument makers as an air-type transformer up to and including 3,000 volts pressure, and above this pressure oil-insulated. These transformers being called upon to give very exact ratios over a wide range of load, it is necessary to wind the coils as near to one another and to the magnetic circuit as possible, thus cutting down the insulation to a minimum. Recognising this, it is easily understood that it is advisable to install oil-insulated transformers even with primary pressures as low as 2,000 volts. A very important precaution when working on the secondary circuit of a series or current transformer, when the primary is carrying current, is to short-circuit its secondary leads, and then to earth them. Unless this precaution is taken a series transformer will heat up and burn out, as the primary turns will act as a badly designed choking coil, reacting on the main circuit, and will in a short time get exceedingly hot and destroy the insulation.

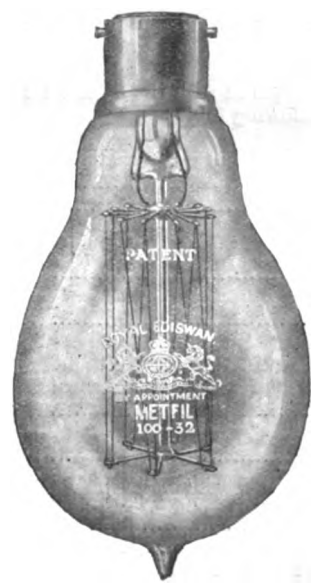
A frequent source of annoyance with oil-insulated current transformers is the leakage of oil through the cast-iron tanks. All makers line the tanks with an enamel impervious to oil, but if this enamel gets chipped off the oil percolates through the cast iron and becomes a nuisance. It is surprising that a stamped steel tank has never been put on the market, similar in manufacture to a coal-elevator bucket, as these would be considerably lighter than cast iron.

In a three-phase installation, star connected, with all the neutrals of the machines earthed, and where it is intended to install reverse-current relays on the generator switches, it is necessary to insert three single-phase potential transformers on each machine. If only two are used it is possible, under certain conditions of working, for the wattmeter movement of the reverse relays to become neutralised or reversed, and they will exert a positive torque even when a heavy reverse current is flowing. For a full explanation of this phenomenon the reader is referred to an article on "Relays for the Control of High-Tension Switchgear," by Dr. Garrard, which appeared in the *Electrical Engineer* of April 26, 1907. All high-tension potential transformers which are permanently alive, such as 'bus-bar voltage transformers, should be connected up through an isolating switch, in addition to the usual fuses. It is necessary to inspect these fuses periodically, and inserting the isolating switch in series with them, as shown in Fig. 5, will permit the operator to inspect and adjust the contacts with safety.

(To be continued.)

BRITISH-MADE METALLIC-FILAMENT LAMPS.

The Edison and Swan United Electric Light Company, Limited, have now placed on the market a very complete and



extensive range of their new British-made metallic-filament lamps, which were introduced under the name of the "Royal Ediswan Metfil." It will be remembered that lamps of this make were exhibited by the company at the Franco-British Exhibition, where they obtained the highest award possible for lamps, etc. At the Manchester Exhibition, also, "Metfil" lamps were on view, and earned the high opinion of everyone who saw and examined them. Since then the firm have been steadily making and selling lamps of this type, whilst at the same time they have been constantly experimenting with the rare metals in order to ensure that the "Royal Ediswan Metfil" lamps were made with the same care and accuracy that has characterised the firm's carbon-filament lamps, the intention of the company being to make certain that the new metallic-filament lamps turned out from the Ediswan Works at Ponder's End should occupy the same pre-eminent position in the lamp world as is occupied by their older type.

As original inventors and patentees of the incandescent lamp, of course the firm were in a enviable position for working with the rare metals in filament manufacture, as they had the lampmaking experience of over a quarter of a century behind them. As a matter of fact, the firm had been working for many years in the direction of producing a high-efficiency, long-life lamp, and whilst the efficiency of the "Royal Ediswan Metfil" may be taken as being as high as that of any other metallic-filament lamp on the market, the useful life is not less than 1,000 hours. A noticeable feature is that the lamps do not blacken with use, many lamps having burned for three or four times the normal life without showing any

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traces of discoloration. In addition, the filaments are not fragile, and will withstand ordinary usage — a point which is of considerable importance. The filaments are so arranged that they are supported throughout their entire length, thus enabling the lamp to be used in any position without fear of the filament sagging or fracturing. The firm have been successful in producing a metallic-filament lamp suitable for use in single parallel on circuits of from 200 to 250 volts. A number of varieties of flame and candle lamps are also listed in the new catalogue which is issued by the firm, and which contains a most comprehensive range of lamps. A further point in connection with the ordinary "Royal Ediswan Metfil" lamps is that they can be used in the same sized shades as are usually used in connection with the carbon-filament lamps of the same size and candle-power, thus rendering it unnecessary to provide shades of special shape or size. The lamp is made for practically every required candle-power and voltage, ranging from small miniature lamps for use with batteries to the somewhat larger lamps used in connection with the firm's auto-transformers, and so on through the 100 and 200 volt ranges.

In order that purchasers may be certain that they are obtaining the product of the firm, who are, by the way, Royal warrant-holders to H.M. the King and H.R.H. the Prince of Wales, every lamp is clearly marked with the Royal arms and the words "Royal Ed'swan Metfil." It is interesting to note, further, that the lamps are marked in standard British candles, and not in Hefner candles.

MANCHESTER CORPORATION ELECTRICITY AND TRAMWAYS DEPARTMENTS.

The reports of Mr. S. L. Pearce (the chief electrical engineer) and Mr. J. M. McElroy (the tramways manager) for the year ended March 31 last have been presented to the respective committees. The first-named shows a drop in the revenue and in the net profits. A summary of the income and expenditure, which may be compared with the figures for the previous year, is given in the following table:

	1908-9.	1907-8.
Sales of current—Lighting and power	£231,648	£238,266
Traction	128,613	140.513
Public lighting	855	851
	£361,116	£384,602
Other income	6,124	4,972
Total	£367,240	£384,602
Working expenditure (including the provision in the year 1908 of £40,000 and in the year 1909 of £21,495 for future renewals)	£205,534	£219,358
Balance	£161,706	£165,244
Being gross profit, from which there falls to be deducted—Interest on mortgage debt, etc.	£67,762	£68,432
Sinking fund	75,913	70,939
Instalment of loan repaid to Public Works Commissioners	6,031	6,330
	£149,726	£145,701
Leaving a net surplus, which was handed over to the city fund in aid of rates, of	£12,000	£19,543

The renewals suspense account amounted to £130,567 at the beginning of the year, and has since been increased by £2,038, being bank interest, and by a further contribution of £21,495 from revenue account, but certain abnormal expenditure, totalling £18,848, chiefly for discarded plant having been debited during the year, the account only shows a net increase of £4,685, leaving a total balance at March 31, 1909, of £135,252. The reserve fund at the beginning of the financial year stood at £13,854. During the year there has been charged to this fund the sum of £5,541 for the cost of land adjoining Stuart-street station, £1,651 for wages of permanent employés engaged on capital account, and £707 being the balance of legal charges incidental to the acquisition of warehouse property in Dickinson-street. On the other hand, there has been credited £403 for interest. The balance forward to next year is, therefore, £6,358. The Local Government Board granted additional borrowing powers to the extent of £81,244, and the capital outlay at the end of March 31 showed a total of £2,521,871. Reductions made in the lighting prices at December, 1907, affected the income for the whole year, and represented a concession to lighting consumers of £16,341.

With regard to the progress of work, Mr. Pearce reports that Messrs. Siemens have replaced the 750-kw. generators on the two Parsons turbines at Dickinson-street generating station with satisfactory results. A contract has been placed with the Tudor Accumulator Company, Limited, for the installation of a large storage battery, boosters, etc. Small extensions at certain of the existing Corporation distributing stations have been made during the past year. Owing to the depression in trade, the number of distributing stations put down on consumers' premises for the purpose of power supplies fell considerably below the number in the preceding year. The high-tension and distributing mains have been extended into the districts of Audenshaw and Droylsden, and a similar extension into the district of Failsworth will be made this summer. When this latter work is completed, the whole of the districts whose provisional orders have been taken over by the Corporation will be receiving a supply of electricity.

The total output of electricity from the three generating stations during the past 12 months amounted to 88,766,232 units, as compared with 82,752,989 units of the previous year, an increase of 7·27 per cent. The quantity measured and accounted for during the same time was 73,715,884 units, showing a difference of 15,050,348 units, or 16·96 per cent., being the quantity used in distribution or otherwise not accounted for. The corresponding percentage in the previous year was 18·65. The total mileage of main conductors laid at March 31, 1909, equals 352 miles 256 yards, being 13 miles 932 yards more than at March 31, 1908.

Tramways.

The revenue account may be summarised as in the following table, the figures for the preceding year being also shown for the purpose of comparison:

	1908-9.	1907-8.
Traffic revenue	£774,035	£760,994
Other revenue	8,804	6,859
Parcels department	1,716	1,219
Total	£784,555	£769,072
Working expenses	£508,072	£500,023
Balance, being gross profit	276,484	269,049
Add bank, etc., interest	2,624	2,104
Leaving a sum available of	£279,108	271,153
Out of which the following charges have been met:		
Interest on mortgage debt	£50,128	£49,035
Redemption of debt	43,037	41,748
Rent, etc., of tramways	26,680	21,195
Leaseholds proportion of outlay	1,069	1,232
Income tax	6,976	6,197
Parliamentary expenses	377	4,848
	£128,267	£124,255
Leaving a balance, which has been appropriated as under:		
Reserve, renewals, and depreciation account	£76,754	£87,790
Contribution in aid of the rates	70,000	55,000
Street improvements round infirmary - interest, etc.	4,086	4,108
	£150,840	£146,898

The total mileage of track open at the end of the financial year was 104¼ miles, 17,316,753 car miles were run, and 155,011,884 passengers were carried. The number of units used was 30,276,365, or 1·748 per car mile. The average traffic revenue per car mile showed a drop from 10·76d. to 10·728d., the total revenue averaging 10·874d. per car mile. Working expenses averaged 5·216d. per car mile (excluding power cost) and 7·043d. (including power cost).

The total amount paid to the city fund in relief of rates since 1901 is now £377,000. Sinking fund has absorbed up to date £232,814, out of which amount £227,587 has been applied in reduction of debt. The renewals and depreciation fund amounted at March 31 last to £400,779.

WOOD GREEN ELECTRIC LIGHTING SCHEME.

Messrs. May and Hawes have prepared a report embodying a scheme for an electric supply undertaking for Wood Green, which has been adopted by the District Council subject to the terms of an agreement with the North Metropolitan Power Company for a bulk supply being arranged to the satisfaction of the Council. The scheme starts with a small building, where the electrical energy would be received in bulk and split and regulated for distribution to the consumers throughout the area of supply. With regard to the system of supply, the system proposed by Messrs. May and Hawes is the three-phase alternating current, the extra high-pressure bulk supply being transformed at the distributing station from 10,000 volts to 3,000 volts, and thence transmitted at high pressure to sub-stations or transformer pillars. From the sub-stations distributing mains would be laid for a three-phase

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alternating-current supply at a low pressure of not exceeding 240 volts for lighting, and a medium pressure of not exceeding 415 volts for power purposes, the frequency being 50 complete periods per second. Under the scheme submitted the bulk supply would be delivered at a central point in the area (the vacant land adjacent to the free library and lying between the Station-road and River Park-road is recommended as an excellent site for the distributing station, being conveniently situated in the area of supply and also quite close to the power company's own depôt). It would then be transformed and distributed under the local authorities' own control to various small sub-stations placed at convenient points in the district. The distributing station would be equipped with transforming plant of a capacity of 500 kw., and the necessary switchgear and regulating apparatus. From the distributing station high-pressure feeder cables would be laid to three small transformer sub-stations.

A supply would be given from the sub-stations by means of four-core cables, the pressure for lighting being 240 volts and for power 415 volts, and the frequency 50 cycles per second. It is proposed to supply suitable house transformers at a moderate rental to those consumers who desire to make use of the new high-efficiency glow lamps. The house services would be made by means of twin or concentric cables, and small branch streets could be treated in the same manner.

The estimates provide an adequate sum for connecting up 450 consumers, including a sufficient number of meters. The pressure for lighting has been fixed at 240 volts, but in order to reduce the pressure so as to enable consumers to use metallic-filament lamps under favourable conditions, it is proposed to fix and maintain house transformers at quarterly rentals. The engineers recommend that the Council should put into active operation the powers conferred upon them by the Wood Green Act of 1903, to undertake the wiring of premises, but they advise at the outset that the house wiring scheme should be restricted to private dwelling-houses; that the work to be carried out by the Council should cover only the fixing of the wires, fuses, and switches, and that the consumers should be left to provide the movable fittings, lamps, and other consuming devices they may desire to use. The scheme provides for 51 "flame" arc lamps.

Dealing now with the financial aspect of the scheme, the estimate of capital expenditure is first given, and this may be summarised as follows: buildings, apparatus, mains, meters, transformers, etc., £27,000; house wiring, £2,500; public lamps, £1,750; total capital expenditure, £31,250.

The undertaking, if established on the lines recommended in the report, will be fully capable of dealing with a load of 335 kw. It is estimated that the output upon this load would amount to 397,000 units, divided as follows: for private lighting and power, maximum demand of 310 kw. used on an average for 2·85 hours per day, would represent an output of 323,000 units sold to consumers for public lighting, 25 kw. maximum demand giving an output of 74,000 units. The average load factor works out at the moderate value of 13·5 per cent., which is equivalent to a daily use of the maximum demand for about 3¼ hours. It is proposed to adopt the following tariff of charges: for lighting—private dwelling-houses, 4½d. per unit; shops, licensed premises, clubs, and places of business, 4d. per unit; public buildings, places of worship, and schools, 4d. per unit; for power—an average rate of 1¾d. per unit. Upon the estimate of the probable demand and output for the different classes of supply, this scale would be productive of an average revenue from the private supply of about 3·85d. per unit sold. For the public arc lighting a rate of 2d. per unit is proposed, which would be equivalent to a fixed charge of £12 per arc lamp per annum, this figure being exclusive of the trimming, cleaning, and maintenance charges, the actual cost prices of which would be refunded to the electricity department by the public lighting department.

The estimated working expenses connected with the delivery of 397,000 units to the private consumers and public lamps is 2·25d. per unit sold, and on this basis the financial results work out as under:

Revenue.

Private lighting and power supply—323,000 units at average price of 3·85d. per unit	£5,180
Public lighting—51 arc lamps, using 74,000 units at average price of 2d. per unit or, say, £12 per lamp per annum	612
Rentals of house meters and house transformers	300
	£6,092

Working Expenses.

397,000 units at 2·25d. per unit	£3,722
Gross profit	£2,370

This gross profit represents a yield of 8¼ per cent. upon the estimated capital expenditure of £28,750 upon the electric supply undertaking, which should be sufficient to cover the interest and repayment charges on the loan and still leave a substantial margin to the good available for appropriation for reserve purposes, etc. The net financial result is shown to be a balance to the good of £500 after payment of all obligatory charges, thus: gross profit, £2,370; loan charges (interest and repayment charges at 6½ per cent. on £28,750), £1,870—surplus, £500.

PHYSICAL SOCIETY.

At the meeting of the society held on June 25 Mr. A. Campbell read a paper on the "Measurement of Wave Length for High-Frequency Electrical Oscillations." The experiments had for their object the calibration of wavemeters for the measurement of the high frequencies (200,000 up to 1,000,000 ~ per second) used in wave telegraphy. Two wavemeters, A and B, were tested, both being of the type consisting of a series of self-inductance coils used singly, L, in series with a variable air condenser, K, and a thermo-ammeter, the reading of K being obtained by altering the capacity until the circuit shows resonance with the working circuit. The coils of wavemeter A were wound with solid wire, those of B with stranded wire (7/36's), each strand being separately insulated. The absolute value of the frequency was determined by photographing spark-trains in the primary circuit by means of a rotating mirror running at a constant and accurately-measured speed. As the following table shows, the value of the frequency, n_1, deduced from the measured values of K and L, with wavemeter B were in close agreement with the actual n deduced from the spark photographs.

n. ~ per second.	n_1. ~ per second.
290,300	290,500
516,800	516,800
818,000	821,200
1,042,000	1,039,000

With wavemeter A the agreement was naturally not nearly so close, but was much improved when the values of the self-inductances of the solid wire coils were corrected to the high-frequency values by the formulas of Heaviside and L. Cohen. The results in the above table show that the inductances of the stranded wire coils are practically unaltered for frequencies from 0 up to 1,000.000 ~ per second.

Mr. W. Duddell said the paper was a valuable one, because accurate experiments on self-induction and capacity at high frequencies were required. With reference to the photographs, he asked if the author had used his method to photograph arcs, and, if so, with what results. It would be interesting to know how low it is possible to get the apparent resistance of a coil with high-frequency currents by stranding the wire.

Dr. Erskine-Murray, referring to Mr. Duddell's remarks, said that in actual practice the resistance could not be reduced more than about 10 per cent. by stranding.

Mr. Taylor congratulated the author, and pointed out that the wavemeters described could only be used at the transmitting station. Wavemeters were required which could be used at receiving stations. Referring to the question of stranding, he pointed out that it was possible to overdo the stranding and obtain less satisfactory results than could be obtained by stranding with a fewer number of wires.

Mr. G. B. Dyke called attention to experiments similar to those described which were being carried out by Dr. Fleming at University College. With reference to the spark photographs, he was surprised that an accuracy of 1 in 1,000 could be obtained.

The Author, in reply, stated that as the whole distributed capacity of the inductance coils had very little effect on the frequency of resonance, the dielectric hysteresis of the ebonite would be negligible, except as regards damping. Sparks appeared to give sharper and more accurately measurable photographs than vacuum-tube discharges or arcs, except mercury arcs, which gave the clearest and best pictures.

A paper by Mr. F. W. Jordan on "An Instrument for Measuring the Strength of an Intense Horizontal Magnetic Field" was read by the author. The method consists in measuring directly the transverse force on a conductor traversed by a current in a direction at right angles to the field. Two copper strips of unform width, each cut to form three sides of a rectangle, are fastened together and connected by short tinsel leads to terminals, so that the current can be sent in the same direction through each of the insulated conductors. The framework is suspended in the field to be measured from a helical spring of phosphor-bronze. The tension in the spring can be adjusted to bring the framework into a sighted position. To make a measurement the horizontal conductors are arranged at right angles to the field, and a known copper weight is suspended from the centre. A current is passed through the wires and its strength adjusted until the framework is again in its sighted position. The strength of the field is then easily calculated. The results obtained with the apparatus using fields from 1,000 to 13,000 gausses agreed with those got by the ballistic method to 1 part in 400.

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BOARD OF TRADE ELECTRIC LIGHTING REGULATIONS.

The Board of Trade have issued a revised set of regulations for securing the safety of the public and ensuring a proper and sufficient supply of electrical energy in order to bring their own regulations into conformity with those issued by the Home Office for the use of electricity in premises under the Factory and Workshop Acts. An addition has been made to Clause 1, "Pressure of Supply to Consumers," (c) 1, relating to the supply for incandescent lamps in series: "The consumer's wires forming the connections to the incandescent lamps, or otherwise in connection with the supply, shall be completely enclosed in strong metal casing and this casing, together with the switches and lampholders, if metallic, shall be efficiently connected with earth." Clause 2, relating to the introduction of the three-wire system into consumer's premises, reads: "When the pressure between the outer conductors of a three-wire system exceeds 250 volts and the three wires of the system or two pairs of wires are brought into a consumer's premises, the supply shall be given to two pairs of terminals arranged in such a manner that there shall be no danger of any shock, and the wiring from those terminals shall be kept distinct." This regulation does not apply with the premises of a factory, a workshop, a mine, or a quarry.

Clause 3 reads: "An extra high pressure shall not be given to any consumer's premises other than a factory, a workshop, a mine, a quarry, or electric traction works; waterworks, sewerage, or drainage works; and no such supply shall be given to electric traction works, waterworks, sewerage, or drainage works except with the consent of the Board of Trade, and subject to such regulations as the Board may prescribe."

Clauses 9 and 10 relate to transformers and connections of transformers with earth. Clause 26 (main fuses or circuit breakers) has been amended by the addition of the following words: "No fuse or automatic circuit breaker shall be inserted in the immediate conductor of a three-wire system."

The amended regulations came into force on July 1 last, except as to so much of any electrical station as was constructed before July 1, 1908; after Jan. 1, 1910, they will entirely supersede the old regulations.

PERSONAL.

Mr. W. L. Brown, chief assistant electrical engineer to the Morley Town Council, has resigned.

The Postmaster-General has appointed Mr. D. Jones, overseer, Cardiff, to be postmaster of Mold.

The Liverpool City Council have decided to increase the salary of Mr. C. W. Mallins, the general tramways manager, by £100 per annum.

The Worksop Urban District Council have decided to increase the salary of Mr. H. A. Best, assistant electrical engineer, to £120 per annum.

The Union Electric Co., Park-street, Southwark, S.E., inform us that their Newcastle address is now Collingwood-buildings, Newcastle-on-Tyne.

Mr. E. Taylor, of West Ham, has been appointed by the Hammersmith Borough Council to the position of fourth assistant engineer of the electricity undertaking.

An honorarium of 100 guineas has been granted to Mr. P. Storey, the borough electrical engineer at Torquay, for his work in designing the plant to provide the tramway supply.

Mr. A. J. Brooks has been appointed electrical station superintendent at the Avonbank power station of the Bristol Corporation at a salary of £175 per annum, rising to £200 after six months' service, and then to £250.

Messrs. W. T. Glover and Co., of Trafford Park, Manchester, inform us that they have appointed Messrs. Haslam and Schontheil, of "Western Mail" Chambers, Cardiff, to represent them in South Wales for the supply of electrical wires, cables, and accessories.

The Osram and Robertson Social and Athletic Clubs had their first annual outing to Hastings on July 3. Some 550 members left Addison-road by special train and arrived in Hastings about 11 o'clock. The staff had luncheon at the Waverley Hotel, Mr. C. Wilson (manager) being in the chair, after which they drove to Battle, and left for London at 7.20, after a most enjoyable day. Amongst the visitors were Mr. Davey (chairman, Association of Electrical Engineers-in-Charge), Mr. T. D. White (G.E.C., London), Dr. Levy (D.G.A., Berlin).

At the London University College the Archibald P. Head Memorial Medal, 1908-9, has been awarded to Mr. R. A. Pfleiderer Engineering diplomas have also been awarded to Messrs. H. F. Anns (civil), E. E. Baily (civil and municipal), S. M. Hitchcock (electrical), J. W. Mason (civil), S. G. Nottage (electrical, with distinction), B. J. Pfleiderer (mechanical), R. A. Pfleiderer (mechanical, with distinction), A. C. Russell (mechanical, with distinction), A. M. Sims (civil and municipal), A. T. C. Sutton (civil and municipal), F. L. Thompson (civil and municipal).

The second annual athletic meeting of the various Vickers, Sons, and Maxim's works was held at the Vickers' Sports Club Ground, Carbrook, Sheffield, on July 10, teams from the following works taking part: Vickers, Sons, and Maxim, Sheffield, Barrow-in-Furness, Erith, and London office; the Wolseley Tool and Motorcar Co., Birmingham; and the Electric and Ordnance Accessories Co., Birmingham. Prizes to the total of £60 were offered, and in addition a 30-guinea silver challenge cup was competed for, to be held for one year by the works whose representatives secured the highest number of points. The start was made punctually at 2.30 p.m., and everything went smoothly and well to the finish, 6.15. Great credit is due to the various officials for the excellent manner in which everything was managed. In addition to those for employés only, there were several open events, including two for local school children. The holders of the challenge cup for the ensuing year are the Barrow works of Messrs. Vickers, Sons, and Maxim, who sent up a contingent of splendid athletes, and secured three firsts, three seconds, and two thirds, making a total of 17 points out of a possible 36. Considering only seven men were present from Barrow, this is a very meritorious performance, and worthy of the highest praise and commendation. The winners of the cup last year were the Electric and Ordnance Accessories Co., Birmingham. The Master Cutler (Mr. Douglas Vickers) was present during the afternoon, and owing to the unavoidable absence of his wife presented the prizes and challenge cup to the successful competitors. Major J. H. Leslie, the president of the Vickers Sports Club, proposed a vote of thanks to Mr. Douglas Vickers, which was ably seconded by Mr. M. Bennet, N.C.A.A. (the handicapper), and carried by acclamation.

CAR MAINTENANCE AT GLASGOW.

Mr. James Dalrymple, general manager of the Glasgow Corporation tramways, has prepared a most interesting series of tables showing in great detail the cost per car mile per year from 1903 to 1909 of the maintenance of cars. These tables appear in the July issue of the *Tramway and Railway World*, and we are indebted to our contemporary for publishing such interesting statistics, from which we may extract the following:

COMPARATIVE STATEMENT OF CAR MAINTENANCE AND INSPECTION.

—	Average per car mile — Year 1903	Year 1908	Year 1909
I. Car bodies, trucks, etc.	d.	d.	d.
Car body	·024	·035	·033
Hand brake gear and shoes	·040	·044	·043
Newell electromagnetic brake and shoes	—	·019	·018
Dashes and gates	·007	·004	·004
Stairs and stair rails	·002	·001	·001
Drawgear, brackets, sand-gear, and gongs	·005	·004	·005
Lifeguards	·010	·009	·009
Trucks	·037	·039	·033
Axles, axle boxes, and bearings	·006	·006	·018
Wheels	·045	·038	·049
Destination and slip boards	·007	·001	·003
Ditto signs and indicators	—	·004	·004
Sundry equipment (point shifters, etc.)	—	·002	·003
Repainting and touching up	·049	·063	·058
Miscellaneous (mechanical)	·011	·004	·004
	·243	·268	·284
II. Electrical equipment of cars.			
Trolley standards, poles, and wheels	·023	·024	·022
Power cables	·018	·010	·011
Lighting cables, lamp brackets, lamps, etc.	·009	·017	017
Bell wiring and bells	·013	·013	·013
Motor case and fasteners	—	·007	·007
Gears, gear cases, and pinions	·006	·010	·010
Motor, axle, and armature bearings	·021	·008	·012
Armatures	·010	·036	·026
Commutators	·004	·006	·004
Field coils	·005	·005	·008
Brush gear	·006	·008	·007
Rheostats, lightning arresters, etc.	·001	·003	·002
Automatic and canopy switches, etc.	·003	·005	·005
Controllers	·031	·047	·045
Miscellaneous (electrical)	·001	·003	·002
	·151	·202	·191
III. Engineers and draughtsmen.			
Salaries and wages (proportion)	·005	·003	·004
IV. Extraordinary expenditure on cars	·073	·082	·074
Total	·472	·555	·553

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

QUESTIONS.

1,198. Are there any homopolar dynamos at present in use, and for what purpose? Give a sketch showing the principle on which this type of machine is designed, and how is the voltage obtained.—H. D.

1,199. On a direct-current three-wire system (460 and 230 volts), when the middle wire fuse on the Board of Trade panel has blown, owing to a fault on either outer, what are the advantages and disadvantages of: (1) earthing the middle wire through a 16-c.p. lamp; (2) or earthing the middle wire through a low resistance, say about 6 ohms? Also state the electrolytic actions which occur under the above conditions. It may be mentioned that the middle wire of this system is somewhat faulty.—LOCALISER.

ANSWERS.

Question No. 1,188.—It has been decided to install an electrically-driven lift in an hotel in British Columbia. Electricity is supplied at about 400 volts, three-phase (four-wire), 50 to 75 cycles. Give the relative advantages and disadvantages of driving by (*a*) repulsion motor or, if preferred, by induction motor; (*b*) direct-current motor per motor-generator set. A quick start is favoured. Assume a five-storey building. Capital outlay need not be discussed.

Answer to No. 1,188 (awarded 10s.).—It is proposed to treat the problem under the following successive headings: (1) types of direct-current and alternating-current motor available and characteristics of each; (2) mechanical and electrical considerations regarding motors, gearing, and switchgear; (3) general inferences and conclusions as to most satisfactory motor; (4) advantages of electric over hydraulic or steam operation.

Type of Motor Available.—Treating, first, direct-current machines, the shunt and compound types are alone suitable for use on lifts. The series machine has a high starting torque, which but for the liability of the motor to race after attaining full speed would make this type very suitable for hoisting loads. Shunt motors are not usually considered suitable for services demanding high starting torques, and are only used in lift work on account of the much simpler switchgear then permissible. To enable them to cope with the starting torques required, specially strong fields must be allowed for, and a wide range of speed variation provided for by means of field resistances. A 2 : 1 ratio between highest and lowest speeds obtainable by varying the excitation is common in this connection. Compound motors for lift work have series coils assisting the shunt coils. The series turns give the high starting torque required, but when the motor has reached full speed they may be cut out, the shunt characteristic alone being suitable for the constant speed period of working, and the efficiency of the machine being raised by the removal of the series winding. The characteristic curves of shunt and compound motors are too well known to need reproduction here, and there is no doubt that motors of either of these types are the most suitable for lift service.

Alternating-Current Motors.—Synchronous motors may be at once dismissed as useless for the present purpose. Induction motors, single or polyphase, and with squirrel-cage or wound rotors or fitted with various compensating coils and connections, form a very wide field from which future developments may evolve a machine capable of competing with the direct-current motor in hoisting (and traction) work. In hoisting service, which is essentially intermittent and very trying to the motors, it is to be feared that no thoroughly reliable type of alternating-current motor yet exists. The low efficiency of alternating-current motors as compared with direct-current machines, the discrepancy usually amounting to 2 to 3 per cent. at least, and rising to 5 to 10 per cent. in extreme cases, is coupled with very poor starting torque capabilities, so that as a whole alternating-current machines are unfitted for lift service, and a motor-generator set supplying a direct-current lift motor should certainly be employed, especially in such a case as the present, where capital cost is not a vital matter. The over-all efficiency from the alternating-current mains to a direct-current lift motor shaft could hardly be expected to exceed 65 to 70 per cent., but the greater reliability and convenience and simpler switchgear would amply repay the increased running costs, especially since these are in any case low compared with those of hydraulic lifts (see later). If ordinary induction motors are used, "wound" rotors would be essential, and this would remove any advantages due to mechanical robustness and less liability to derangement from the alternating-current machines. Certain compensated types of alternating-current commutator motors might be used, but their efficiency is not high, usually about 75 per cent., and these machines are usually very costly, heavy, and complicated in themselves, disadvantages which are reflected in the switchgear necessary for their control. In passing, reference may be made to the Ferranti-Schuler one-phase motor, which is probably the most suitable alternating-current motor at present available for lift service. This machine, starting up as a repulsion motor, is *smoothly* converted to an induction machine by the closing of its rotor circuits through a gradually reduced resistance. By this device the advantages of repulsion and induction machines are combined. The starting torque is about twice full-load torque, the current taken being only about 80 per cent. in excess of full-load current—a great improvement on the ordinary induction motor, which taking 3 × normal current develops a full-load torque on starting. The starting torque of the Ferranti-Schuler machine varies almost directly with the starting current, and, in a particular case, the writer found the relationship between the starting torque and the current to be given by $T = 7{\cdot}15\ C - 28{\cdot}5$ (T in foot-pounds; C, amperes), this equation being satisfied over a range of current from $\frac{1}{4}$ to $1\frac{1}{2}$ × normal current: beyond this limit the torque fell off slightly with increased current (the falling off from the value given by the equation being about 6 per cent. when the current = 2 × normal).

2. Alternating-current motors of the simple induction class have the advantage over direct-current machines in the matter of simplicity of design, care needed during running, and general hardiness under unfavourable conditions, but this advantage does not extend to the special types of machine necessary if alternating current is to be used at the lift motor. Motors should always be totally enclosed and situated in as dry, clean, well-ventilated, and accessible position as is compatible with convenient coupling to the winding drum. The continual starting and stopping and heavy current rushes impose great strains on the switchgear controlling lift motors, and necessitate in it a most careful and liberal design. Under these circumstances the greatly added complexity involved by the use of alternating-current motors should only be incurred under absolute necessity. The motor controller is operated by a rope or chain passing through the lift cage in some installations, but in a large equipment of the present nature pilot switches should be fitted in the cage, these operating pilot motors at the shaft head, which in turn drive the heavy controller drum of the main motor. Where attendants are dispensed with in the lift, such automatic pilot buttons are essential. Their arrangement is much simpler and their action more reliable where direct-current is used than where alternating-current motors are employed. In all cases where automatic switchgear is employed this should operate at definite intervals of time, these being made amply long enough, even at the risk of slightly

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lengthening the acceleration period, rather than by relays depending on the successive growth of the current strength to predetermined values. The latter arrangement is theoretically preferable, but involves extra complications which are not justified in view of the indifferent technical skill of the lift attendant in most cases. Mechanical automatic cut-off gear should in any case be fitted to the winding drum and operated by the latter to prevent overwinding in either direction. Slack cable safety switches are usually fitted to cut off the current supply and apply safety brakes, should the cage or its counterpoise meet any obstruction. The safety mechanical friction brake should always be *held off by the current flow.* Suitable winding speeds range from 150 ft. to 350 ft. per minute.

3. The general influences in the choice of a motor include: the speed characteristic of the service required (this is usually rapid acceleration and subsequent constant speed at all loads in the cage); quiet starting and operation at all loads (aided by a sufficiently powerful motor and well-made worm gearing between it and the winding drum), all shafts being ring lubricated and the worm being lubricated by an oil bath; high overload capacity (largely depends on a liberal design and rating of the motor in the first place); and the frequency of service (some lifts serving private rooms may be used only a few times daily, while others—*e.g*, up the public staircase—may be in a continuous service). As has been mentioned, what is frequently the most vital consideration of all—capital cost—is here of

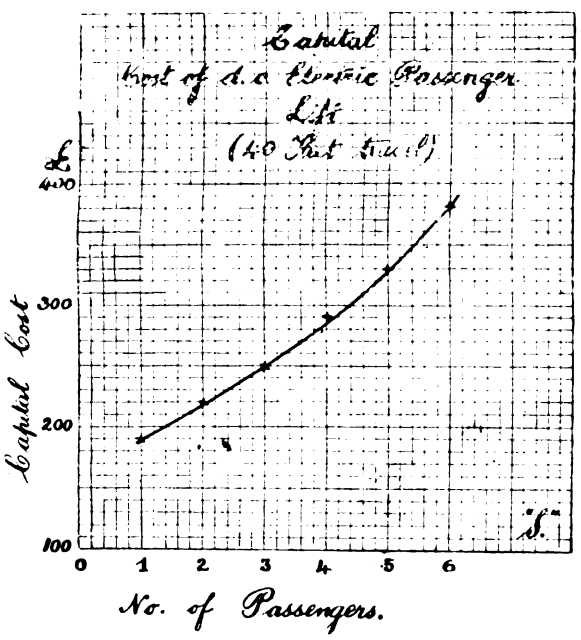

FIG. 1.

little importance, but in spite of the small importance attached to it the information included in Fig. 1 will probably be of interest. As the result of the above considerations it may safely be concluded that the direct-current system is far preferable in the present case, and it is a fact that it is recommended in preference to alternating current by all authorities on hoisting practice.

4. *Advantages of Electric over Hydraulic and Steam Lifts.*—Briefly summarised, these advantages are: easy, clean, and safe conveyance of energy to any desired spot; easy manipulation of the motors, quiet and clean working, unobtrusive nature of equipment, small space occupied, and no special foundations, pitch, etc, required, and quicker, cheaper service. Steam winding for lifts is practically unknown in private installations for obvious reasons, being costly, troublesome, dirty, and noisy. It is used in some factories, but the inconvenience and noise of square shafting, tumbler bearing, and so on is rapidly leading to the replacement of the steam-engines by electric motors. Hydraulic power is the only serious competitor of electrical energy in the matter of lift operation, and though the capital cost of electrical equipments is higher than that of hydraulic sets, the working costs are much less. These points are illustrated by Table I., while the information of Table II. (from actual tests) confirm these results and show the economy factor of electrical operation to range from 2·3 to 4·1, the mean value being 3·45. The rate for electrical energy on which these figures are based is 2d. per unit, while the hydraulic power rate is in accordance with the published scale of charges of the London Hydraulic Power Company.

TABLE I.

	Per cent.
First cost: high-pressure hydraulic	50 to 75
Low-pressure hydraulic	85 to 90
Electric	100
Efficiency at full load: high-pressure hydraulic	45·2
Low-pressure hydraulic	45·2
Electric	50·5

TABLE II.

Hydraulic Lift.

Load, cwt.	Cost per up and down tip per cwt., pence.	
7	0·0414	Mean
7	0·0636	0·0525
9	0·0358	Mean
9	0·0236	0·0288
9	0·0319	
12	0·0292	Mean
12	0·0350	0·0321

Electric Lift.

7	0·0227	
9	0·0073	Mean
9	0·0068	0·00705

Mean electric cost = 0·095d. and mean hydraulic cost = 0·326d per round trip; therefore, electrical economy = 3·45 : 1.

The attention required by electric lifts is possibly slightly more skilled than that needed to pack the glands, re-leather the plunger, and attend to the valves of the hydraulic installation, but the difference is very slight.—S.

Question No. 1,189.—What is the best form of cement or jointing arrangement for attaching *metallic* filaments to their supports in incandescent lamps? How should the same be applied? What effect has the material of the joint upon the vacuum—*i.e.*, by giving off gases?

Answer to No. 1,189 (awarded 7s. 6d.).—Paste containing Colloidal Metal.—One of the earliest forms of paste used for attaching metallic filaments to the leading-in wires contained as its principal constituent a refractory metal in a colloidal state, with or without an agglomerant. A colloidal solution was obtained by forming an electric arc in a non-conducting liquid between roughened electrodes of the metal. This solution was carefully evaporated or mixed with glycerine or alcohol, and the paste so obtained mixed with 50 per cent. of finely divided metal, and applied to the joint. After drying the joint was raised to a white heat, either *in vacuo* or surrounded by an inert gas. This paste has subsequently been improved by substituting colloidal oxides or hydrates for the colloidal metal.

Paste containing Carbides of Refractory Metals.—This paste is made by mixing powdered carbide or a mixture of a metal with carbon, or an organic compound with gum arabic, sugar solution, or other agglomerant. This paste is applied to the joint and raised to a white heat *in vacuo* or in an inert gas as before. The metals used are usually either tungsten or iron. In some cases a carbon compound of aluminium or silver, or both, is added to the mixture.

Paste containing Tungsten Oxide.—An early G.E.C. paste contained tungsten oxide mixed with glucose, and was used with filaments made from plastic threads of metal and glucose. The filament and joint were dried in a furnace at 250 deg., carbonised at 350 deg., placed in a bulb, exhausted, and raised to a white heat to drive off part of the carbon and reduce the oxides. The remainder of the carbon being eliminated by first oxidising and then reducing.

Paste containing Silver.—A paste due to the G.E.C., using silver, contained finely divided gas, free silver, and a decomposable compound of silver—such as the oxide. The paste was applied to the joint and heated to 300 deg. to decompose the oxide, and then by a flame or red-hot platinum wire to consolidate the metal. In a recent paste employing silver it is made in a thick paste with a volatile liquid, which is applied to the joint, and after drying is heated sufficiently to cause the silver to flow.

Paste containing Refractory Metal Powder.—In the G.E.C. paste of this class a refractory metal powder is mixed with a vaporisable inorganic compound, such as cadmium, amalgam, or cadmium bismuth alloy. After applying the paste the joint is heated in an exhausted bulb to expel

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the volatile products. The Howell paste consists of a mixture of finely-divided tungsten or copper with gum arabic for use with platinum leading-in wires, or iron and gum arabic for copper leading-in wires. The joint is made as follows: the filament, A (Fig. 1), is placed in a hook, B, on the leading-in wire and a small quantity of paste, C, placed in position. Electrical contact is made at D, and an arc drawn out by means of electrode, E, at the end of the hook. This melts the end of the hook and part of the paste to form a fused joint, the remainder of the paste being carbonised and strengthens the filament just beyond the joint, the point where trouble is most often experienced.

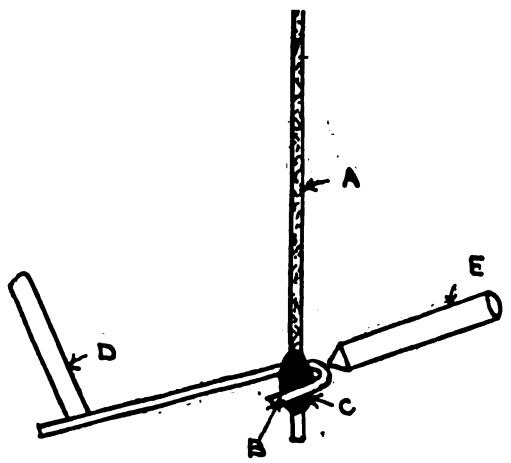

FIG. 1.

Paste containing Metallic Oxides and Aluminium.—In this method of jointing patented by the Westinghouse Company the parts are united by alloys which are produced at the joints by means of reactive mixtures of metallic oxides with aluminium, calcium cerium in equi-molecular proportions. A flux which does not act on the materials is added to the mixture, mercuric chloride with aluminium, alcohol with calcium. The filaments are placed in hooks as in Fig. 1, some paste applied which is dried and heated by current or otherwise to start the reaction. The alumina, etc., produced is removed by dipping in hydrochloric acid.

Of the pastes described, the last two are probably the best, but when using a paste of any kind there is

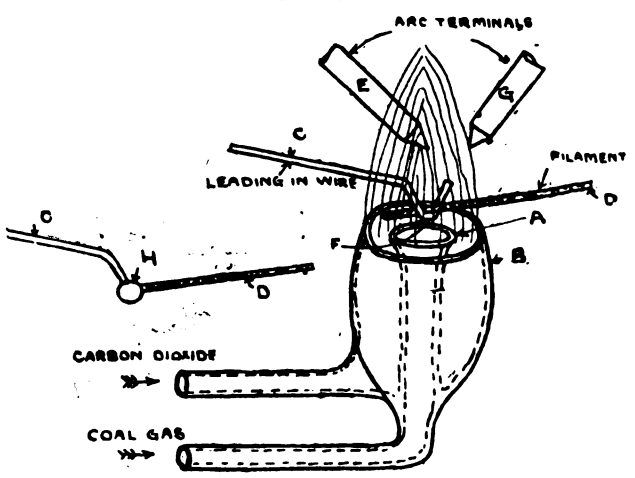

FIG. 2.

always a possibility of a small portion of carbonaceous or vaporisable matter remaining, which under the continued heating action of the incandescent filament might disintegrate or act injuriously on the filament. As in all the methods the joints are raised to a white heat before finally sealing off, the amount of gas given off after sealing is usually not sufficient to seriously affect the vacuum.

A more modern method is to employ a simple fused or welded joint without the use of a paste of any kind. An electric arc is usually employed to melt down a portion of the leading-in wire, and produce a globule of metal surrounding and in intimate contact with the filament. The difficulty with this method is that such metals as tungsten are readily oxidised, and must therefore be protected from the damaging effect of the arc when the weld is made. Several methods for obviating this difficulty have been proposed, such as performing the operation in an inverted vessel containing coal gas, or by projecting a stream of nitrogen against the joint during the fusing operation and so prevent the air coming into contact with the joint. In another method the fusing operation is performed under the surface of a liquid, such as alcohol or turpentine, which yields reducing compounds or inert gases when decomposed by the arc. Probably the best and simplest method is that patented by the British Thomson-Houston Company, and consists in conducting the fusing operation in a stream of reducing gas (coal gas) which is prevented from firing by surrounding it with an atmosphere of inert gas (carbon dioxide). Not only does the gaseous jet prevent oxidisation, but by its cooling action ensures a rapid solidifying of the fused metal, and therefore a compact joint, and further assists in controlling the length and position of the arc.

A convenient form of apparatus for carrying this out is shown diagrammatically in Fig. 2, and consists of a small nozzle, A, supplying coal gas, surrounded by a larger nozzle, B, supplying carbon dioxide. The leading-in wire, C, and filament, D, are supported by suitable clips so that the joint is directly over the small jet, then the electrode, E, is put into contact with the wire, C, and an arc drawn out at the end of the hook, F, by means of electrode, G, causing the metal to form a globule, H, as shown in Fig. 3. In some cases the electrode, E, in the form of a platinum wire is permanently fixed in the centre of the nozzle, A, to ensure when using unskilled labour that the welding operation always takes place in the reducing jet.—A. B. C.

Answer to No. 1,189 (awarded 7s. 6d.).—Metallic filaments may be, and are at the present day, secured either by a paste or cement of varying composition or by mechanical means. It may at once be stated that the latter method is, on the whole, preferable if well executed, but, bearing in mind the conditions of manufacture, the former is most likely to give a high percentage of satisfactory joints, and has, therefore, been most widely adopted.

The paste or cement employed may be composed of any of the various mixtures which have been specified from time to time as being suitable for the manufacture of the filaments themselves. These mixtures are too diverse and numerous to permit of detailed mention here, but, in general, they consist of: (1) a paste of finely divided metal (W, Os, Ta, etc., according to the filament material) mixed with certain organic binding materials—*e.g.*, paraffin or carbon—or rare earths—*e.g.*, thorium oxide—or with ductile metals of comparatively low melting point—*e.g.*, copper, nickel; (2) a colloidal or albuminoidal compound of the metal of which the filament is composed; (3) certain salts of the metal of the filament, alone or mixed with colloids. These preparations are reduced to the metallic form by the action of heat alone or by reduction by incandescing in an atmosphere of hydrogen. Whatever the exact mixture and process employed in the filament manufacture, it is clear that if a similar mixture be used to joint the finished filament to its leading-in wires, and be then subjected to the heating or reducing action, the paste will be converted to metal just as in the former case. This is a principle widely employed at present, and though a satisfactory mechanical and electrical joint can usually be so effected, the method is not universally applicable, since some filaments are subjected to processes to which it would be impossible, for economic or other reasons, to subsequently submit their terminal joints. It is not always necessary to employ such a complicated process for the jointing as for the filament manufacture. Thus, while a very complex series of operations may be involved in the production of a certain metallic filament in satisfactory form, it often suffices to use for the jointing a simple paste of the ground metal and, say, paraffin, a permanent mechanical joint being completed by heating off the paraffin and "sintering" the finely divided metal to a coherent and adherent mass (by electric or external heat).

In all the above methods the paste is mixed to a fairly fluid consistency and applied with a small brush, the ends of the filament being hooked through wire loops, bent

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round the leading-in wire or nipped into place by tweezers, in order to hold it in position till the paste sets or is "burnt on." Instead of applying the metal to the joint as a paste, it may be deposited from a volatile compound of the metal (say tungsten chloride in the case of tungsten filaments). The joint is made roughly mechanically, and is then incandesced by the passage through the imperfect joint of an electric current in an atmosphere of the metallic compound. The metal is then deposited on the heated parts just as carbon is deposited on the Pt-C junction of carbon lamps when the joint is incandesced under the surface of benzine or in a volatile hydrocarbon. The clips employed in such a case may be identical with those used for carbon filaments. The Westinghouse Company (British patent No. 18,923 of 1907) claim that a durable joint may be effected between leading-in wires and metallic filaments by an alumino-thermic method. Metallic oxides, of the metals of which the leading-in wires and the filament are composed, are mixed with finely divided aluminium, and, the action being started by heating, a thorough welding together is obtained at the joint.

Such jointing materials as the above, being simply metal globules when the process is complete, do not affect the vacuum of the lamp in the least. Owing to the very high temperature of metallic lamp filaments, no jointing material capable of thermal or electrolytic dissociation must be used. Carbon must never be used at the joint, not only on account of its rapid subsequent volatilisation, leading to a defective joint and blackening of the lamp bulb, but also because the carbon would combine with the metal of the filament to a greater or less extent, forming a carbide

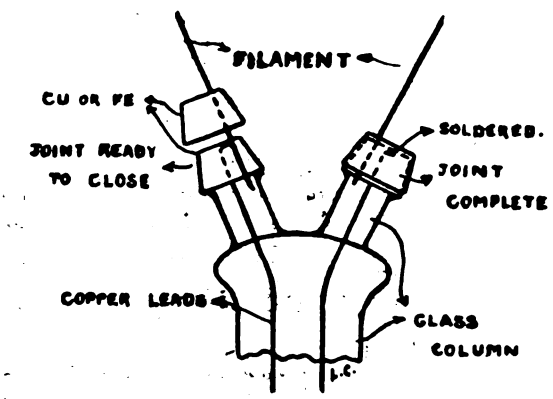

FIG. 1

which, in most cases, would so alter the electrical and mechanical nature of the filament as to lead to rapid failure. For this reason, no carbonaceous paste must be used for securing metallic filaments, the metals at present used (Ta, Os, W, etc.) being especially liable to such contamination.

A method of securing mechanical contact to the filament is indicated in Fig. 1. This system is not so satisfactory as the methods described above and below, but has the advantages of avoiding the necessity for platinum leading-in wires and of simplifying manufacture by enabling the jointing to be completed in one operation (no subsequent baking, etc., required). As shown in the sketch, the glass leading-in column has two short glass tubular extensions at its inner end. To the open end of each of these tubes are sealed sheet-iron or copper caps about $\frac{1}{100}$ in. thick, slightly conical and provided with copper tails, soldered to their inner sides, these tails forming the terminal leads of the lamp. Owing to their thinness, no difficulty is experienced in sealing these metal caps to the glass, and by their position they are immune from mechanical injury. A slightly tapered ring is slipped over the leg of the filament, the end of the latter is laid down the flank of the tapered cap, and the ring pushed down on to the cap, so nipping the filament between the latter and itself. This system gives fairly good electrical results, but the other methods mentioned are preferable.

Tungsten, the metal which has, at present, such bright prospects as regards its future use in metallic-filament lamps (its efficiency being 1·3 × that of osmium and tantalum lamps, and its mechanical properties being superior in many respects), has certain very fortunate characteristics from the manufacturing point of view. This metal (and to a less extent osmium and molybdenum) is brittle when cold, but very soft and ductile when hot. This fact opens up several very neat methods of manufacturing tungsten filaments (such as drawing through hot dies, etc.), but the point which at present concerns us is that by nipping tungsten filaments on to their leading-in wires by *hot pliers* a very satisfactory *mechanical and electrical* joint is obtained. The operation can be carried out in air, the temperature required being below visible red heat and below the temperature at which oxidation of the tungsten commences. So apparent is this adhesive tendency of tungsten filaments *when hot* that the guiding loops for the filaments must be made of or covered with refractory materials (usually a species of porcelain made from rare earths) to prevent the metal of the filament sticking to them. Another valuable property of tungsten which may be employed in jointing is the ease with which it can be welded by means of an arc (which may be struck with the tungsten itself as one electrode). This property is frequently demonstrated by the self-repair of the broken filament of a tungsten lamp, by arcing between and consequent sticking of the ends of the fracture. Such a joint is quite durable, and if it be effected the lamp frequently lasts another 1,000 to 1,500 hours. Applying this action to the jointing of the filament to its terminal leads, the ends of the latter are melted by an arc to form small globules which securely hold the filament.

Of the methods described above, most are in more or less extensive commercial use at the present day, but, undoubtedly, the paste and the welding or fusion methods are most widely used. The welding method needs no more than manipulative skill to enable its execution, but the composition of jointing pastes is very variable, and, being still in the experimental stage, is likely to alter for some time to come. Nevertheless, the general nature of such compounds has been given sufficiently definitely to enable successful experiments to be conducted as to the best material for any particular case—this depending on the size and shape of the filaments and lamp bulbs, the methods of manufacture, and the number of lamps dealt with per day.—L. C.

INSTITUTION OF MINING ELECTRICAL ENGINEERS.

At a meeting held on Thursday, the 8th inst., at Ilfracombe, under the chairmanship of Mr. H. J. F. Stewart, A.M.I.E.E., it was unanimously resolved to form a branch of the above institution, there being many prospective members present, and among them several mining engineers and managers from the Gloucester and Somerset coalfields and the Cornish tin mines.

The Chairman, in opening the proceedings, said that the meeting had been called in accordance with the resolutions carried at the inaugural meeting of the institution at Manchester on April 24, when Mr. W. Maurice, F.G.S., M.I.E.E., M.I.M.E., the general manager of the Hucknall Colliery Company, Limited, occupied the chair. Meetings have been held in other parts of the country, and at the present time there were 12 centres. He then gave a detailed explanation, which had already appeared, of the origin, aims, and progress of the institution, and referred to the various organising and administrative points which would be settled at the next general meeting. In conclusion, he remarked that the southern section would cover a very large district, but, as a matter of fact, its mineral area was almost entirely confined to the western counties, and London, therefore, as its headquarters was quite out of the question. On the other hand, this part of Devon was about midway between the Gloucester mines and the wheals of the duchy, and, seeing the unique nature of its mining operations in these islands, he hoped the Stannaries would send strong support to the institution. Altogether the number of applications already received was entirely satisfactory, the members and associates showing the total to date of 230.

After answering a number of questions it was resolved to form a local branch of the institution, and several names were accordingly added to the list of members. It was further agreed that the hon. secretary should be asked to approach Mr. H. Hood Haggie, A.M.Inst.C.E., M.I.E.E., M.I.M.E., with a view to his election as president of the section.

A small provisional committee was elected, of which Mr. H. J. F. Stewart consented to act as chairman until the general meeting in September. The proceedings then terminated with a vote of thanks to the chairman.

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CONTENTS.

Domestic Electric Heating and the Central Stations ...	57	Manchester Corporation Electricity and Tramways Departments	68
The Electric Lighting Bill ...	58	Physical Society	69
Coal Trade Crisis	58	Technical Problems, with Solutions by Practical Men	69A
Is Central - Station Work Played Out?	58	Institution of Mining Electrical Engineers..... ...	72A
The Engineering of Ordnance	59	Board of Trade Electric Lighting Regulations	70
Telephone Exchange Fires ...	61	Personal	70
Electric Cooking by "Silundum"	61	Car Maintenance at Glasgow	70
New-Pattern Reflector Lamp	62	Correspondence	71
The "Petter" Patent Oil Engine.....	63	Appointments Vacant	71
Freight Locomotives for the New York, New Haven, and Hartford Railroad.....	63	Legal Intelligence.....	71
Public Lighting in the City of London	64	Companies' Meetings and Reports	72
Electricity Supply Tariffs ...	65	Lighting Notes	74
Some Elementary Considerations of High - Tension Switchgear	66	Traction Notes	76
British-Made Metallic-Filament Lamps	67	Contracts for Electrical Supplies	77
Wood Green Electric Lighting Scheme	68	Provisional Patents, 1909 ...	81
		Specifications Accepted	82
		Companies' Stock and Share List	82
		Traffic Returns	84

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C.*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC LIGHTING ACTS (AMENDMENT) BILL.

SIR,—May I direct the serious attention of electrical companies to the grave danger of allowing this Bill to pass in its present form. The Bill does not give effect—as might be inferred from the memorandum accompanying the Bill—to the recommendations of the joint committee of 1898, nor does it carry out the promises made by a former president of the Board of Trade. On the other hand, it imposes fresh conditions of a very onerous kind on electrical companies.

The effect of Clause 6 is to empower the Board of Trade to authorise a local authority to supply outside its area and to compete with a company without the consent of such company, while a company can only be authorised to supply outside its area and compete with a local authority with the consent of such local authority. Clause 13 relates to the audit of companies' accounts. Under this clause a company may be compelled to comply with the recommendations and requirements of the Board of Trade auditor in regard to matters affecting the interests of the authority empowered to purchase the undertaking. In view of the fact that many electric lighting companies have agreed with the local authorities on special terms of purchase, this clause is exceedingly dangerous to the interests of such company.

No one doubts the impartiality of the Board of Trade officials, but they cannot be expected to do more than fairly interpret the law, and if this Bill becomes law, many electric lighting companies are certain to suffer grievous injustice. It is safe to say that there is no precedent for this kind of legislation in the law affecting any other industry in this country.

Does anyone still doubt the urgent necessity of the electrical industry possessing some organisation which will protect its interests in these matters?—Yours, etc.,

July 12, 1909. E. GARCKE.

QUESTION 1,188.

SIR,—Kindly permit us to refer to a point in the answer to the above question by "Wren," published in your last issue. With regard to the efficiency of reduction gears used for electric lifts, he gives this as "80 to 90 per cent. or over." We do not say that it is impossible to obtain this efficiency from worm gear, but it would certainly be very objectionable for passenger lift work, owing to the fact that the angle of the worm would have to be so great that it would allow the load to drive the motor. The safety of the cage and its contents would, therefore, depend entirely upon the break. Should this fail to act for any reason, there is nothing to prevent the lift falling. It has always been the practice of best English makers to sacrifice a certain amount of efficiency in order to obtain greater safety by designing the angle of the worms such that it will not allow the load to drive the motor; this brings the efficiency out at about 50 per cent. The loss of efficiency does not amount to a great deal, as shown by the fact that the average total cost of energy is about 4d. per car mile for a five-passenger lift, the average for a busy city lift being about three car miles per day.

Should your inquirer be sufficiently interested to communicate with us, we should be able to show him either direct, single, or polyphase lifts in actual operation, and give him any information regarding them.—Yours, etc,

A. W. PENROSE AND CO., LIMITED.

109, Farringdon-road, E.C., July 14, 1909.

APPOINTMENTS VACANT.

Private Agent for sale of article selling with telephone wire. See advertisement.

Improver.—The Stretford Urban District Council invite applications for an improver, about 18 years of age, at the electricity generating station. Applications to Mr. R. Rowland, resident engineer. See advertisement.

Assistant Engineer.—The Municipal Council invite applications for the position of assistant engineer. Age not above 25 years. Candidates must have been articled to a civil engineer and possess a practical knowledge of municipal engineering in all its branches. Salary, Rs.4,500 per annum, and allowance Rs.900 per annum—*i.e.*, Rs.600 for a horse and Rs.300 for a rickshaw. Applications, stating age, etc., must be addressed to the Chairman, Municipal Council, Colombo, by Aug. 15. Further particulars from Mr. R. Skelton, municipal engineer, care of Crown Agents for the Colonies, London.

LEGAL INTELLIGENCE.

TRAMWAYS ASSESSMENT APPEAL.

On the 1st and 2nd inst. the appeal of the Rhondda Tramways Co. against the assessment placed upon their undertaking in the Pontypridd union came before the Glamorgan Quarter Sessions at Cardiff.

Mr. J. Sankey, K.C., and Mr. A. Parsons appeared for the Assessment Committee, and Mr. E. Page, K.C., Mr. R. W. L. Vaughan-Williams, and Mr. G. I. Phillips represented the appellants.

Mr. C. Spencer Hawes, M.I.E.E., Mr. G. Humphreys-Davies, Mr. W. B. Cownie, and Mr. Nisbett gave evidence on behalf of the appellants, and Mr. A. L. Ryde, Mr. Lacey, and Mr. G. Phillips for the Assessment Committee.

After hearing the evidence of both parties, the Sessions decided to allow the appeal with costs, and reduced the assessment from £16,000 gross estimated rental and £6,250 rateable value to £13,500 gross estimated rental and £5,500 rateable value.

ELECTRICAL MACHINERY DISPUTE.

In the City of London Court, before his Honour Judge Lumley Smith, K.C., and a jury, a claim was made by Messrs. J. T. Williams and Sons, South Bermondsey, against the Beckenham Urban District Council to recover £74. 15s. 2d. for work done in repairing a burnt-out armature and supplying a new governor valve and spindle in respect of certain electrical machinery. Mr. Warren appeared for the plaintiffs, and Mr. Richards for the defendants.

Plaintiffs' case was that a contract was made between the parties for the hire of a Siemens generating set used for supplying electrical power. It had been used by the Underground Railway Co. for generating electrical power. They only wanted it for temporary purposes, and the plaintiffs bought one of two sets which were sold. On Oct. 16, 1906, defendants agreed to hire the set of the plaintiffs at the rate of £60 a month for six months certain, and if the defendants wanted to purchase the price was fixed at £1,430. If the defendants decided not to purchase, the hire was to be increased to £125 a month. At the expiration of the hire defendants were to return the machinery in the same good condition as when they received it, fair wear and tear only excepted. The Court would not be concerned about the purchase. Plaintiffs' case was that the defendants did not return the machinery as they received it. An armature became burnt out in the course of using it; hence plaintiffs' claim for necessary repairs. As to the governor valve, when the machinery left defendants' hands it was discovered that there was a flange that had been cracked

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or broken. All the repairs were due to the machinery firing. It was afterwards disposed of to the Southampton Corporation.

Mr. RICHARDS, for the defendants, said that they only ran the generating set for 109 hours during the six months that they had it. Therefore, they could not have caused the repairs sued for to be necessary. They refused to pay because they did not get what was bargained for. Legal proceedings were brought by the plaintiffs, and any possible claim that could now be made was, he urged, settled in a previous action under the head of "damages for breach of contract," when plaintiffs received £500. The case would never have been settled if it had not included everything in dispute between the parties.

Mr. WARREN contended that there was no settlement of the present cause of action. The defects complained of were only discovered after the £500 was paid.

Judge LUMLEY SMITH, K.C., held that the plaintiffs could not recover after the previous action, and he found for the defendants, with costs.

COMPANIES' MEETINGS AND REPORTS.

BRITISH ELECTRIC TRACTION.

The annual general meeting of the shareholders in this Company was held last week, Sir Charles Rivers Wilson (the chairman) presiding.

The CHAIRMAN, in moving the adoption of the report, said that accompanying the annual report was a separate document giving particulars and statistics relating to the associated companies, from which it would be seen that a unique and economical organisation had been devised for the administration of about 60 undertakings, which, although they had many interests in common, had to be maintained as separate entities for legal and other reasons. The enterprises in which they were interested had taken many years to develop. While they were passing through the period of construction and growth it was impossible to present to the shareholders and the public the consolidated and matured information they could now afford. The directors felt disappointment that the net result of the heavy work of the last 13 years had not been more profitable in recent years. They had always looked forward to the time when these undertakings would be able to return such profits as to compensate amply for the exertions which had been made, but, unfortunately, they had fallen upon bad times. They had been subjected to unnatural competition and opposition by the local authorities. They had had to submit to a gradual but serious reduction of fares, representing a loss of something like £200,000 per annum, and now their difficulties were aggravated by the exceptional trade depression prevalent all over the country—such depression as he felt himself warranted in describing as the most severe and general the country had experienced since its adoption of Free Trade. It was inevitable that the receipts of tramway companies should suffer under these circumstances, and that people should endeavour to keep down their electric light bills. If there were no profits there could be no creation of fresh capital, and without new capital there could not be extension of enterprise. The revenue from the associated companies was about £33,000 less than in the previous year, a large number of the companies having paid slightly reduced dividends in consequence of smaller profits and larger outlay on repairs and maintenance. In the aggregate the traffic receipts from the federated companies showed an increase, but this was due mainly to the increases at Auckland and Bombay, while in the case of the Metropolitan Co. additional lines had been opened. He hoped that with a revival of trade the receipts would again increase, but he confessed his inability to predict when such a revival might be expected. For the current year, while they had been able to hold their own, as compared with 1908, there had been no marked improvement, and unless trade revived before the end of the year he feared that the dividends of the associated companies for 1909 would not show any material increase. It had been their hope to pay the reduced dividend of 3 per cent. per annum on the preference shares as a minimum dividend by a regular half-yearly instalment in August and February. The profits for the past year, however, were £15,000 less than the amount required to pay 3 per cent. on the preference shares—that was to say, they had brought forward £35,393 and would carry forward only £20,203 after paying this dividend. Unless the net profits increased it would obviously be unwise to pay the same dividend for the current year, and the directors were of the opinion that, unless the prospects materially improved, it would be wiser to suspend the payment of preference dividend until the accounts for the year were made up. The officers of the Company had been engaged in endeavouring, wherever possible, to increase the extremely low level of fares. The average per passenger in 1908 was only 1·23d., an improvement of ·02d., as contrasted with 1907, an apparently trifling increase which represented £24,000, or six months' interest on the preference shares. In 1901 the average fare was 1·38d., and if they could return to that figure the increase in the revenue would be no less than £200,000. With regard to the Brush Co., practically every other manufacturing company was similarly situated, and it was not possible to ascribe the troubles of that undertaking to other than general causes. A very small measure of tariff reform would make an enormous difference to the prosperity of the electrical industry generally. At the previous meeting he had mentioned that the Board were considering various proposals for electrical enterprises in other countries, where the conditions for the investment of capital were more favourable than at home. The managing directors had been much engaged during the year in examining and following up business of this description. Steps had been taken with a view to securing a concession for the tramways in St. Petersburg, accompanied by contracts for the work of construction. They were exposed to very powerful competition, but had been able to join forces with German and Russian competitors, and, under the auspices of powerful financial institutions, a syndicate had been formed, by means of which the chief competition for this concession had been eliminated. The Company had a substantial participation in the syndicate. Other negotiations were pending in regard to enterprises abroad.

Mr. EMILE GARCKE (joint managing director), in seconding the motion, said that no industry in the country laboured under such onerous legislative burdens as the electrical industry. The Board of Trade in the present session had introduced the Electric Lighting Acts (Amendment) Bill, containing clauses detrimental to the industry without being beneficial to the public, and the Bill was being referred to a Standing Committee instead of a Select Committee, so that parties interested—like the British Electric Traction Co.—would be unable to appear and give evidence. One clause of the Bill gave power to local authorities with electric lighting undertakings to go outside their areas and compete with companies without the consent of the latter, which could not, however, go outside their areas and compete with local authorities without the consent of those authorities. There were other obnoxious clauses in the Bill, which, if passed, would cause further depreciation of the securities of such companies. It was impossible to read the Bill without feeling that it had been drafted with intent to prevent private enterprise from further engaging in the electrical industry; and it applied not only to future undertakings, but to those already in existence. No human effort could contend against legislation of that kind.

The resolution was, after a short discussion, unanimously adopted.

BOMBAY ELECTRIC SUPPLY AND TRAMWAYS.

The ordinary general meeting of this Company was held on Tuesday last, Sir Edward Sassoon, Bart., M.P. (the chairman), presiding.

The CHAIRMAN, in moving the adoption of the report and accounts, said that the net receipts, as the result of the year's operations, amounted to £67,066, compared with £40,880 for the previous year, an increase of £26,186. After deducting the proportion of debenture interest, amounting to £24,592, chargeable to revenue, there remained the sum of £42,474, to which had to be added the amount brought forward, £2,889, making an available total of £45,363. The preference dividend paid to Aug. 15, 1908, together with the accrued dividend to Dec. 31, amounted together to £33,977, leaving £9,385, which the directors recommended should be carried forward. The total revenue from all sources, including the amount represented by the sale of current to the tramways, amounted last year to £177,855, an increase of £49,935, and this additional revenue was obtained at an increase in the expenses of only £23,749. The traffic receipts derived from working the tramways accounted for £21,195 of the gross increase, and the receipts from the electric supply account for £26,148. Ten additional cars were to be added to the rolling-stock during the year, making a total of 172. The total receipts of the electric supply branch of the undertaking amounted to £47,714, compared with £21,566, while the working expenses amounted to £39,737, compared with £19,544. The proportionate increase in working expenses was to be accounted for by the fact that over 66 per cent. of the total units sold were sold to the tramways, on which only a very small profit is made. Excluding the amount represented by the current supplied to the tramways, the gross receipts from the electricity supply branch of the business amounted to £25,683, compared with £17,707, an increase of nearly £8,000. The balance carried to profit and loss account was £7,976, compared with £2,021, an increase of about £6,000. During the past year 215 consumers were added to the mains, representing 40,238 equivalent 8 c.p. lamps. The progress was being well maintained this year, as up to end of May they had connected 135 new consumers, representing 20,629 equivalent 8 c.p. lamps. Having regard to the increasing business, and with a view to lowering the cost of generation, they had completed arrangements for erecting a new generating station at Kussara Basin. Negotiations were in progress for a supply of electric power to the Bombay, Baroda, and Central India Railway workshops at Parel, which would take a supply of about 500 kw., while other important contracts were also being negotiated, so that the supply thereunder might commence about the date when the new power station would be completed and working early in 1911.

Sir CHARLES OLLIVANT seconded the motion, which was unanimously carried.

NEW GENERAL TRACTION.

The annual general meeting of this Company was held on Tuesday, Baron Emile B. d'Erlanger (the chairman) presiding.

The CHAIRMAN, in moving the adoption of the report, said that the receipts from the Coventry property for 1908 were exactly the same as for 1907, whilst those from Norwich were £913 less, and from Douglas £58 less. On the other hand, the Philadelphia property paid £482 more than in the previous year, represented by the increase of ½ per cent. in the rate of dividend on their shares in that undertaking for the second half of 1908; and the interest received on the outstanding balances owing to them by the Coventry Co. on construction account was £1,050, against £750. The result was that their receipts were practically the same as in the previous year, being, in fact, only £190 less. In addition to the income mentioned, however, they had also received out of the profits of the Coventry Co. for 1908 a further payment of £1,000 on account of the indebtedness of that company to the Traction Co., which payment would appear in the next year's accounts. Turning to the debtor side of the profit and loss account, general expenses etc., showed a reduction of £518 and interest on loans a reduction of £356, the result for the year being that they had a small profit to show of £427. They had, since the date of the last annual report, disposed of a further amount of £5,000 of the bonds of the Philadelphia property, which reduced the total amount of securities

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held at March 31 last to £643,248. Since that date they had realised, yet further, about £12,000 of those bonds, which had been sold at better prices than those previously obtained—viz., 95. The receipts for the year from their various subsidiary companies showed their position. As to Norwich Tramways, the directors of that company had for some time been hard at work, together with the manager, trying to devise some means by which the expenses might be reduced and the traffics increased, and he was glad to think that those efforts were bearing fruit.

Mr. E. A. HOPKINS (managing director) seconded the motion, which was carried unanimously.

NATIONAL TELEPHONE.

The report of the Company for the half-year ended June 30 last, to be presented to the meeting on the 22nd instant, states that the income accrued in respect of the business of the half-year amounts to £1,546,837, as compared with £1,452 569 for the corresponding period of 1908, an increase of £94 268. The working expenses for the half-year amount to £893,767. as compared with £828,969 for the corresponding period of 1908, being an increase of £64 798. The net result for the half-year (after deducting the Post Office royalties amounting to £148 951) is a profit balance of £501,118. as compared with £484 068 for the corresponding period of 1908, being an increase of £20,050. The rentals carried forward for unexpired terms of running contracts amount to £1,366,283, as compared with £1,314 591 at the corresponding period of 1908. being an increase of £51,692. Out of the available balance of £379,850, shown by the net revenue account, the Board recommend the payment for the half-year of a dividend at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred stock, and 6 per cent. per annum on the deferred stock, less income tax in all cases. The Board also propose to transfer £150,000 to the reserve fund account, and to carry forward the balance of £11,100. The sum of £313 393 has been expended on capital account during the half-year in the erection of 13,848 additional exchange and private stations, and in the construction of underground works.

GENERAL ELECTRIC.

The report of the General Electric Co. for the year ended March 31 last, to be submitted at the ordinary general meeting to be held at 71, Queen Victoria street, London, on Monday, the 19th inst., at 12 noon, states that the net trading profits and income from investments, etc., amount to £78,200 ; after deducting depreciation and debenture interest amounting to £26,987 there remains a balance of £51,213, out of which the dividend on the preference shares at the rate of 5 per cent. for the year ended March 31, 1909, has been paid, absorbing £12,500, leaving an available balance of £38,713, which the directors recommend should be appropriated as follows: provision for managing directors' and employés' bonus, £3,871 ; provision for dividend on ordinary shares at the rate of 5 per cent. for the year ended March 31, 1909, £18,697 ; to reserve account £16,144. The reserve account stands in the accounts at £120,343, being the amount of undivided profits as at March 31, 1908. The proposed appropriation of the undivided profit of the year ended March 31, 1909, amounts to £16,144, giving a total of reserve account of £136 488. The result of last year's working can be considered satisfactory in view of the prevailing depression in the engineering trades. The works of the Company at Witton, Salford, Birmingham, and London have been profitably employed throughout the year, although they have not been working up to their full capacity. The Osram metal-filament lamp has established during last year a great reputation. A considerable proportion of lamps recently supplied have been produced at the new works at Hammersmith, and the quality has proved in every respect equal to those supplied by the Continental factory. The Company's telephone works at Salford have been considerably extended. Further ordinary shares to the number of 1,342 have been allotted during the period covered by the accounts to the directors and staff at par. Mr. H. Bevis tendered his resignation as director, which was accepted by the Board. Mr. Ernest G. Byng retires by rotation from the position of director, and offers himself for re-election.

ELECTRIC CONSTRUCTION.

The report of the directors, to be submitted to the shareholders at the sixteenth annual general meeting of the Company to be held on Thursday, July 15, 1909, at Winchester House, 50, Old Broad-street, London, E.C., at 12 noon, states that the net profit for the year ended May 31, 1909, after payment of £10,250 for debenture interest, and crediting £5,000 as formerly to depreciation account, is £10,731. The sum brought forward from last year is £1,746, and the amount available for dividend is, therefore, £12,477. From this amount there has to be deducted the dividend on the 7 per cent. cumulative preference shares for the year ended May 31, 1908 (paid Jan. 15, 1909), £4,394, leaving for distribution £8,083. The directors now recommend a dividend on the 7 per cent. cumulative preference shares for the year ended May 31, 1909 (to be paid on July 31), which will absorb £4,394, leaving a balance to be carried forward of £3,683. The increase in the volume of business referred to in last report is reflected in the foregoing results, which show a considerable improvement on those of the past few years. The reduced demand for electrical plant, caused by the introduction of metallic filament lamps and the general depression in trade, affected the volume of home orders received by the Company during the past year, but this was counteracted to some extent by an increase in export business. The directors are very hopeful that the enhanced profits now reported will be fully maintained, notwithstanding that the industry is still in an unsatisfactory condition. The directors who retire at the annual general meeting are Mr. Walter S. B. McLaren and Sir Henry C. Mance, who are eligible for re-election.

EDMUNDSON'S ELECTRICITY.

The annual report states that the net profit for the year ended March 31, 1909, after payment of interest on the debenture and prior lien debenture stocks, amounts to £597. Adding to this amount the balance of £20,417 brought forward from the previous year, less the expenses of the issue of prior lien debenture stock, there remains the sum of £14,809, which the directors recommend should be carried forward to the next account. The dividends and interest received have increased by £2,871, the loss on working the local authorities' undertakings is reduced by £957, and the Urban Co.'s guarantee is less by £386. In view of the conditions which have adversely affected almost all electric supply undertakings during the past year, the directors consider that these results are not unsatisfactory. The reduced net profit is attributable to the diminution in the trading profits consequent upon a reduced capital outlay by the subsidiary companies, but as it is the avowed policy of the Board to restrict capital expenditure as far as is reasonably possible, this feature of the accounts need from this point of view occasion no regret. Mr. A. A. Campbell Swinton retires from the Board by rotation and offers himself for re-election.

UNITED RIVER PLATE TELEPHONE.

The gross receipts for the year ended March 31, 1909, were £287,064, against £250,750 for last year. Deducting expenses in Argentina and London, debenture interest, dividend on preference shares and interim dividend on ordinary shares, and adding interest on investments, transfer fees, etc., there remains a profit of £89,233, to which must be added £4,904 brought forward from the previous year, making an available balance of £94,138. After applying £32,000 to reduction of special replacement account and £25,000 to reserve, the directors recommend a final dividend of 5 per cent. on the ordinary share capital, making a return of 8 per cent. for the year, free of income tax, that a sum of £2,000 be voted towards a staff provident fund which is being formed among the Company's employés in Argentina, and that the balance of £5,138 be carried forward.

VICTORIA FALLS AND TRANSVAAL POWER.

The report of the Victoria Falls and Transvaal Power Co. for 1908, to be submitted to the meeting on the 16th inst., as published in the *Financial Times*, states that in March last the name of the Company was, by special resolution, changed from the Victoria Falls Power Co., Limited, to the Victoria Falls and Transvaal Power Co., Limited. As mentioned in the last report, the years 1907 and 1908 were occupied by the work of construction, during which interest on the preference shares issued in December, 1906, was paid by the British South Africa Co. In these circumstances a profit and loss account has not been included, but a revenue and expenditure account is incorporated in the Company's balance-sheet, and shows a surplus for 1908 of £48,177, which, with the surplus shown in 1907 of £36 685, makes a total of £84 863 to be carried forward. At Dec. 31, 1908, the share capital of the Company was £1,801,050, divided into 1,000,000 ordinary shares and 801,050 preference shares of £1 each. Since this date 1,270 shares of the 6 950 preference shares forfeited have been reinstated. The British South Africa Co. guaranteed the payment of the remaining 5,680 forfeited preference shares. The debenture capital at Dec. 31, 1908, remained £800,000. During the present year a further issue of £900,000 preference shares was made under prospectus dated April 7, 1909. Arrangements were at the same time completed whereby subscriptions for a further issue of £900,000 5 per cent. first mortgage debentures have been guaranteed. These debentures form part of the authorised issue of £3,000,000 first mortgage 5 per cent. debentures. The new issues of preference shares and debentures are in connection with the formation of the Rand Mines Power Supply Co. When the proposed formation of a competing company first took shape, as explained to the shareholders at the meeting held on Oct. 23, 1908, the chairman, assisted by a committee, was entrusted with the difficult negotiations which ultimately resulted in the acquisition by the company of the large power contract with the Rand Mines in accordance with the terms of an agreement dated Dec. 2, 1908, and in the successful carrying through of the above increase of capital, amounting to £1,800,000, which places the Company amongst the largest undertakings in the world engaged in electric power supply business. In recognition of the strenuous work so successfully accomplished the Board voted a special sum of £7,500 to be applied by the chairman as remuneration to himself and the committee. The directors have no doubt their action will meet with the cordial approval of the shareholders. Throughout 1908 the station at Driehoek, purchased from the General Electric Power Co., continued to work satisfactorily, chiefly supplying power to the Consolidated Gold Fields group of mines and the town of Germiston, and at the present time is still working at full load. The original station at Brakpan, purchased from the Rand Central Electric Works, supplied current till the autumn, and now is mainly used as a reserve for the new 8,000-h.p. installation which was put in work in September. The land on which these works are built is held on lease and is not freehold, as inadvertently stated in the last report. The Company completed a provisional contract for supply of current to the Municipality of Johannesburg in June, 1908, and the plant thus released was at once employed for the power requirements of various mines. Rapid progress in the construction of the 16,000-h.p. station

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at Simmer Pan has been maintained, and half the plant has already been put into commercial use. Applications for the supply of power continued to be received in a very satisfactory manner and will provide work for the whole of the Simmer Pan station, and also necessitate an immediate extension of the plant. The new transmission lines along the reef have been in use since October, 1908, and are working satisfactorily. In compliance with the prospectus of April 7, 1909, the Rand Mines Power Supply Co. has been registered in the Transvaal Colony with a capital of £500,000, in shares of £1 each, the whole of which is owned by this Company. The Rand Mines Power Supply Co. will supply 15 mines controlled by the Rand Mines and Messrs. H. Eckstein and Co., with the whole of the power requirements of these mines for the next 20 years in the form of electricity or compressed air. The mines estimate that in the near future they will require 270,000,000 units of power annually. The construction of the plant necessary to fulfil the obligations of the Rand Mines Power Supply Co. is being undertaken by this Company, and the work will proceed with all possible dispatch. A modification of the original agreement with the Vereeniging Estates has been come to in Johannesburg, and a formal agreement embodying this will shortly be signed. In order to cope adequately with the great increase of business, Mr. Arthur E. Hadley has been appointed managing director, with powers to be exercised in consultation with the chairman. As this arrangement will involve, on the part of the chairman, practically the same close attention and constant attendance to the affairs of the Company as will be given by the managing director, the Board feel sure the shareholders will recognise that the chairman should be adequately remunerated. Subject, therefore, to your confirmation, the Board has fixed the remuneration of the chairman at £3,000 per annum, to take effect on his return from South Africa, where he is now engaged on the business of the Company. The chairman and the managing director thus together constitute an executive committee, for which provision is made in the Company's articles of association. Since the last meeting the Hon. Sir Lewis Michell and Mr. Henry Wilson Fox have resigned their seats on the Board, and the directors have accepted their resignation with much regret. Mr. R. G. Fricker and Mr. Armandus Brakhan have been appointed directors of the Company.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Arbroath.—The Town Council have granted permission to Messrs. Webster and Sons to lay an electric cable between Alma and Burnside Works.

Oldham.—The Town Council have passed a resolution giving power to the Electricity Committee to borrow £1,000 for extensions to the electricity mains.

Ontario.—The Port Arthur City Council has consented to purchase the local plant of the Bell Telephone Co. for £7,190, subject to the ratification of the ratepayers.

Nenagh.—The Urban District Council have decided to call a special meeting in order to discuss a proposal to establish a supply of electricity for street-lighting, etc.

Eccles.—The Town Council have decided to install electricity for lighting purposes in a number of the Corporation cottages, and to charge 6d. per week extra on the rent.

New Romney.—Messrs. Foote and Milne have given notice to the Town Council of their intention to apply to the Board of Trade for a provisional order to supply electricity in the New Romney district.

Heywood.—The Electricity Committee have reported to the Town Council that the consumption of current for lighting purposes, as compared with the same month last year, showed an increase of 3,179 units.

Petersfield.—The Rural District Council have received notice from the secretary to the Petersfield Electricity Supply Co. of his intention to apply for a provisional order to supply current to Liss, Sheet, and Steep.

Brechin.—The Postmaster General has given notice of the intention of his department to erect the necessary poles, etc., for carrying telegraph lines along the public road between Barrelwell and Careston Church.

Bishop's Stortford.—The Bishop's Stortford and Stanstead Electric Lighting Co. have notified the Urban District Council of their intention to apply for a provisional order authorising them to supply electricity within the district.

Newport.—The electrical engineer is negotiating with a large firm for the supply of electrical energy in bulk. If the customer is secured, a large extension of the Corporation's plant, involving an expenditure of £70,000, would have to be made.

Ashford (Kent).—At the last meeting of the Council notice was received from Mr. Mark Parker, of Dover, of his intention to apply for a provisional order under the Electric Lighting Act of 1882 to supply electric light within the urban district of Ashford.

Electric Batteries and Carbons, Limited.—A debenture, dated June 2, 1909, to secure £1,500, charged on the company's undertaking and property, present and future, including uncalled capital. Holder: R. G. Orr, End House, Cavendish-road West, N.W.

Tiverton.—At the last Council meeting the Lighting Committee reported the receipt of a notice from Messrs. Foote and Milne, of London, of their intention to apply to the Board of Trade for a provisional order to supply electricity within the borough. The Council made no comment.

Blackpool.—The electricity works were called upon for a supply of 50,025 units of current during May, as against 43,103 units in the corresponding period of last year. The consumers now number 800, an increase of 110 during the year.

Failsworth.—At the last meeting of the District Council a letter was submitted from the Manchester Corporation Electricity Committee asking if there was a probability of a supply of electricity being required by the Council for street-lighting or other purposes. The clerk was directed to obtain information.

Stroud.—The Urban District Council have received notice from the Gloucestershire Electric Power Syndicate of their intention to apply to the Board of Trade for an electric lighting provisional order to enable them to supply electric light and energy to private consumers in the combined districts of Nailworth Urban, Stroud Urban, and Stroud Rural.

Bandar Sumatra Rubber Co., Limited.—This company has been registered with a capital of £100,000 in £1 shares. Objects: to adopt an agreement with the Rubber Estates Agency, Limited to acquire and turn to account any estates, plantations, and freehold and leasehold lands, and to carry on the business of planters and producers of rubber, etc. Registered office: Mincing-lane House, 59, Eastcheap, E.C.

Dawlish.—At the last Town Council meeting a letter was received from the Electric Supply Corporation stating that it was proposed to form a local limited liability company to at once proceed with an electric supply undertaking for the town. The Council were asked to agree to take 12 arc lamps for public lighting on certain conditions similar to those in force in other towns. It was decided to consider the whole matter at a special committee meeting of the Council.

Swansea.—At a meeting of the Corporation Tramways Committee last week, Mr. Edward Harris, solicitor, on behalf of a company, submitted a proposal for the taking over and working of the municipal electrical undertaking. The proposal was not well received. During a short discussion the mayor said that the Corporation had in this undertaking a very good thing, and that these gentlemen now applying fully realise it. The committee decided not to entertain the proposals.

Derby.—Presenting the minutes of the Electric Lighting Committee for consideration by the Council, Alderman Butterworth said that arrangements had been entered into with the Chloride Electrical Storage Co. to renew and maintain the tramway battery, as mentioned in our last issue, and he also moved that application be made to the Board of Trade for a provisional order extending the limits of supply of electricity to certain parishes. After some discussion the resolution was agreed to by the Council.

Kent.—Owing to the fact that the Post Office underground telegraph wires are now in operation from London through a considerable part of Kent, the department's wires on the South-Eastern and Chatham and Dover Railway Co.'s main London-to-Dover line are now being removed. On Sunday traffic was reduced to a minimum, and a body of linesmen and others with a special train were engaged in taking down over 20 wires running from Bromley to Chatham. The wires between Bromley and London are being similarly dealt with.

Darlington.—The demand for electricity for lighting and power purposes in Darlington continues to largely increase. At last week's meeting of the Electricity Committee it was reported that 78,870 units had been generated during June, this being an increase of 8,760 units, or 12·3 per cent. upon the corresponding period of last year. The committee decided to extend the feeder mains to Albert Hill to meet the growing demand for power in that district, at a cost of £1,100, and also to extend them along Greenbank-road at an outlay of £58.

Bodmin.—Messrs. H. and W. Meager, of Kestle, who are proposing, subject to the approval of the Council, to install electric light in the town, submitted details of the scheme for the approval of the Council at the last meeting. They undertook to enter into a contract to light the streets, municipal buildings, market house, turret clock, etc., at a cost of £200 per annum, to include cost of conversion from the present system of incandescent lighting; this they considered would mean a saving of £150 a year. The matter was referred to the whole Council in committee.

Loughborough.—In moving the adoption of the minutes of the Gas and Electricity Committee at the last meeting of the Council, Alderman Bumpus referred to a most interesting feature. For the year ended March 31 they showed a profit carried to the revenue account of £536. 13s. 9½d., which stood against a loss for the previous year of £314. 7s. 8d. This showed that last year the financial result had improved, as against the previous year, to the extent of £860. This, he thought, they might claim as a substantial improvement. The minutes were adopted.

Skelmorlie.—At a meeting of the Northern District Committee of the Ayrshire County Council, held at Kilwinning, intimation was given from the Skelmorlie Electrical Supply Co. that they intended to make application to the Board of Trade for a provisional order to authorise the company to supply Skelmorlie and district with electric light. The meeting remitted the matter to a special committee to act along with Skelmorlie Lighting and Scavenging Committee in conjunction with the Law Committee at Ayr to consider the order and see whether there are any objectionable clauses in it.

Kirkcaldy.—The sixth annual report on the working of the Corporation electric lighting and tramways has just been issued. In the electric lighting department the gross profit carried to net revenue account was £3,599. 4s. 11d., as against £3,790. 8s. 11d. last year, and after payment of interest, sinking fund charges, etc., there was a net profit of £240. 5s. 5d. on the year's working. In regard to the tramways, the gross profit carried to net revenue account was £4,716. 15s. 8d., as against £4,923. 19s. 7d. last year, and after payment of interest, sinking fund, and depreciation there was a deficit of £209.

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16s. 9d. The loss on the tramway receipts was accounted for by the depression in trade.

Wolverhampton.—The report of the Electricity Committee submitted to the Council at the last meeting on the work of the undertaking during the year ended March 31, 1909, stated that a gross profit was made of £16,891. 13s. 11d. Out of this amount the following charges had to be met: interest, £5,185. 9s. 9d.; bank interest, £506. 5s. 6d.; sinking fund and repayment of loans, £7,789. 17s. 9d.; balance, being net profit for the year, £3,401. 0s. 11d., £1,417 of which went to the relief of the improvement rate. The Council adopted the report and passed a resolution that sanction should be sought to the borrowing of £10,000 to cover the expenditure on extensions of mains.

Morley.—At the last Town Council meeting Alderman Smith proposed the adoption of the report of the Electricity Committee. The engineer reported the resignation of Mr. W. S. Brown, chief assistant, and suggested a reorganisation of the staff which would avoid any additional appointment. It was resolved that Mr. Ellis's proposals be approved. Mr. J. E. Ellis (electrical engineer) reported that the output from the electricity works for the month ending May 31 was 8,996 units, as compared with 10,642 units the same month last year, being a decrease of 1,646 units. The quantity sold to consumers by meter was 5,815 units, against 8,381 units the same month last year, being a decrease of 2,566.

Finchley.—The accounts of the Council's electricity undertaking show that for the year ended March 31 last there was a balance of £86 to the good, as compared with a deficit of £292 last year. Mr B. Todd, chairman of the Electricity Committee, at the last meeting said he understood that the object of a local authority in supplying electricity to ratepayers was to afford an opportunity of a cheap light, and not for the purpose of making a profit in order to save local rates. The committee felt that the time had come when the position would have to be revised, particularly with regard to charges for power. The committee would consider the question of a reduction to large users of electricity for power, and also concessions to shopkeepers who had arc lamps outside their shops.

Oulton Broad.—The General Purposes Committee at the last Council meeting reported that the deputy clerk had submitted replies received from 18 urban district councils of similar size to the urban district as to the steps taken in connection with electric lighting provisional orders obtained by them, and the same were considered, and it was resolved: "That the clerk be asked to obtain further information from the Urban District Councils of Sandgate, Wembley, Hampton, Leatherhead, and Cromer, together with a copy of the agreements entered into by them and the transfer to the companies mentioned, and that he be authorised to pay any fees incurred in so doing"; also "That the information so obtained be tabulated and submitted to the next meeting of your committee."

Aston.—The Electricity Committee have sanctioned the extensions of the Erdington low-tension mains as follows: (*a*) from existing four-way box at corner of Silverbirch-road, along east side of Sutton-road, to three new houses situate between Chester-road and Silverbirch-road, consisting of 130 yards of ·03 sq. in. four-core cable, laid and jointed, at an estimated cost of £49. 12s. 11d. (plus service to houses, £24. 13s. 8d.); (*b*) from existing road, crossing along the south pavement of Silverbirch-road, to supply Mr. Clewley's new house, 68 yards ·03 sq. in. four-core cable, laid and jointed, at an estimated cost of £38. 7s. 10d. (plus service, £6. 4s. 5d.). During the past month of May the sale of current for lighting, power, and traction was as follows: units sold, 364,717; 1908, 296,628—increase, 68,089.

Colchester.—At the last meeting of the Corporation Electricity Committee the engineer reported relative to the proposed erection of an overhead electric cable between Mill-road and the infectious diseases hospital, and it was decided to communicate with the Board of Trade, inquiring whether the Board would be prepared to give their consent to the erection of such cable. The engineer's report contained the following particulars: output of electricity (lighting) in units during May, 1909, 47 852, against 40 545 in 1908 and 53,092 in 1907; ditto traction, 39,266, against 40,880 in 1908 and 44,276 in 1907; used in generating station, 20,032, against 14,167 in 1908 and 16,562 in 1907; number of consumers at end of May, 1909, 1,559, against 1,346 in 1908 and 1,147 in 1907; total number of 8 c.p. lamps connected, 52,040, against 47,928 in 1908 and 44,024 in 1907.

Fareham.—The Lighting Committee reported to the last Council meeting that they had, as arranged, visited Trinity-street and inspected the temporary incandescent lamps erected by the electrical engineer with a view to comparing them with the existing arc lamps. The committee were unanimously of opinion that it was desirable to substitute six incandescent lamps of 50 c.p. for the two arc lamps in Trinity-street, and seven incandescent lamps for the two arc lamps in Grove-road. It was also recommended that an incandescent lamp be erected at the west end of Gordon-road, and an additional one in Grove-road. The report was adopted. At the suggestion of the electrical engineer the committee recommended that a low-tension main be laid in Portchester-road at an estimated cost, with transformer, of about £50, and this recommendation was also adopted.

Frome.—The clerk announced at the last Urban District Council meeting the receipt of the auditor's report on the Frome electricity supply. From this it appeared that the loans authorised up to date for the electric works amounted to £45,235. The Council had borrowed £35,230, leaving a balance of £10,005 sanctioned, but not yet taken up. Of the £35,230 borrowed, £6,755. 12s. had been repaid, leaving a balance of loans outstanding of £31,574. 8s. On the recommendation of the Finance Committee payment was ordered to be made of accounts amounting to £1,543. 11s. 4d. The clerk reported that there were outstanding cheques for £269. 12s., so that the Council's total indebtedness was £1,813. 3s. 4d. The balance at the bank was £493. 13s. 3d., leaving a temporary deficit of £1,319. 10s. 1d. The balance due on outstanding rates was £2,765. 5s. 11½d., and there was due from other sources £1,282. 8s. 10d., making a total sum to come in of £4,047. 14s. 9½d.

Pendleton.—A serious accident occurred in Bolton-road, Barrhill, Pendleton, early on Sunday morning. Two men were badly injured, while two others sustained minor injuries. The men were all employed by the Salford Corporation electrical department, and the first three were repairing the overhead tramway lines from the platform of a tower emergency cart, almost at its full height. One set of wires had already been repaired, and the car was being turned on to the other set of metals by the driver, George, when the vehicle overturned. The three linesmen were pitched on to the roadway, one alighting on his head and sustaining a fractured skull, and the other breaking his ankle. Another had several ribs fractured, while one of the hands of the man who had charge of the vehicle was injured. The ambulance was sent for, and the injured men were taken to the Salford Royal Hospital, where it was found necessary to detain two of the men, one of whom has since died. The other two were sent home after they had had their injuries attended to.

Walsall.—At the last meeting of the Town Council the mayor proposed the adoption of a recommendation of the General Purposes Committee authorising an application to the Local Government Board for sanction to a loan of £35,000 for extensions of the electricity undertaking, and in doing so pointed out that a special consultative committee had endorsed this proposal as the only step which could be taken both in the interests of the concern and of the public. While it was proposed to obtain power to expend £5,000 on an extension of the mains to Bloxwich, the money would not be expended until the committee were satisfied the outlay would be remunerative. Mr. Hayward, in seconding, said the extensions would enable the committee to supply current for power purposes, and it was hoped many of the manufacturers of the town would be induced to become customers of the undertaking. Mr. Slater said there was reason to hope it would be found possible as a result of the new plant which was to be laid down to reduce the cost of production with a prospect of the undertaking becoming a profit-making concern. After further discussion the recommendation was approved.

Stoke-on-Trent.—The Electric Lighting Committee at the last Council meeting reported having considered further the question of the defective lighting and loss of pressure at the hospitals, lodge, tramp wards, etc., due to the cables being overloaded. The consulting engineer stated that to remedy this matter it would be necessary to run a pair of auxiliary overhead cables to the fire-escape house on the existing poles to assist the present overloaded mains and strengthen the sub-mains to nurses' home and male tramp ward, the approximate cost of which would be about £40, and also, if the present lamps were replaced by metal-filament lamps of 32 c.p., the consumption of current would be reduced by about 6 h.p., and a much better light obtained at a reduced cost, the strain on the night load being also relieved. Three alternative schemes were also presented by Messrs. Edwards and Shaw, the estimated costs of which were £125, £273, and £174. The committee recommended that, with a view to remedying the matter at a minimum of expense, the auxiliary cables, as suggested, be installed and 32-c.p. metal-filament lamps be purchased to the amount of £25, making a total cost of £65. The recommendation of the committee was adopted.

Dover.—The report and accounts of the borough electricity department have just been issued for the year ending March 31, 1909, being the fifth year of working since the acquisition of the undertaking by the Corporation. Applications have been received during the year for an equivalent of 9,987 30-watt lamps. The total connections now number about 50,000 30-watt lamps. The output to private consumers was 538,270 units, being a decrease of 79,636 as compared with the previous year. This decrease is almost entirely due to the general adoption of metal-filament lamps in the town, by using which consumers have been able to effect large reductions in the lighting accounts. Since the last report the Local Government Board have sanctioned a further loan of £9,774, payable in 18 years, to cover the capital expenditure incurred during the two years ended March 31, 1907. This amount has been borrowed at 3¼ per cent. The Board have refused sanction in respect of items amounting to £1,190. 9s. 3d., and this sum has accordingly been transferred to net revenue account. The sum of £2,973. 3s. 10d. has been expended during the year on new works, the principal items being £587. 15s. upon plant and machinery, £1,304. 13s. 10d. on mains extensions and service connections.

Gillingham.—The Local Government Board have advised the Council to engage a highly qualified electrical engineer to investigate the working of the electric light undertaking, and report on the best means to reduce the annual loss incurred. The Council had applied for permission to borrow £5,000, and have actually spent the money on the works, but the Local Government Board have sanctioned only £2,084. The committee recommended the Council at the meeting last week to reply pointing out what had already been done to reduce expenses, but Alderman King moved that they take steps to carry out the suggestions of the Local Government Board. On a vote being taken the Council were equally divided, and the mayor (Councillor S. Vinall) announced that he should give his vote in favour of having expert advice. It was decided to ask the President of the Institution of Electrical Engineers to give six names for the Council to choose an expert from. At a meeting of the Electric Light Committee the engineer reported that the equivalent of 285 8-c.p. lamps had been connected with the mains since the last monthly meeting of the committee, making a total of 26,790 equivalent in 30-watt lamps = 803,692 kw. with 482 consumers connected, and that applications had been received from seven other persons.

Bath.—At the last meeting of the Rural District Council a letter was received from the town clerk (Mr. F. D. Wardle) giving notice of

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the intention of the Corporation to apply to the Board of Trade for a provisional order authorising them to supply electricity in the Bath rural district, in view of the numerous applications for a supply received by the City Council outside the city. He trusted that the Rural District Council would see their way to support the application. Notice was also received from the Weston Electric Construction Co. to the same effect of their intention to apply for a provisional order, giving powers to supply electricity for public and private purposes in the rural district. They also desired the Council's support. Mr. Long suggested that the Council should support the Corporation's application, provided they would reimburse them for what they had spent. Mr. Tanner: Has our order lapsed? The Clerk: No; it has not been cancelled yet. Mr. Tanner advised that the Council should communicate with the Board of Trade to make sure whether the order was still in existence. If the order was still in existence, they might, perhaps, enter into negotiations with the City Council for the disposal of it. Mr. Long also favoured the idea that the City Council should be approached to see if they were prepared to meet the Rural Council in any way, and eventually the matter was referred to the Electric Lighting Committee.

Wimbledon.—At the meeting of the Town Council last week the question of supplying the district with electricity in bulk was brought forward. The minutes of a meeting of the Electric Lighting Committee showed that the town clerk reported the result of an interview which he had had with the Board of Trade respecting the proposal that the Corporation should supply electricity in bulk for consumption within the urban district of the Maldens and Coombe, and stated (*a*) that it was doubtful whether the Board would issue another provisional order authorising the supply of electrical energy in the Maldens and Coombe district until the order granted in 1907 to the County of London Electric Supply Co. was cancelled or expired; and (*b*) that it might be necessary for the Corporation to apply to Parliament for powers enabling them to supply energy in bulk to the Maldens and Coombe Council. A deputation, consisting of three members of the Maldens and Coombe Urban District Council and the clerk, thereupon conferred with the committee respecting the terms upon which the Corporation would give a supply of energy to the Maldens and Coombe district; and it was arranged that the Urban District Council should communicate their views as to the offer with as little delay as possible, and that, as a preliminary step, notice under Section 4 of the Electric Lighting Act, 1882, should be given by the Corporation to the Urban District Council. It was resolved that the town clerk be directed to serve the necessary notice authorising them to supply electricity for public or private purposes within the urban district of the Maldens and Coombe. Alderman Holland, in moving the adoption of the minute, said that the order referred to would expire on Aug. 17 next, and it was necessary to make the application for an order before the end of June so as to authorise the negotiations, which otherwise would have been hung up for a year. He thought he was safe in saying the terms proposed were fairly satisfactory to the deputation. One or two small matters had to be considered by the Maldens and Coombe Council, but they expected to have a communication soon. The minute was adopted.

TRACTION.

Newport.—Alderman Clifford Phillips has given notice of a resolution to the Town Council, that the Tramways Committee be instructed to prepare a scheme for extending the Corporation-road tramlines as far as the transporter bridge.

Darlington.—At the last meeting of the Rural District Council a letter was read from the Board of Trade stating that they had after careful consideration decided to grant an extension for two years of the order to extend the tramway line from Darlington to Haughton-le-Skerne.

Lampeter.—On the proposition of the Rev. J. N. Evans at the last Council meeting it was agreed to advance the sum of £1,000 to the promoters of the Aberayron Light Railway, and that £750 should be advanced by way of loan and that the balance of £250 should be advanced as part of share capital of the company.

Tanshelf.—The West Riding County Council having asked the Board of Trade to declare that the running of trams through Front-street, Tanshelf, was dangerous to the public, Major Pringle, the Board's inspector, recently held an inquiry, as the result of which he has now reported that so long as the Board of Trade regulations are, as at present, adhered to, there is no ground for apprehending danger to the public.

South Shields.—The Corporation trams last week carried 153,803 passengers, and the receipts amounted to £623. 5s. 3d., an average of 9·67d. per car mile, as compared with 148,848 passengers and £599. 9s. 7½d. in fares, an average of 7·11d. per car mile, in the corresponding week of last year. The Jarrow cars running on the South Shields lines carried 18,298 passengers and collected £74. 3s. 2½d., an average of 10·74d.

Queensferry.—The Mid Lothian County Council Surburban District Committee have considered a communication from Messrs. Deas and Co., inquiring whether the local authority would look favourably on a proposal for a tramway from Edinburgh to South Queensferry, and it was unanimously decided to reply that such a scheme would meet with the favourable consideration of the road authority, provided the promoters insert in the order satisfactory clauses for their protection.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Joint Tramways and Electricity Board have authorised the engineer to get out plans for a cross-over at Thompson Cross and a loop at Hey Heads, and the commercial manager to serve the necessary notices and apply to the Board of Trade for the necessary consent. The Generating Station Committee have resolved to have the flagging on the Gee Cross extension carried out by the Board's own men, and authorised the engineer to go to Edinburgh to carry out the tests in connection with repairs to No. 4 turbine.

Cardiff.—At last week's meeting of the Electric Lighting and Tramways Committee the report of the expert called in by the Corporation to report generally upon the condition of the tramway track in the city came up for consideration. Dr. Smith suggested that it was such a complicated report that it would be advisable to call a special meeting to discuss it. The Chairman said that one very pleasing conclusion of the report was that no blame was attached to the contractors in any way, and that the work had been carried out satisfactorily. It was agreed to hold a special meeting a fortnight hence to deal with the report.

Falkirk.—The work of extending the Falkirk electric tramway line to Laurieston is being rapidly pushed forward. The poles for the supporting of the overhead equipment have been erected from the east end of the High-street to Mary-square, Laurieston. The construction of the permanent way has also been commenced, but this part of the work has been slightly hampered owing to a delay in the delivery of the rails. The contractors have, however, opened up a long stretch of the road, and have prepared the cement basis on which the rails are to lie, so that once the rails are delivered the construction of the line will be rapidly proceeded with.

Rotherham.—The tramway receipts for the month of May amounted to £2,768. 5s. 9d., as compared with £2,693. 7s. 1d. in the corresponding month of last year. The Tramways Committee are recommending the Council that their resolution of March 9 last, authorising the borough engineer to proceed with the work of laying the tramway track between Market-street and Dominie-lane be not proceeded with. It is also recommended that various tramway extension powers obtained by the Corporation in the Rotherham Corporation Act, 1904, be not acted upon. With regard to the High-street terminus, it is proposed to instruct the borough engineer to arrange for the laying of a loop line at the top of High-street at an estimated cost of £200.

Bury.—The annual report of the working of the Corporation tramways for the year ended March 31 states that the expenditure on repairs and maintenance of permanent way compared with the previous year showed an increase of 20 per cent., the total being £1,330. The expenditure on overhead equipment and cables had been £659, practically double the amount of the previous year. The gross traffic receipts had been £58,923, an increase of £1,630. The number of passengers carried had been 7,265,909, equal to the estimated population of the district being carried 100 times. The working expenses were 4·112d. per car mile, exclusive of power, and the total working expenses were 5·833d. per car mile. The financial statement showed a net surplus of £3,120.

Heywood.—The Town Council at their last meeting discussed the minutes of the Electricity and Tramways Committee with regard to the new agreement with Bury and Rochdale in relation to the running of the trams between the three towns. Councillor Popple said that Heywood had been justified in going to Parliament to bring about better terms with Rochdale and Bury. In the new agreement they would get all they desired—in one or two instances they would get more than they anticipated. All the Corporations would have running powers into one another's boroughs, but Heywood did not propose to run their own cars, but would allow Bury and Rochdale to do so for them. The Corporation would take the whole of the fares collected in their boroughs, and the cost of working would be what was actually incurred. It was decided to seal the agreement.

Exeter.—At the tramway depôt a new recreation room was opened last week by Mr. E. C. Perry, J.P. The room contains a bagatelle board and draughts, and various other games are provided. Speeches were made by Councillors Perry, Vicary, Linscott, and Mr. G. L. Boundy. Bouquets were presented to Miss Shepherd, who has been one of the prime movers in connection with the formation of the games room, and Mrs. Perry. A vote of thanks was proposed by Mr. F. Gray (general foreman), seconded by Mr. A. Chapman (depôt foreman), to Mr. Perry for his kindness in opening the room. After the opening ceremony Mr. H. C. Bartlett (manager), on behalf of the tramway staff, presented Mr. Perry with a case of fish knives, forks, and servers, as a token of the esteem in which he was held by the whole of the men, who regretted his leaving the city. Mr. Perry, in responding, said he had received every support from the officials. Other speeches of regret at Mr. Perry's departure were made by Inspector Norcombe, Chief Inspector Yates, Motor Inspector Nicholls, Messrs. Clements and Vowler, and motormen Cobley and Hawkins.

New North Lincolnshire Railway.—An order of the Board of Trade sanctioning the construction of the light railway in North Lincolnshire from Barton-upon-Humber to Immingham, has been issued. The route of the new line is as follows: "Commencing in the parish of Barton-on-Humber by a junction with the Barton branch of the Great Central Railway at or near the half-mile post between the 109 and 110 miles posts from Manchester, thence running in an easterly direction through the parish and township of Barton-on-Humber, and the parish of Goxhill, where it passes over the New Holland branch of the Great Central Railway, thence into the parish of East Halton, thence in a south-easterly direction through the parishes of North and South Killingholme, and terminating in the parish of Immingham at the boundary of the property of the Humber Commercial Railway and Dock Co., at a point three chains or thereabouts south-west of the sluice at Immingham Haven." The new line will be connected with the existing lines by branch lines, one through the parish of Goxhill with the New Holland line, and two connections with the Humber Commercial Railway from South Killingholme. For the purpose of working the railway the company may erect works

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and buildings on lands abutting on the Humber bank between South Killinghome Haven and Immingham Haven

Colchester.—At the last monthly meeting of the Town Council, Mr. Cheshire, in moving the adoption of the Tramway Committee's report, said that during the pageant rehearsal week the trams had carried 48,953 passengers, and had taken £276. 11s. 4d. in fares. During pageant week the receipts amounted to £310. 9s. 10d., making the total for the two weeks £587. 1s. 2d., which represented an increase of £150 over the corresponding fortnight of the previous year. The tramway staff had worked during the pageant from 12 to 14 hours a day, while the town hall staff had been allowed half a day off throughout the week. Mr. Taylor drew attention to the fact that as the result of increased fares they had during six months lost £858. 1s. 11d., and had carried 356,379 fewer passengers than in the corresponding period of the preceding year. He thought that this justified his original contention that no benefit would accrue from increased fares. He believed they would have to revert to the penny fares, and to have halfpenny intermediate stages. Mr. Jarmin remarked that the figures quoted by Mr. Cheshire did not really represent the exact benefit the trams had received from the pageant. For a long series of weeks the tram returns had shown considerable comparative decreases, but the pageant rehearsals and the pageant itself had brought them to a much higher figure. Mr. Shaw thought it was time they dropped this vexatious question of fares. He believed Colchester people had settled down to the present prices, and were satisfied that they could not ride any cheaper.

Wolverhampton.—The report of the Tramways Committee states that the gross profit for the year on electric traction account was £17,048. "The committee regret, however, that the traffic receipts on the electric cars, in common with most other tramway undertakings, show a considerable decrease for the year as compared with the previous 12 months. The total reduction in revenue from passenger and parcels traffic is £1,797. 14s. 8d., and the cause is attributable principally to the very great depression in trade experienced during the year, and also to weather conditions." On the other hand, the report further states it was very gratifying to record a substantial decrease in the working costs per mile of the Lorain system as compared with last year, being 6·374d., as against 6·509d., or a reduction of ·135d. per car mile. The figure of 6·374d. per mile was below the average of other municipal tramway undertakings in the country, and Wolverhampton was one of the few towns where the working costs showed a decrease per mile over the previous year. The expenditure had gone down from £26,461 to £25,466, but, on the other hand, the receipts had decreased from £44,432 to £42 614. The loss on the motor-bus account decreased from £234 to £82. The gross profit had been disposed of as follows: interest on capital, £6,609. 9s. 8d.; income tax on profits, £185; repayment of loans, £4,346. 3s. 8d.; loss on omnibus account, £82. 10s. 10d.; reserve or renewals account, £4,505. 0s. 8d.; extraordinary items of expenditure, £573. 5s. 3d. The balance of £746. 13s. 9d, added to the balance brought forward from 1908 of £392. 7s., made a total unappropriated amount of £1,139. 0s. 9d. The Wolverhampton trams last year carried 9,050,459 passengers, or 400 000 fewer than the year before. The chief decreases in traffic were noticeable on the Dudley-road, the Willenhall-road, the Wednesfield-road, and the Bushbury cars, while Tettenhall-road cars carried 2,102,182 passengers, as against 2,104,736.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Bromley (Kent).—The Town Council are inviting tenders for the supply of a motor fire-engine. Particulars from the Town Clerk.

Dublin.—Tenders are invited by the Corporation Cleansing Department for the supply of an electrically driven goods lift of one ton capacity.

Birmingham.—The City Council invites tenders for the annual supply of stores to the electricity department. Tenders by Aug. 1 to the Clerk.

Manchester.—Tenders are invited by the Directors of the Yorkshire and Lancashire Railway Co. for widening a bridge. Tenders by July 21.

Ulverston.—The Rural District Council invite tenders for the supply of about 200 tons of cast-iron pipes valve hydrants, and fittings for Cartmel district water supply. Tenders by July 22.

Sheffield.—Tenders are invited for the purchase of 225 kw. generator, condenser, switchboard, and 20 h.p. high-speed engine. Particulars from the General Manager, Division-street. Tenders by July 23.

Long Eaton.—The Urban District Council invite tenders and schemes for the installation of a water-softening plant at the electricity works. Particulars from Mr. F. Worrall, engineer and manager. Tenders by July 20.

Leigh-on-Sea.—The Urban District Council invite tenders for the supply and delivery of galvanised wire and wrought-iron standards. Particulars obtainable from Mr. John W. Liversidge, A.M.Inst.C.E., surveyor to the Council.

London, W.C.—The Postmaster-General invites tenders for creosoting telegraph poles. Forms of tender, containing all particulars, obtainable from Mr. G. Morgan, controller of stores, Stores Department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders must be sent in by Aug. 9.

Harrow-on-the-Hill.—The Urban District Council invite tenders for the supply of a petrol motor fire-engine. Particulars obtainable from Mr. John Strachan, clerk, Council Offices, Harrow-on-the-Hill, to whom tenders must be sent by July 24.

Pontypridd.—The Urban District Council invite tenders for the supply and delivery of one 500-kw. steam dynamo for the electric light and tramways department. Specification, etc., from the Clerk upon receipt of a deposit of £1. 1s. Tenders by July 27.

Luton.—The Corporation invite tenders for the supply and erection at the electricity works of one 500-kw. steam-driven generator and condensing plant. Specification from Mr. W. H. Cooke, borough electrical engineer, to whom tenders must be sent by July 19.

Sandbach (Cheshire).—The Congleton Rural District Council invite tenders for the supply of cast-iron pipes and specials. Specification and form of tender obtainable from the engineer, Mr. W. Woodley Wyatt, Whitchurch, Salop. Tenders to Mr. H. Ferrand, clerk, Sandbach, Cheshire, by July 20.

Rochdale.—The Waterworks Committee invite tenders for the supply of 1 000 6 in. cast-iron spigot and socket pipes. Specification, form of tender and particulars obtainable at the Waterworks Office, Lord-street, Rochdale. Tenders to Mr. Wm. Henry Hickson, town clerk, Town Hall, Rochdale, by July 20.

Edinburgh.—The School Board invite tenders for boiler plant for heating installation at Dalry School. Specifications obtainable at the office of Mr. George Thomson, A.M.Inst.C.E., M.I.M.E., 11, Randolph-place. Tenders to Mr. G. W. Alexander, clerk, School Board Offices, Castle-terrace, Edinburgh, by July 23.

Sunderland.—Tenders are invited for the supply of mackintoshes for motormen to the Corporation (Tramways Department). Particulars obtainable of the General Manager, Tramways Offices, Monkwearmouth, Sunderland. Tenders to the Chairman of the Tramways Committee, Town Hall, Sunderland, by July 29.

Ealing.—The Corporation invite tenders for the supply of cylinder oil, crank chamber oil, bearing oil, paraffin, best rope waste, stoneware pipes, etc., to the electricity works. Particulars from Mr. J. Douglas Knight, borough electrical engineer and manager, Electricity Department, Town Hall Ealing, W. Tenders by July 19.

Rawmarsh.—The West Riding County Council District Sub-Committee invite tenders for supplying and fixing new boiler for heating apparatus at the Parkgate Ashwood-road Provided School. Specifications obtainable from Mr. S. Marshall, Education Office, Swinton, Rotherham, to whom tenders must be sent by July 23.

Bradford.—The Tramways Department invite tenders for eight automatic point controllers. Tender forms and further particulars obtainable from Mr. C. J. Spencer, tramways general manager, Tramway Offices, 5 and 7, Hall Ings, Bradford. Tenders to the office of Mr. Frederick Stevens, town clerk, Town Hall, Bradford, by July 30.

Derby.—The Corporation invite offers for the privilege of placing advertisements on the electric tramcars of the Corporation. Particulars and forms of tender obtainable on application to the Tramway Manager, Tramway Offices, Victoria-street, Derby. Tenders to Mr. G. Trevelyan Lee, town clerk, 16, Tenant-street, Derby, by July 17.

London, E.C.—The Directors of the Burma Railways Co. invite tenders for the supply of miscellaneous tools and stores. Specifications and forms of tender obtainable at the Company's Office, 199, Gresham House, Old Broad-street, E.C. For each specification a fee of 20s. will be charged, which will not be returned. Tenders by July 16.

Blackburn.—The Electricity Committee invite tenders for the supply and delivery of steam coal for the 12 months ending Aug. 31, 1910. Specifications and forms of tender obtainable at the Electricity Works, Jubilee-street. Tenders, addressed to the Chairman of the Electricity Committee, must be sent to the Town Hall by July 26.

Eccles.—The Health Committee invite tenders for the installation of electric wiring and light fittings in 12 houses now in course of erection by the Corporation. Specification and form of tender can be obtained from the Town Clerk on deposit of 10s. 6d. (returnable). Tenders to Mr. Edwin Parkes, town clerk, Town Hall, Eccles, by July 19.

Whitehaven.—Tenders are invited for lighting the harbour, quays etc., by electricity, gas, or other means for five years, or such other period as may be agreed upon, from Jan. 1, 1910, for the Harbour Commissioners. Application must be made to the Harbour Master for particulars. Tenders to Mr. John Tyson, clerk, Harbour Office, Whitehaven, by July 20.

Crumpsall.—The Prestwich Board of Guardians invite tenders for providing and fixing an apparatus for heating some of the rooms in the workhouse, Delaunays road, Crumpsall. Particulars obtainable at the Workhouse from Mr. Hill, workhouse master. Tenders to Mr. Edward W. Ogden, clerk, Union Offices, Cheetham Hill-road, Manchester, by July 22.

London, S.W.—The Directors of the Madras and Southern Mahratta Railway Co. invite tenders for the supply of about 15 tons of paint, etc., as per the specifications, which can be seen at the offices of the Company. The charge for the specifications is £1. 1s., which will not be returned. Tenders to Mr. H. Bonham Carter, secretary, 91, York-street, Westminster, by July 20.

Manchester.—The Tramways Committee invite tenders for the supply of pitch for paving purposes. Specifications and forms of tender obtainable from Mr. J. M. M'Elroy, tramways general manager, 55 Piccadilly, Manchester. Tenders, addressed to the Chairman of the Tramways Committee, 55, Piccadilly, Manchester, must be sent in by July 20.

Paddington.—The London County Council invite tenders for an installation of electric lighting and fans at the extension of the Paddington Technical Institute, Saltram-crescent, W. Tenders to Mr. Maurice Fitzmaurice, C.M.G., the chief engineer of the Council, at the County Hall, Spring-gardens, S.W., by July 21. Full particulars in advertisement columns.

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Bury.—The Corporation invite tenders for the supply and erection of three water-tube boilers, each capable of evaporating 25,000 lb. of water per hour. Copy of the specification and form of tender obtainable from Mr. S. J. Watson, M.I.E.E., engineer and manager, Electricity Works, Bury, on a deposit of £2. 2s. (returnable). Tenders to the Town Clerk, Bury, by Aug. 16.

Hull.—The Corporation invite tenders for the necessary electric and gaslight fittings required for the new public hall. Plans of the building can be seen and specifications obtained at the office of Mr. Joseph H. Hirst, city architect, Town Hall, Hull. Tenders and designs, addressed to the Chairman of the Property Committee, must be sent to the Town Clerk's Office, Hull, by July 28.

Hull.—The Corporation invite tenders for the supply of uniforms, overcoats, and caps for the tramways staff. Forms of tender and particulars obtainable at the Town Clerk's Office. Samples, under separate cover, must accompany endorsed tenders, which must be addressed to the Chairman of the Clothing Committee and sent to Mr. E. Laverack, town clerk, Town Hall, Hull, by July 19.

Hellingly.—The Visiting Committee invite tenders for the supply, delivery, and fixing of a storage battery at the county asylum, Hellingly, Sussex. Particulars, etc., obtainable from the Resident Engineer at the Asylum. Only tenders from makers will be considered. Tenders, addressed to the Chairman of the Works Committee, Resident Engineer's Office, must be sent in by July 20.

Wimbledon.—The Corporation invite schemes for the heating of the isolation hospital, Gap-road, and tenders for carrying out the work. On payment of £1. 1s. (returnable) general conditions and plans of the existing and proposed buildings will be supplied by the Borough Surveyor, Town Hall, Wimbledon. Tenders, addressed to the Chairman, Sanitary Committee, must be sent in by July 22.

Hull.—The Electric Lighting Committee invite tenders for the supply and laying of electric mains, etc., required in connection with extensions during the period ending March 31, 1910. Forms of tender and specification obtainable on depositing £1. 1s. (returnable) with the city treasurer, Mr. T. G. Milner, Town Hall, Hull. Tenders to the Chairman of the Electric Lighting Committee, Town Hall, Hull, by July 29.

Eastbourne.—The Highways and Drainage Committee invite tenders for the supply of about 465 tons in all of cast-iron pipes, 4 ft. to 5 ft. internal diameter. Drawings and specification can be seen and forms of tender and copies of the specification obtained at the Borough Engineer's Office on payment of £2. 2s. (returnable). Tenders to Mr. A. Ernest Prescott, borough engineer, Town Hall, Eastbourne, by July 31.

Rochdale.—The Electricity Committee invite tenders for the supply of steam coal. Particulars as to quantity, etc., and forms of tender obtainable from the Borough Electrical Engineer, Dane-street, on payment of a deposit of 10s. (returnable). Additional copies obtainable on payment of a fee of 5s. per copy, which will not be returned. Tenders to Mr. Wm. Henry Hickson, town clerk, Town Hall, Rochdale, by July 21.

London, W.—The London County Council invite tenders for an installation of electric lighting and fans at the extension of the Paddington Technical Institute, Saltram-crescent, W. Tenders, upon the official form, obtainable from Mr. Maurice Fitzmaurice, C.M.G., chief engineer of the Council, County Hall, Spring-gardens, S.W., upon deposit of the sum of £1 (returnable) for the specification, etc. Tenders must be sent in by July 21.

Edinburgh.—The Corporation invite tenders for steam-boiler, water-tanks, and hot-water installation works at new slaughter-houses, Gorgie, according to plans and specifications which can be seen at the office of Mr. James A. Williamson, A.R.I.B.A., Public Works Office, City Chambers, from whom also schedules of quantities can be obtained on personal application. Tenders to Mr. Thomas Hunter, W.S., town clerk, City Chambers, Edinburgh, by July 17.

Whitehaven.—The Harbour Commissioners invite tenders for the supply of miscellaneous stores during the year ending July 31, 1910, including the following: iron castings, wrought iron, ironmongery, and tools; cement; lead, oils, paints, coal tar, etc.; rubber hose, washers, etc.; crane chains and wire rope; timber. Forms of tender obtainable from Mr. John Tyson, clerk, Harbour Offices, Queen's Dock Quay, Whitehaven, to whom tenders must be sent by July 19.

London, E.C.—The Directors of the Bombay, Baroda, and Central India Railway require the following stores: (1) chemically-dressed wagon covers; (2) smithy coal, furnace coal, and foundry coke; (3) red and white lead. Tenders must be made on forms, copies of which, with specifications, can be obtained at the Company's Offices on payment of 21s. each (which will not be returned). Tenders to 2, 3, and 4, Bishopsgate-street Without, London, E.C., by July 20.

Ilford.—The Education Committee invite tenders for the supply and delivery of a Robin Hood boiler, and for incidental work in connection therewith, at the Cleveland-road Council School, Ilford. Specification and form of tender obtainable at the offices of Mr. H. Shaw, M.Inst.C.E., Town Hall, Ilford, during office hours. Tenders, together with specification, must be sent to Mr. W. S. Torbitt, M.A., LL.B., secretary, Education Offices, Cleveland-road, Ilford, by July 19.

Leyton.—The Education Committee invite tenders for the electric wiring and fittings for an installation of electric light required at Sybourn-street School. Specification, conditions, and form of tender obtainable from Mr. William Jacques, A.R.I.B.A., of 2, Fen-court, Fenchurch-street, E.C., after July 20, which application must be accompanied by a deposit of £1 (returnable). Tenders must be delivered at the meeting of the Council to be held on July 27 at 7 p.m.

Ringwood.—Persons desirous of tendering for the installation of low pressure hot-water apparatus at the Ringwood new Council School (310 children), in the county of Southampton, can, on deposit of £2. 2s., see plans, specification, and general conditions of contract, and obtain all other information at the office of Mr. W. J. Taylor, county surveyor, The Castle, Winchester, during office hours. No information sent by post. A copy of the plans will be handed to contractors. Tenders by July 19.

Wigan.—The Corporation invite tenders for the supply of best quick firing slack, or best nuts, to be delivered free in boats at the electricity works, Bradford-place, Wigan, as required either for a period of six or twelve months, commencing Aug. 10, also for a supply of best quick firing slack or best nuts, to be delivered free at the electricity works, Tunstall-lane, Pemberton, as required, during either of the same periods. Tenders, giving the name of the mine, must be sent to Mr. Harold Jevons, town clerk, Wigan, by July 19.

Southport.—The Southport, Birkdale, and West Lancashire Water Board invite tenders for the supply and erection of two beam pumping engines, three Lancashire boilers, and other machinery required at the Bickerstaffe pumping station. Drawings can be seen and a copy of the specification with form of tender obtained at the office of Messrs. H. Rofe and Son, civil engineers, 8, Victoria-street, Westminster, S.W., upon a deposit of £5. 5s. (returnable). Tenders to Mr. Alleyne Brown, clerk to the Board, 11, St. George's-place, Lord-street, Southport, by Aug. 9.

West Ham.—The Borough Council invite tenders for the supply of six double-deck electric tramcars, six trucks, and six complete electrical equipments. Specification, form of tender, and further particulars obtainable from Mr. H. E. Blain, tramways manager, Greengate-street, Plaistow, E., on the deposit of a £5 Bank of England note (returnable). A bond with two sureties for the due performance of the contract will be required to be entered into. Payment of wages and observance of hours of labour as are embodied in the schedule which will be part of the contract. Tenders to Mr. Fred. E. Hilleary, town clerk, Town Hall, Stratford, E., by July 16.

London, W.—The Metropolitan Water Board invite tenders for the supply and erection of coal transporter and appurtenant works at the Hammersmith pumping station. Contractors desirous of tendering can obtain forms of tender, conditions of contract, specification, drawings, etc., on application to the Engineer, Metropolitan Water Board, Western District, 41, Commercial-road, Pimlico, S.W., on the production of an official receipt for the sum of £10 (returnable), which sum must be deposited with the Accountant at Savoy-court, Strand, W.C. Documents to be sent back. Tenders to be sent to the Clerk, Metropolitan Water Board, Savoy-court, Strand, W.C., by July 19.

London, S.W.—The Directors of the South Indian Railway require the following: (1) 376 pairs of disc wheels with axles; (2) 752 laminated bearing, 1,128 elliptical, and 2,256 helical springs; (3) about 995 tons of steel rails and fishplates; (4) about 1,030 tons of tiebars, gibs and cotters. Specifications and forms of tender obtainable at the Company's Offices. Tenders, addressed to the Chairman and Directors of the South Indian Railway Co., must be sent to Mr. V. E. de Broë, secretary, 91, York-street, Westminster, S.W., by July 20. A charge, which will not be returned, will be made of £1 for each copy of specification Nos. 1 and 3, and 10s. for each copy of Nos. 2 and 4. Copies of the drawings can be obtained at the office of Mr. Robert White, M.Inst.C.E., consulting engineer to the company, 3, Victoria-street, Westminster, London, on payment of 5s. per sheet.

London, W.C.—Tenders are invited by the Postal Authorities for the supply of telegraph poles of (*a*) home-grown larch or fir; (*b*) Swedish, Norwegian, Finland, or Russian red fir. The poles are to be delivered at any one or more of the following ports as may be directed: London, Tilbury, Grimsby, Hull, West Hartlepool, North and South Shields, Ellesmere Port, Swansea, Cardiff, Newport, Southampton, Leven (Fifeshire), Ardrossan, Belfast. The poles to be felled during the winter of 19.9-10, and to be delivered during the following summer. Butt sections, 2 in. thick, stamped with the shipper's or tenderer's mark from not fewer than three poles, to show the quality of the timber offered, must precede or accompany the tender of any person who has not already supplied the Postmaster-General with poles. Forms of tender, containing all particulars, obtainable from Mr. G. Morgan, controller of stores, Stores Department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders by Aug. 9.

COLONIAL AND FOREIGN.

Rome.—The Italian State Railways Department invite tenders for the supply of two lathes. Tenders by July 20.

Sofia.—The District Finance Commission invite tenders for the supply of iron bars and wire. Tenders by July 23.

Victoria.—The Postmaster-General invites tenders for the supply of 5,000 telephones complete. Tenders by Aug. 10.

Vernon.—The Municipality invite tenders for the provision of two gas motors. Particulars from the Maire. Tenders by July 27.

Charlottenburg.—Tenders are invited for pumping machinery, boilers, crane, etc., by Aug. 4. Particulars from the Municipality.

New South Wales.—The Postmaster General invites tenders for the supply of 10 switchboards for 100 metallic circuits. Tenders by Sept. 10.

Saarbrucken.—The Prussian State Railways invite tenders for pumps and compressors by Aug. 3. Particulars from K. Eisenbahn Direction.

Prahran.—The Prahran and Malvern Tramways Trust invite tenders for the supply complete of 12 electric tramcar bodies. Tenders by Aug. 27.

Brussels.—The Belgian State Railways Department invite tenders for the construction of a section of the Schaerbeck-Hal line. Tenders by Aug. 14.

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Liege.—Tenders are invited for an electric supply installation at Hollsgm-aux-Pierres. Particulars from the Communal Secretary. Tenders by July 27.

Wilhelmshaven.—Tenders are invited for the supply of broad-gauge ammunition railway wagons to the Marine Artillery Depôt. Tenders by July 31.

Toulon.—Tenders are invited for the supply of copper wire required at the Arsenal. Particulars from the Ministére de la Marine, Paris. Tenders by July 22.

Madrid.—Tenders are invited by the Public Works Department for the construction and working of a railway from Villajoyeso to Denia. Tenders by July 31.

Paris.—Tenders are invited for the supply of machine tools bolts, etc., to the Colonial Office. Particulars from Galerie d'Orleans, Palais Royal. Tenders by July 20.

Bukarest.—The Roumanian State Railways Department invite tenders for the supply of copper tubes for locomotive and tender funnels. Tenders by Aug. 19.

Bukarest.—Tenders are invited for the supply of brass rods, copper tubes, and lead bars to the Arsenal. Particulars from the Direction de l'Arsenal. Tenders by July 19.

Brussels.—Tenders are invited for the annual supply of accessories of Vignoles rails for the Belgian State Railways. Specification from 11, Rue de Louvain. Tenders by July 31.

Bar-le-Duc.—Tenders are invited for the construction of a railway from Verdun to Montpellier. Particulars can be obtained at the Prefecture de la Meuse. Tenders by July 20.

Paris.—Tenders are invited for a three years' supply of bolts, nuts, and rivets required for the French Colonies. Particulars from Galerie d'Orleans, Palais Royal. Tenders by July 20.

Narvik.—Tenders are invited by the Commissioners of the Norwegian State Railways for the supply of 15 tons of firebars. Particulars from Ofotenbahn, A. Tenders by July 30.

Alicante.—The Harbour Commissioners invite tenders for the supply of three centrifugal pumps and three gas-motors. Particulars from Junta de Obras del Puerto. Tenders by Aug. 12.

Bukarest.—Tenders are invited by the Roumanian State Railways Department for the supply of tubes for train heating, copper sheets, tin, and parts for Westinghouse brakes. Tenders by July 16.

Koslow.—The Tambow Government invite tenders for the equipment of the central electric station for distribution purposes. Particulars from Govodskaja Uprawe, Koslow. Tenders by July 16.

Buenos Ayres.—Tenders are invited for the supply of seven locomotives for use on the Patagonian railways. Particulars from the Direccion General de Vias y Communicaciones. Tenders by Aug. 21.

Brussels.—Tenders are invited for the supply of tirefonds, bolts, and nuts to the Belgian State Railways Department. Specification No. 237 can be obtained from 11, Rue de Louvain. Tenders by Aug. 4.

Robida.—The Public Works Department, Madrid, invite tenders for the construction of a railway to Robida. Particulars from the Direccion de Obras Publicas, Ministerio de Fomento. Tenders by Aug. 20.

Rome.—Tenders are invited for the supply of electric cable to the Italian Government Railways Department. Particulars from Ferrovie dello Stato Segretariato Generale, Sezione Contratti. Tenders by Aug. 10.

Victoria.—The Postmaster-General invites tenders for the supply and delivery at the post office, Hawthorn, of eight sections of a common-battery switchboard and subscribers' apparatus. Tenders by Sept. 14.

Brussels.—Tenders are invited by the Commissioners of the Belgian State Railways for spare parts in connection with carriage and wagon construction. Specifications from 11, Rue de Louvain. Tenders by July 28.

Brussels.—Tenders are invited for the supply of insulators, phosphor-bronze wire, and other electric lighting material for Tournia lighting. Specification from 15, Rue des Augustins. Tenders by July 28.

Alexandria.—Tenders are invited for the supply and erection of cast-iron grooves for the regulator under construction on the Rayah Behera. Particulars from the Inspector of Irrigation. Tenders by July 26.

Santa Croce.—The Municipality of Santa Croce, Tenerifa, invite tenders for the provision of suction dredger and pontoon with steam-engine. Particulars from the Junta de Obras del Puerto. Tenders by Aug. 27

Santiago.—Tenders are invited by the Chilian Railways Department for the supply of rails, fishplates, dog-spikes, and bolts. Particulars from the Direccion-General de Obras Publicas. Tenders by Sept. 1.

Wevelghem.—Tenders are invited by the Vicinal Railways Department, Brussels, for the construction of a line to Wevelghem. Specification, price 10d., can be obtained from 14, Rue de la Science. Tenders by Aug. 4.

Bukarest.—Tenders are invited for the supply of copper bars, copper plates for fire-boxes, Martin steel tyres for goods wagons, and tin. Particulars from the Roumanian State Railways Department. Tenders by July 19.

Saarbrucken.—Tenders are invited for the supply of seven travelling cranes, one fixed crane, and the provision of a transporter bridge. Particulars from the Preussischen Staats-Eisenbahnen. Tenders by July 19.

Sydney (N.S.W.).—The Postmaster-General invites tenders for the supply and delivery at departmental stores, Sydney, of 150 relays non-polar W.E. Co.'s type 12,505 wound to 250 ohms to schedule. Tenders by July 21.

Emden.—Tenders are invited for the supply of two electrically-driven dredgers. Particulars can be obtained from K. Maschinen bau-inspection. Tenders by July 20.

Paris.—The Directors of the Railways de l'Etat invite tenders for doubling the section of the French State Railways from Argentan to Flers of the Paris de Granville line. Papers from 42, Rue de Châteaudun. Tenders by July 29.

New South Wales.—The Postmaster-General invites tenders for the supply, delivery, and erection of a branching multiple-magneto switchboard at the Edgecliffe telephone exchange in accordance with Specification No. 247. Tenders by Sept. 29.

Barcelona.—The Public Works Department, Madrid, invite tenders for the construction and exploitation of electric tramways in Barcelona. Particulars from the Direccion-General de Obras Publicas, Ministerio de Fomento. Tenders by Aug. 27.

Rome.—The Italian State Railways Department invite tenders for carrying out various works of railway construction in connection with the Bivio-Sciacca-Bivio Greci Porto Empedocle line. Particulars from the Direzzione Generale. Ferrovie dello Stato. Tenders by July 20.

Melbourne.—The City Council invites tenders for bare hard-drawn copper cables (13¼ miles) and 6,410 yards single conductor lead-covered cable and 1,400 yards concentric lead-covered cable. Tenders by July 23 to McIlwraith, McEacharn, and Co., Proprietary, Billiter-square-buildings, E.C.

Madrid.—The Public Works Department invite tenders for the construction and exploitation of an electric tramway between Monarhil and the suburbs of Gabia Grande, Granada. Particulars can be obtained from the Commercial Intelligence Department of the Board of Trade. Tenders by Aug. 26.

Santiago.—The Chilian State Railways invite tenders for the supply of five locomotive tenders, in accordance with the specifications, which can be obtained at the Servicio de Materiales, Santiago. A deposit of 500 pesos (£37. 10s.) for each locomotive tender will be required to qualify any tender. Tenders to the office of the Dirección Jeneral de los Ferrocarriles del Estado, Santiago, by July 31.

Buenos Ayres (Argentine).—The Ministry of Public Works invite tenders for the supply of seven locomotives for the Patagonian Railways, in accordance with plans and specifications (in Spanish), copies of which can be seen on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C. Tenders to the Direccion General de Ferrocarriles, Buenos Ayres, by Aug. 21.

Adelaide.—The Municipal Tramways Trust invite tenders for the erection of buildings for power station on the site of Ocean Steamers' Wharf, Port Adelaide. The sum of 10 guineas will be charged per copy of specification, which will only be refunded on receipt of *bona fide* tender and return of specification. Particulars from Mr. H. C. Mais, 31, Queen-street, Melbourne. Tenders to Mr. W. G. T. Goodman, chief engineer and general manager, 8, King William-street, Adelaide, by July 27.

Honefoss (Norway).—The Commercial Intelligence Branch of the Board of Trade are notified that tenders are invited by the Norwegian State Railways for the supply of pumps with motors. Tenders, marked "Anbud paa pumpeverk," must be delivered at Overingeniorens Kontor, Honefoss, Norway, by July 25. Copies of the specification and conditions of tender, together with drawings, can be inspected by British makers on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

Melbourne (Australia).—The Corporation invite tenders for the supply of one overhead travelling crane. Tender form, conditions of tendering, specification, and plans, etc., can be obtained on application to Messrs. McIlwraith, McEacharn, and Co., Billiter-square-buildings, London, E.C., agents for Melbourne City Council, by depositing the sum of £1. 1s., which amount will be returned on receipt of a *bona fide* tender. Tenders to the Chairman, Electrical Supply Committee, Town Hall, Melbourne, by 2 p.m. on Aug. 4.

Brisbane (Australia).—The Board of Waterworks invite tenders for the supply of 42-in. and 48 in. steel pipes, or alternatively 42 in. and 48-in. wrought-iron pipes or 42 in. and 48-in. cast-iron pipes. The whole of the material to be used in the manufacture of the pipes must be the product of the United Kingdom or of the Commonwealth of Australia. Specifications and drawings can be obtained on application at the office of the Engineer to the Agent-General for Queensland, 409 and 410, Strand, London, W.C., on payment of a fee of £3. 3s Tenders must be sent to the Secretary, Brisbane Board of Waterworks, Brisbane, Queensland, by Sept. 1.

Copenhagen (Denmark).—The Commercial Intelligence Branch of the Board of Trade have been notified by his Majesty's consul at Copenhagen (Mr. L. C. Liddell, M.V.O.) that tenders are invited by the Copenhagen Lighting Corporation for the supply of (1) a quantity of continuous-current cable; and (2) 800 electric meters for alternating currents. The period of delivery, in both cases, is to extend from Aug. 1, 1909, to Aug. 1, 1910. Tenders, marked "Tilbud paa Jaevnstroms Kabler" in the case of (1) and "Tilbud paa Vekselstromsmaalere" in the case of (2), should reach Directoren for Belysningsvaesenet, Raadhuset, Copenhagen, by 12 noon on July 19 and 17 respectively. Copies of the specifications and conditions of tenders can be seen by British makers interested on application at the Commercial Intelligence Branch of the Board of Trade.

Rome (Italy).—The Rome *Gazzetta Ufficiale* of June 17 announces that tenders are invited for the construction of the Ostiglia Negara section of the Bologna-Verona Railway, nine miles long, and of various junctions. The upset price is placed at 3,650,000 lire (£146,000), and the competition will turn on the percentage of reduction offered thereon. To qualify any tender a deposit of 182,000 lire

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(£7,280) will be required, to be increased by the successful tenderer to 365,000 lire (£14,600). Tenders must be enclosed in sealed envelopes, marked on the outside "Offerta per Asta: tronco Ostiglia-Nogara," and addressed to Direzzione-Generale delle Ferrovie dello Stato (servizio 1, ufficio contratti), *via* Ludovisi 4, Rome, where they will be opened on July 31. Tenderers will be required to furnish certificates of competency. The award in respect of this competition will no doubt involve the purchase of a substantial quantity of permanent-way material, which may have to be obtained wholly or in part out of Italy. The *Gazzetta*, containing further particulars, can be seen by British firms interested on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall street, London, E.C.

RESULTS OF TENDERS.

Chester.—The Town Council have accepted the tender of Crompton and Co., at £785, for the supply of a switchboard.

Rochdale.—The Rochdale Electric Co. have received the order for the electric lighting of St. Mary's Church, Rochdale.

Woolwich.—The tender of Babcock and Wilcox, at £70, has been accepted for repairs to a boiler at the electricity works.

Colchester.—The Town Council have accepted the tender of T. J. Ward, at £32, for the erection of a small sub-station on land at the Hythe.

Dewsbury.—The tender of Hirst and Co., Dewsbury, has been accepted for an electrical installation at the Foundry-street Hippodrome.

Northallerton.—The Urban District Council have accepted the tender of the Northallerton Electric Lighting Co. for the lighting of the town.

Darlington.—For the supply of a motor-generator set, switchboard, etc., to the Town Council the tender of W. E. Dove and Co., Darlington, has been accepted.

Bury.—The Town Council have accepted the tender of Ferranti, Limited, Hollinwood, Lancs., for the provision of a main high-tension switchboard.

Derby.—The Town Council have accepted the tender of Jerram and Co., Derby, at £27. 5s., for the provision of a boiler in connection with the heating apparatus.

Wolverhampton.—The Town Council have accepted the tender of James Hodgkinson, Limited, Salford, at £750, for coal-conveying plant and coking stokers.

Cupar (Scotland).—For the work in connection with the heating and ventilating of the parish church the tender of D. Houston, Cupar, at £166, has been accepted.

Adelaide.—In connection with the Adelaide tramway system, the tender of J. P. G. Brill Co., Philadelphia, U.S.A., at £35,673, for 50 car bodies, has been accepted.

Luton.—The Town Council have accepted the tender of C. Franklin for about 2,000 tons of Kilburn nutty slack, at 10s. 7d. per ton, during the year ending June 30, 1910.

Bradford.—The City Council have accepted the tender of Manlove, Alliott, and Co., at £2,472, for the reconstruction of the destructor cells at the Cliffe-road destructor works.

Woolwich.—The London County Council have accepted the tender of T. S. Knight and Sons, at £278, for providing and fixing a new boiler at the Conway-road School, Woolwich.

Barking.—The Urban District Council have accepted the tender of Clark, Hunt, and Co., 159-160, High-street, Shoreditch, at £37. 5s., for heating work at North-street School.

Larne.—The Urban District Council have accepted the tender of the Larne Electric Light Works, at £480 per annum from Aug. 1 next, for the public lighting of the town for three years.

Keynsham.—The tender of the Keynsham Electric Light and Power Co. for public lighting from Aug. 10 to May 10, 1910, for the sum of £260. 15s., has been accepted by the Parish Council.

West Hartlepool.—The Durham Education Committee have accepted the tender of Cox-Walker, Limited, Darlington, at £192 10s., for an electric light installation at the Henry Smith Schools.

Salford.—The Town Council have accepted the tender of Edward Wood and Sons, at £36, for the supply and erection of a steel gallery at the works in connection with the switchboard extension work.

Worcester.—The tender of Heenan and Froude, at £656, has been accepted by the Town Council for the provision of a steel storage bunker and coal elevator and conveyor for the Electricity Committee.

Swansea.—The tender of A. Arnold and Sons, Newport, for electrical installation at the Swansea Technical School has been accepted. The tender amounted to £289. 12s. 8d., and was the lowest.

Colchester.—The Essex County Council have accepted the tender of Dargue, Griffiths, and Co., 25, Bucklersbury, E.C., at £19.028. 9s., for the provision of hot-water heating apparatus at the Colchester Asylum.

Dudley.—The Guardians have accepted the tender of Whittaker Bros., Wolverhampton-street, at £93, for the supply, delivery, and erection of a 10-h.p. motor, with shafting and belting, in the workhouse laundry.

Glasgow.—The Electricity Committee of the Town Council have accepted the tender of the British Thomson-Houston Co., at £425. 13s., for providing and erecting three motors for driving fans for cooling towers at St. Andrew's Cross Station.

Stepney.—The Borough Council have accepted the tender of the Sloan Electrical Co., Fore-street-avenue, E.C., at £1,091. 13s., for supply of carbons for two years; and of the Reason Manufacturing Co., Brighton, for the supply of meters at £671. 10s.

Leamington.—The D.P. Battery Co., of Bakewell, have received an order from the Midland Electric Light and Power Co., Leamington, to install and maintain for 10 years a storage battery of their L.S. 17 type in replacement of two batteries of another make.

Glasgow.—The Electricity Committee of the Town Council recommend the tender of Austin and Co. at £215 for an electric goods elevator in connection with the erection of a store and the extension of the boiler-house, etc., at the Port Dundas generating station.

Derby.—The Town Council have accepted the tender of the Chloride Electrical Storage Co. for the renewal of the tramway battery and maintenance for 10 years. Note.—The Council are to pay £100 down, and £100 per annum for six years and £70 per annum during each of the 10 years.

Hammersmith, W.—The Borough Council have accepted the following tenders for the provision of exhaust-steam and water pipe, also an Invincible centrifugal pressure pump with motor: Aiton and Co., Derby, water-pipe, £95; Gwynnes, Limited, 81, Cannon-street, E.C., pump, etc., £415.

Cape Town (S A.).—The Corporation have accepted the following tenders in connection with the electric lighting of Sea Point Siemens, Limited, 450 steel poles £1,326, 700 cross arms £134; Clyde Engineering Works, eight transformer pillars, etc., including two spare 5 kw. transformers and two 10 kw. transformers, £1,134.

Glasgow.—The Town Council have received the following tenders for the supply of motor pumps to the Fire Brigade Committee of the Town Council:

Dennis Bros.	£895
Halley's Industrial Motors	975

Wigan.—The following tenders have been provisionally accepted by the Town Council for the proposed extension at the electricity works: W. Park and Co., constructional steelwork, £720; W. T. Glover and Co., cables, £9,237; Babcock and Wilcox, boilers, £3,066; Tickle Bros., pipework and condensers, £1,689.

Mexborough.—The Urban District Council have accepted the following tenders: Bellis and Morcom, Birmingham, engine; Siemens Bros. Dynamo Works Co., London, 100-kw. generator; Ledward and Beckett, condenser; Drake and Gorham, Victoria-street, S.W., switchboard extension; Stewarts and Lloyds, Glasgow, pipework; Paterson Engineering Co., London, water softener.

Fulham, S.W.—The Borough Council have received the following tenders for painting the whole of the electric light standards in the borough:

G. R. Alldred, 41, Waldemar-avenue*	£131	13	6
H. Cooper, 37, New King's-road	179	11	2
T. Lester, 213, Dawes-road	213	0	0
Harwood and Co., 510, Fulham-road	268	12	6
Swan Bros., Beaufort Works, North End road	404	0	0

* Recommended for acceptance.

London.—The London County Council have received the following tenders for the supply of wooden fittings for 130 electric cars:

J. Challis, Limited, Holloway, N.	*£771	19	8
B. E. Nightingale, Albert-embankment	936	16	7
Hurst, Nelson, and Co., Motherwell	1,049	19	6
United Electric Car Co., Preston	1,417	11	6

Note.—The Highways Committee recommend that the work of supplying the wooden fittings be carried out under their management by the direct employment of labour. * Less 2½ per cent. discount.

Leyton.—The District Council have accepted the following tenders for the annual supply of meters:—Motor-type ordinary meters: Venner and Co.—1½ amperes, £1. 13s.; 3 amperes, £1. 16s.; 5 amperes, £2; 10 amperes, £2. 5s.; 25 amperes, £2. 10s.; 50 amperes, £2. 14s.; 100 amperes, £3. 3s. Motor-type slot meters: Venner and Co.—1½ amperes, £2. 15s.; 3 amperes, £2. 17s. 6d.; 5 amperes, £3. Electrolytic-type ordinary meters: Reason Manufacturing Co.—10 amperes, 10s. 6d.; 25 amperes, £2; 50 amperes, £2. 10s; 100 amperes, £3 (less 5 per cent). Electrolytic-type slot meters: Mordey, Fricker, and Co.—1½ amperes, £1. 13s.; 3 amperes, £2. 2s.

Calcutta (India).—The Corporation have received the following tenders for the supply and laying of a steel main, 6 ft. diameter reduced to 5 ft.: United States Steel Products Expert Co., 30, Church-street, New York, U.S.A., Rs.4,71,631-5 (c.i.f. only); Ashmore, Benson, Pease, and Co., 39, Victoria-street, London, S.W., Rs 7,83 562-5; British Welding Co., 25, Victoria-street, London, S.W., Rs 8,50,006-2 (c.i f. only); Burn and Co., Howrah, Calcutta, Design No. 1 Rs 8,61,163 8, No. 2 Rs.8,92,131, No. 3 Rs.8,11,586, No. 4 Rs.7.85.156; J. Simpson and Co., 10, Clive-street, Calcutta, Rs.10,49,589-8. Note.—One pound sterling equals 15 rupees.

London, S.W.—The London County Council have received the following tenders for the provision and fixing of additional heating apparatus at Munster-road School:

R. H. and J. Pearson, 145, High-street, Notting Hill-gate*	£59	10	0
Korting Bros., 53, Victoria-street	62	0	0
T. S. Knight and Sons, 222, Great Portland-street	76	15	0
J. Gray, Danvers-street, Chelsea	85	0	0
J. Grundy, 395A, City-road	87	0	0
G. Davis, 206, Church-street, Kensington	88	0	0
Hayward Bros. and Eckstein, 187-201, Union-street, Borough	93	17	2
H. Lucas and Son, Compton-road, Cradley Heath	98	10	0
C. Kite and Co., 132, Euston-road	125	0	0
A. Macintosh and Son, 14, Market-place, Cambridge	138	10	0
B. Harlow and Son, Macclesfield	173	0	0

* Recommended for acceptance.

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Wrenbury (near Nantwich).—The following tenders have been received for the heating of the church :

B. Harlow and Son, Macclesfield (accepted)	£152	19	8
D. Lowe and Sons, Manchester	152	17	0
R. Alger and Sons, Shrewsbury	171	16	2
W. H. Smith and Co., Whitchurch	178	1	6
R. Bridgeman and Sons	179	15	1
T. Kimberley	191	0	0
G. T. Wells, Sheffield	227	0	0

London.—The London County Council have received the following tenders for the provision and fixing of new boilers at the undermentioned schools :

Gopsall-street School, Haggerston.			
H. J. Cash and Co., Caxton House, Westminster*	£151	0	0
Comyn, Ching, and Co., 54, Castle-street, Long-acre	191	10	0
J. Grundy, 393A, City-road	207	0	0
G. Davis, 206, Church-street, Kensington	208	0	0
Hayward Bros. and Eckstein, Union-street, Borough	210	2	3
J. Yetton and Co., 4, Carr-street, Limehouse	214	10	0
J. Gray, Danvers-street, Chelsea	260	0	0
Thornhill-road School, Islington.			
R. H. and J. Pearson, 145, High-street, Notting Hill-gate	196	0	0
T. S. Knight and Sons, 222, Great Portland-street*	197	7	0
Palowkar and Sons, 90 and 91, Queen-street	197	18	0
J. and F. May, 33, Whetstone-park, Lincoln's-inn-fields	198	10	0
Strong and Collings, Medley Boiler Works, Bermondsey-street	218	15	0
Moorwood, Sons, and Co., 30, Gray's-inn-road	225	0	0
J. F. Phillips and Son, 21, Old Queen-street, Westminster	249	0	0
Stevens and Sons, 239, Southwark Bridge-road	261	0	0
The Millwall School, Poplar.			
R. H. and J. Pearson	158	0	0
J. and F. May*	160	10	0
G. and E. Bradley, 77, Lever-street	161	0	0
Cannon and Hefford, Stanbury-road, Peckham	166	10	0
W. G. Cannon and Sons, 107, London-road	168	0	0
G. Davis	168	0	0
Strong and Collings	171	0	0
H. J. Cash and Co.	185	10	0
F. Burkitt, 10, Lant-street, Borough	188	0	0
W. Simmons, Frederick-street, Stratford	200	0	0
Conway-road School, Woolwich.			
T. S. Knight and Sons*	278	0	0
R. H. and J. Pearson	278	0	0
J. and F. May	280	10	0
Brightside Foundry and Engineering Co., 28, Victoria-street	285	0	0
Palowkar and Sons	293	0	0
A. Macintosh and Sons, 14, Market-place, Cambridge	310	0	0
J. F. Phillips and Son	323	0	0
C. Kite and Co., 132, Euston-road	338	0	0
Korting Bros., 53, Victoria-street	344	10	0
Moorwood, Sons, and Co.	350	0	0
H. Lucas and Son, Compton-street, Cradley Heath	393	0	0

* Recommended for acceptance.

PROVISIONAL PATENTS, 1909.

JULY 2.

15438. Improvements in electricity meters. George Hookham, 4, New Bartholomew-street, Birmingham.

15441. Improved construction of quick make and break electrical switch. Veritys, Limited, and William George Pipkin, 11, Burlington-chambers, New-street, Birmingham.

15444. Adapter for converting oil or similar lamps for use with electric light. Henry Rivers Rivers-Moore, 37, Kempsford-gardens, Earl's Court, London.

15475. Improvements in electrically-operated apparatus for locking railway carriage and other doors. Ralph Brooks Nelson, John Ormsby, and Edward Nicholson, 37, Chancery-lane, London. (Complete specification.)

15494. Improvements in rotary electric transformers and motor-generators. Crompton and Co., Limited, James Colquhoun Macfarlane, and Harry Burge, 55, Chancery-lane, London.

15496. Process for the manufacture of metallic filaments for electric incandescent lamps. Rudolf Jahoda, 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, May 10, 1909, being date of application in Austria.) (Complete specification.)

JULY 3.

15532. Improvements in or applicable to stage arc lamps and other similar lamps. Austin Walters, 4, St. Ann's-square, Manchester. (Complete specification.)

15544. Electrically-controlled brakes for cranes and the like. Bertram Thomas and Eustace Thomas, Worsley-street, Hulme, Manchester.

15554. Improvements in magazine electric arc lamps. Charles Franklin Tubbs, Birkbeck Bank-chambers, Southampton-buildings, London.

15572. Safety devices for electric annunciators. Andre Georges Marcel Cathiard, 7, Southampton-buildings London.

15574. Improvements relating to overhead lines for electric traction. Charles Marie Edouard Priestley, 7, Southampton-buildings, London. (Complete specification.)

JULY 5.

15578. Improvements in or relating to electric switches. John Alexander Kennedy-McGregor, 5, Corporation-street, Birmingham. (Complete specification.)

15580. Improvements connected with the attachment of telegraph and similar line wires to insulators. William Edward Bandfield, 11, Burlington-chambers, New-street, Birmingham.

15605. Improvements in electric arc lamps. Siemens-Schuckertwerke G. m. b. H., Caxton House, Westminster. (Date applied for under Section 91 of the Act, July 6, 1908, being date of application in Germany.) (Complete specification.)

15647. Improvements in and relating to the manufacture of electric carbons. Rudolf Lessing, Birkbeck Bank-chambers, Southampton-buildings, London.

15650. Improvements in electrical indicators. Hon. Stuart Pleydell Bouverie and William Robert Rawlings, 34, High Holborn, London.

JULY 6.

15670. Improvements in and relating to electrical and other recording and measuring instruments. Ernest Sydney Heurtley, care of Capital and Counties Bank, Oxford.

15672. Improvements in apparatus for controlling and operating the points of electric railways and tramways. Adolf Lustgarten, 19, Rathbone-place, Oxford-street, London.

15681. Improvements in electric switches. Bertram Thomas and Eustace Thomas, Worsley-street, Hulme, Manchester.

15682. Improvements in electric collectors. Bertram Thomas and Eustace Thomas, Worsley-street, Hulme, Manchester.

15714. Improvements in electrical water-level indicators. The Hon. Stuart Pleydell Bouverie and William Robert Rawlings, 34, High Holborn, London.

15725. Improvements relating to braking apparatus for railway or like vehicles. Westinghouse Electric Company, Limited, 2, Norfolk-street, Strand, London. (Date applied for under Section 91 of the Act, July 14, 1908, being date of application in Germany.) (Complete specification.)

15737. Improved method of securing metal contacts to carbon electrodes. Stephan Benkö, 111, Hatton-garden, London. (Date applied for under Rule 13, Dec. 28, 1909. An invention comprised in application No. 28290, dated Dec. 28, 1908.) (Complete specification.)

15771. Improvements in dynamo-electric machinery. Albert Henry Midgley and Charles Anthony Vandervell, 1, Queen Victoria-street, London.

15786. Improvements in or relating to electric heaters for fluids or liquids. Alfredo Ponzini, 111, Hatton-garden, London. (Complete specification.)

15790. Improvements in or connected with electric fuses. Harry Robinson Slack, Norfolk House, Norfolk-street, Strand, London.

15795. New or improved protector for insulators on telegraph or telephone posts and the like. Frank Stevens, 38, Chancery-lane, London.

JULY 7.

15800. Improved continuous-current dynamo-electric machine. Roughsedge Wallwork, Charles Henry Wallwork, and Bernard Joseph Shillito, 64, Barton-arcade, Manchester.

15802. Improvements in or relating to electric ignition apparatus for internal-combustion engines. Boultbee Brooks and Frank Herbert Alston, 24, Temple-row, Birmingham.

15803. Improvements in or relating to the electric ignition systems of internal-combustion engines. Boultbee Brooks and Frank Herbert Alston, 24, Temple-row, Birmingham.

15854. Improvements in electrical mercury switches operated by a vehicle passing along a railway. Siemens Bros. and Co., Limited, and Luiz de Moraes Gomes Ferreira, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

15862. Improvements in electrical block signalling systems. Ernest Ardissna Richardson, 24, Southampton-buildings, London. (Date applied for under Section 91 of the Act, July 11, 1908, being date of application in France.) (Complete specification.)

15863. Improvements in operating signals. René Bujon and Compagnie de Signaux Electriques pour Chemins de Fer, 24, Southampton-buildings, London. (Date applied for under Section 91 of the Act, July 17, 1908, being date of application in France.) (Complete specification.)

15867. Improvements in and relating to the manufacture of filaments for electric lamps. August Bourdos, 18, Southampton-buildings, London.

15880. Improvements in or relating to electric arc lamps. Hendricus Johannes Jacobus Jaburg, jun., 37, Furnival-street, Holborn, London. (Date applied for under Section 91 of the Act, May 26, 1908, being date of application in Germany. An invention comprised in application No. 7471, dated March 29, 1909.) (Complete specification.)

15888. Automatic battery overcharge preventer. Henry Leitner, 4, South-street, Finsbury, London.

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15868. Improvements in and connected with the detection of magnetic ore. Harry William Buddicom, 18, Southampton-buildings, London.

15881. Improvements in or relating to electric arc lamps. Hendricus Johannes Jacobus Jaburg, jun., 37, Furnival-street, Holborn, London. (Date applied for under Section 91 of the Act, July 1, 1908, being date of application in Germany. An invention comprised in application No. 7471, dated March 29, 1909.) (Complete specification.)

15889. Improvements in automatic electric regulators, output adjusters, and the like. Henry Leitner, 4, South-street, Finsbury, London.

15891. Improvements in generators for wireless telegraphy and telephony with continuous oscillations. Erich Huth, 55, Chancery-lane, London. (Complete specification.)

JULY 8.

15928. Improved contact maker. John Weller, 42A, Martell-road, West Dulwich, London.

15929. Improvements relating to electrical testing apparatus. Thomas Edward Gambrell and Charles Thomas Gambrell, 23, North-side, Clapham Common, London.

15960. Improved electrolytic cell. Joseph Francis Flood, 9, Clitheroe-road, Stockwell, London.

15978. Improvements in or relating to electric signalling systems for railways and the like. John Daniels Taylor, 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, Jan. 30, 1908, being date of application in United States. An invention comprised in application No. 1788, dated Jan. 25, 1909.) (Complete specification.)

15980. Improvements relating to telegraphy. Benjamin Davies and Alexander Robertson Hardie, 18, Southampton-buildings, London.

15981. Improved method and means of producing synchronism between the rotation of a controlling machine and the rotation of one or more electrically-driven machines. Eugene Louis Amédée Lertourné, 18, Southampton-buildings, London. (Complete specification.)

15991. Improved electric locking and unlocking device for locks. Gustav Sahmer, 7, Southampton-buildings, London. (Complete specification.)

16004. Improvements relating to electrically-controlled pneumatic dispatch tubes, cash railways, and the like. Charles William Bluemel, Ernest Adolphus Bluemel, Frank Henry Bluemel, trading as Bluemel and Bros., C. W., and Percy Richardson Shill, 11, Southampton-buildings, London. (Application for patent of addition to No. 3770/08.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on July 22.)

1908.

13734. Electrodes and resistances for electric furnaces, radiators, lamps, and the like. Comaro. (Date applied for under International Convention, June 27, 1907.)

13957. Regulating device for electric circuits. Ritchie.

14461. Combined telephone and telautograph exchange system. Ritchie.

14463. Automatic electromagnetic switch or cut-out for disconnecting charged conductors in overhead systems of electric traction or the like. Barraclough.

15792. Electrolytes for electrolytic cells. British Thomson-Houston Company. (General Electric Company.)

18246. Electroplating and like processes. Hutton and Hutton.

19883. Electrical ignition systems of internal-combustion engines. Bell. (Cognate application, 20226/08.)

19992. Automatically regulating direct-current and alternating-current machines. Akt.-Ges. Brown, Boveri, et Cie. (Date applied for under International Convention, Aug. 24, 1908.)

20447. Stranded electric cables. Beaver and Claremont.

21857. Signals for railway and like systems. British Thomson-Houston Company. (General Electric Company.)

22135. Protective devices for electric distribution systems of the type known as lightning arresters. British Thomson-Houston Company. (General Electric Company.)

22551. Electric cooking and heating apparatus. Coiseur. (Date applied for under International Convention, March 27, 1908.)

23726. Manufacture of filaments for incandescent electric lamps. British Thomson-Houston Company and Needham. (General Electric Company.)

24211. Incandescent electric lamps. Société Française d'Incandescence par le Gaz (système Auer). (Date applied for under International Convention, Nov. 12, 1907. Application for patent of addition to No. 12720/05.)

26796. Mechanical connectors for electric cables. Stratton and Claremont.

28378. Wireless telegraphy and the like. Eisenstein.

1909.

4122. Alternating-current arc lamps. Körting.

9516. Electric arc lamps. Bleckly and Brown.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos 1-70,000	1	–	½-⅝
—— Ord., 1,125,000	1	–	½-⅝
Avon Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	½-⅝
—— Ordinary, Nos. 1-125,000	1	–	11/32-15/32xd
British Aluminium Co., Ordinary, 2,001-40,000	5	–	⅜-½
—— 7 per cent. Cum. Pref., 1-40,000	5	–	1-1⅛
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	–	2½-3½
—— 4 per cent. Funding Certificates, 1-20,000	5	–	2½-3⅞
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	83-88
—— 5½ per cent. Loch Leven Deb. (Reg.), Red., 1-3,000	100	–	94-99
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	7⅛-7⅜
—— 6 per cent. Cum. Pref., 1-100,000	5	–	6⅛-6⅜
—— 4½ per cent. Mortgage Debentures	100	–	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	91-96
British Westinghouse Elec. and Manuf. 10 per cent. Pref. £75,001-£75,000	5	–	3/16-7/16
—— 4 per cent. Mortgage Debenture Stock	100	–	38-42
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	–	0-¼
—— Non. Cum., 6 per cent., Pref.	2	–	0-¼
—— 4½ per cent. 1st Debenture Stock	100	–	43-48
—— 4½ per cent. 2nd Debenture Stock	100	–	27-31
Callender's Cable, Debentures	100	–	105-107
—— Ordinary	5	–	9¾-10¼ xd
—— 5 per cent. Pref.	5	–	5¼-5½
Consolidated Electrical Co., Ordinary, 1-110,000	1	–	7/16-9/16
Crompton and Co., Nos. 1-85,000	3	..	1-1¼
—— 5 per cent. 1st Mort. Reg. Debs., Nos. 1-900 of £100, and 901-1,100 of £50, Red.	—	..	91-96
Dick, Kerr, and Co., Ordinary, 1,260,000	1	–	1 1/16-1¼
—— 6 per cent. Cum. Pref., 1-305,000	1	–	1 3/32-1 7/32
—— 4½ per cent. Debenture Stock, Red.	100	–	99-102 xd
Edison and Swan United, 'A" Shares, 1-99,261	5	–	1-1¼
—— "A" Shares, 01-017,139	5	–	1¼-2½
—— 5 per cent. Debentures	100	–	68-73
—— 4 per cent. Deb. Stock, Red.	100	–	93-96
Electric Construction, Nos. 1 to 112,100	2	–	7/16-½
—— 7 per cent. Cumulative Pref.	2	–	1 7/16-1 11/16
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	61-65
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	71-77
General Electric Company (1900) 5 per cent. Cum. Pref.	10	–	7¼-7½ xd
—— 4 per cent. 1st Mort. Deb. Stock	100	–	86-88
W. T. Henley's Telegraph Works, Ordinary	5	..	11⅜-12⅜
—— 4½ per cent. Preference	5	..	5-5⅜
—— 4½ per cent. Debentures	100	..	105-107
India Rubber, Gutta Percha, and Telegraph Works	10	..	14½-15½
—— 4 per cent. Debentures	100	..	99-101
National Electric Construction Co., 1-170,000	1	–	½-¾
Telegraph Construction and Maintenance	12	..	35-36½
—— 4 per cent. Bonds	100	–	99-101
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	–	9½-10½ xd

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	–	5¼-5⅝
Bournemouth and Poole, Ordinary	10	–	9⅜-10¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9⅜-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	10½-10⅞
—— 4½ per cent. Debenture Stock, Red.	100	–	99-103 xd
Bromley (Kent) Electric Light and Power Co.	5	–	4¼-5
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	93-96
Brompton and Kensington, Ordinary	5	–	8-8¼
—— 7 per cent. Preference	5	–	8-8¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-100,000	5	–	5¾-6¼
Cambridge Electric Supply Company, £10 Ord.	8	–	12½-13¼
Canadian General Electric Co., Common Shares	$100	–	115-118
—— 7 per cent. Cum. Pref. Stock	$100	–	117-119
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	–	97-100
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	–	3¼-4⅜
—— 4½ per cent. Cum. Pref., 1-80,000	5	–	4⅜-4⅝
—— 4 per cent. Debenture Stock, Red.	100	–	96-99 xd
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000	5	–	3⅜-4⅛ xd
Chelsea Electricity Supply	5	–	3⅜-4
—— 4½ per cent. Debentures	100	–	100-103 xd
City of London, Ordinary	10	–	10¼-11
—— 6 per cent. Cumulative Pref.	10	–	12-12⅜
—— 5 per cent. Debenture Stock	100	–	121-124
—— 4½ per cent. 2nd Deb. Stk., Red.	100	–	99-102 xd
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	–	90-98
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	–	2⅜-3¼
—— 5 per cent. Preference, 1-50,000	5	–	3¼-3⅜
County of London Elec. Supply, Ordinary	10	..	8¼-8⅜
—— 6 per cent. Cum. Pref.	10	–	10⅜-11¼
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	..	103-106
—— 4½ per cent. 2nd Debentures Prov. Certs	100	..	100-103
Edmundson's Electricity Corporation, Ordinary, 1-80,000	5	..	3/16-5/16
—— 6 per cent. Cum. Pref.	5	..	⅜-⅝
—— 4½ per cent. First Mort. Deb.	100	..	60-65
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	—	..	85-87 p e.
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	–	85¼-88¼ xd
Folkestone Electric Supply, Ord., Nos. 1-10,000	5	..	4½-5
—— 5 per cent. Cum. Pref., Nos. 1-10,000	5	–	5-5½
—— 4½ per cent. First Deb. Stock, Red.	100	–	98-101
Hove Electric Lighting, Ord., 1-13,000	5	–	7¼-7
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	5	–	1¼-2
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100	–	74-78
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	–	25/32-¾
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5	–	6⅞-7
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	–	98-101

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Name.	Amount paid. £		Last price. £
London Electric Ordinary	5	—	1⅞-2⅛
—— 6 per cent. Pref.	5	—	5⅛-5⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red	100	—	93-97
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	—	76-80
Metropolitan Ordinary, 100,001-300,000	5	—	4⅛-4⅜
—— 4½ per cent. First Mortgage Debenture Stock	100	..	105-108 xd
—— 4½ per cent. Cum. Pref.	5	..	4⅜-5⅛
—— 3½ per cent. Mortgage Debenture Red.	100	..	82½-86½
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,000 ($500) M 1-4,400 ($1,000) ($500) 4,001-14,000 ($1,000)	—	..	82-84 p.c.
	—	..	88-90
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	92-96
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-87,500	5	..	4⅜-5¼
—— do. 87,501-137,500 (issued at £1 prem.). All paid (Prov. Certs.)	5	..	4⅜-5¼
—— do., 5 per cent. Pref., 1-87,500 (Prov Certs.)	2	..	4⅜-5¼
—— 5 per cent. Pref., 87,501-137,500 (Prov. Certs.)	4	..	4⅜-5¼
Notting Hill Electric Lighting	10	..	11¼-12½
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	..	6-6½
—— 4 per cent. Debenture Stock	100	..	94-97
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	..	1⅛-1 7/16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	1 1/32-1 5/32
—— 5 per cent. Debenture Stock, Red	100	..	102-105 xd
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20,000	5	..	5 5/16-5 9/16
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5	..	5⅝-6
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	102-104
Shawinigan Water and Power. Co., 5 p.c. Cons. 1st Mt. Bds.	—	..	106-108 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	..	9/16-13/16
South London, Ordinary	4	..	2⅛-3⅛
South Metropolitan Electric Light and Power, Ord.	1	—	5/16-9/16
—— 7 per cent. Cum. Pref.	1	..	1 5/16-1 5/16
—— 4½ per cent. 1st. Mort. Deb.	100	..	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	8⅜-9⅛
—— 7 per cent. Pref.	5	..	7-7⅛
—— 3½ per cent. Deb.	100	..	84-88
Urban Electric Supply Co., Ordinary, 8-30,007	5	..	⅜-1
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	1⅛-2⅛
—— 4½ per cent. First Mort. Debenture Stock, Red.	100	..	80-84
Westminster, Ordinary	5	..	8⅛-9⅛
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	—	5-5⅛

Electric Tramways.—

Name.	Amount paid. £		Last price. £
Anglo-Argentine 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007	5	..	9 3 16-9 7/16
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	91-92
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	101-103
Bath Elec. Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	..	⅛-⅜
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1	..	9/16-11/16
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	..	87-91
Blackpool and Fleetwood Tramroad	10	..	13⅜-13⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	10	..	9½-10
—— 4½ per cent. Deb. Stock, Red.	100	..	93½-95½
Brisbane Tramway Invest., Ord., 1-75,000	5	..	6-6½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	5-5⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	100½-104½
British Columbia Electric Railway Co., Ord. Def.	100	..	143-147
—— Ord. Pref.	100	..	121-123
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	113-113
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	..	102-104
—— 4½ per cent. Vancouver Power Deb.	100	..	102-105
British Electric Traction, Ord. 1-30,000 & 60,001-90,000	10	..	⅛-⅞
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	2⅛-2⅞
—— 5 per cent. Perpetual Debenture Stock	100	..	86-90
—— 4½ per cent. 2nd Deb. Stock	100	..	66-70
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	..	81-86
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	..	102-107
—— 5 per cent. Deb. Bonds, Red., 1-2,275	100	..	103-106
Buenos Ayres Lacrose Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	99-101
Calcutta Tramways Ord., Nos. 1-137,610	5	..	4⅛-4⅜
—— 5 per cent. Cum. Pref., Nos. 1-30,000	5	..	4⅜-5
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	97-100
Cape Electric Tramways, Nos. 1-480,000	1	..	⅛-⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	4⅛-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	..	97-101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	..	5⅜-5⅞
—— 4 per cent. Deb. Stock, Red. (1985)	100	..	98-101 xd
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	98-101
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13-14
—— 6 per cent. Cum. Pref.	10	..	12⅜-13⅜
—— 4 per cent. Debentures	100	..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	12½-13½
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	..	90-95
Hastings and Dist. Elec Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	74-79
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000	..	93-96
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14½
—— 4½ per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	..	⅜-1⅜ xd
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	..	59-63
Kalgoorlie Electric Tramways, 1-250,000	1	..	1/32-3/32
—— 5 per cent. "A" Deb. Stock	100	..	89-92
—— 6 per cent. "B" Deb. Stock	100	..	64-68
Kidderminster and District Lighting and Traction, Pref.	5		9 15/16-10 3/16
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	..	82½ 90½
—— £296,500 2nd Mort. Deb. Stock	—	..	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	..	15/16-1 1/16
—— 5 per cent. Cum. Pref., Nos. 1-425,553	1	..	15/16-1 3/16
—— 5 per cent. Mort. Deb., 1-5,000, Red.	100	..	96-99

Name.	Amount paid. £		Last price. £
London United Trys. (1901) 5 per cent. Cum. Pref.	10	..	1½-2½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	63 67
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	..	80½-83½
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	..	94-96
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5	..	4⅛-5
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	86-91
Metropolitan Elec. Trams., Defd., 1,000,001-1 314,016	1	..	1/32-5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	23/32-27/32
—— 4½ per cent. Deb. Stock, Red.	100	..	95-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	—	92½-94½
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort. Bonds (1926) 1-5,500 and 7,001-8,000	$1,000	—	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922)	100	—	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	—	⅛-⅜
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mort. Deb. Stk.	100	..	100½-103½
Potteries Electric Traction, Ordinary, 1-245,000	1	..	3/16-7/16
—— 5 per cent. Cum. Pref., 300,001-545,000	1	—	⅛-⅜
—— 4½ per cent. Debenture Stock	100	..	86-89
Provincial Tramways Co., Ordinary, 1-24,912	10	..	4-4⅛
—— 6 per cent. Cum. Pref., 1-10,000	10	—	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	—	5⅛-5⅜
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	—	99-101
Sao Paulo Tramway, Light, and Power Co.	$100	..	147-150
—— 5 per cent. 1rt Mort. Deb., Red. (1929) 1-12,000	$500	..	97½-99½ p.c
South Metropolitan Electric Tramways and Lighting Co. 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	⅜-⅝
—— 4 per cent. Deb. Stock, Red. (1940)	100	..	70-74
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red., 1-1,600	100	..	82-86
Yorkshire (West Riding) Elect. Tram. Co., Ord., 70,001-110,000	5	..	⅛-⅜
—— 6 per cent. Cum. Pref., 1-46,261	5	..	1⅜ 2⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	84 88

Electric Railways.—

Name.	Amount paid. £		Last price £
Central London, Ordinary	100	..	61-63
—— 4 per cent. Pref.	100	..	83-85
—— " " deferred	100	..	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	102-104
City and South London, Consolidated Ordinary	100	..	31-32
—— 4 per cent. Debenture Stock	100	..	99-101
—— 5 per cent. Pref. Stock '91	100	..	110-112
—— " " " '96	100	..	106-109
—— " " " '01	100	..	102-105
—— " " " '03	100	..	93-95
Liverpool Overhead, 5 per cent. Pref.	10	—	10-10⅛
—— Ordinary, 1-50,000	10	—	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	94-98
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	—	102-103

Telegraphs and Telephones.—

Name.	Amount paid. £		Last price £
Amazon Telegraph Co., 1-25,000	10	—	2⅜-3¼
—— 5 per cent. Debs., Red., within 1-1,069	100	—	92-96
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	—	97-99
Anglo-American Telegraph Co., Ordinary	100	—	57-59
—— 6 per cent. Preferred Ordinary	100	..	100½-101½
—— Deferred Ordinary	100	..	16-16½
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	—	102-104
Chili Telephone Co., 1-44,000	5	—	8-8⅜
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	..	89-91
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	—	8⅛-8⅜
—— 10 per cent. Preference, 1-6,000	10	..	17-18
Direct Spanish Telegraph Co., Ordinary	5	..	2⅜-3⅛
—— 10 per cent. Cum. Preference	5	..	8⅛-8⅜
—— 4½ per cent. Debs., 1-600	50	..	99-101
Direct United States Cable Co.	20	..	12⅜-13⅛
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	..	98-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000 (1909)	100	—	100-102
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy) 1-8 000 (1913)	25	..	102½-104½
Eastern Extension, Australasia and China, 1-300,000	10	..	11½-12
—— 4 per cent. Mort. Deb. Stock, Perp.	100	..	102½-104½
Eastern Telegraph Co., Ordinary Stock	100	..	127-130
—— 3½ per cent. Preference Stock	100	..	—
—— 4 per cent. Mortgage Debenture Stock	100	..	104½-106½
Great Northern Telegraph Co. (of Copenhagen)	10	..	25½-26½
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red	100	..	99-101
Indo-European Telegraph Co.	25	..	51½-53½
Marconi's Wireless Telegraph Co., Nos. 256,128-384,190	1	..	23/32-27/32
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	⅛-1
—— 5 per cent. Preference, 1-86,492	1	—	13/16-15/16
National Telephone, Preferred	100	..	108-109⅛
—— Deferred Stock	100	..	124-126
—— 6 per cent. Cum. First Pref.	10	..	10½-11
—— 6 per cent. Cum. Second Pref.	10	..	10-10⅛
—— 5 per cent. Non. Cum. Third Pref.	5	..	5 9/16-5 13/16
—— 3½ per cent. Deb. Stock, Red.	100	..	97-99
—— 4 per cent. Deb. Stock, Red.	100	..	99-101
Oriental Telephone and Electric Company	1	..	1 5/16-1 7/16
—— 6 per cent. Cum. Pref.	1	..	1 1/16-1 3/16
Pacific and European Tel., 4 p c Guar. Debs., Red, 1-1,000	100	..	99-101
United River Plate Tele. Co., Ordinary, 1-100,000	..	..	6⅛-7⅛
—— 5 per cent. Cum. Pref., 1-40,000	5	..	5-5⅛
—— 4½ per cent. Debenture Stock, Red.	100	..	102-103½
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	..	98½-100½
West African Telegraph Co.	10	..	12⅜ 13⅝
West Coast of America, 1-30,000 and 53,001-53,008	2½	..	1⅜-1⅝
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	—	99-101
West India and Panama Telegraph Co., Ordinary	10	..	⅛-1⅛
—— 6 per cent. Cum. 1st Preference	10	..	8⅛-8⅜
—— 6 per cent. Cum. 2nd Preference	10	—	8-9
—— 5 per cent. Debs., Red., 1-800	100	—	100½-102½
Western Telegraph Co., 1-207,930	10	—	13⅛-13⅝
—— 4 per cent. Debenture Stock, Red.	00	—	93-96

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns week. Ending	1909.	1908.	Increase or decrease. Week.	Current year.	Miles of track open. 1909.	1908.	Accounts for past year. Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Passenger	Receipts per Car mile.	Receipts per [illegible] of track.	Cost per car mile.
		£	£	£	£				£						
Aberdeen Corporation	July 7	1,539	1,462	+ 77	- 285	27½	27½	May 31	71,800	17,517,304	1,566,119	98	11·02	4,940	5·33
Ayr Corporation	,, 10	375	339	+ 36	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	,, 10	3,765	3,090	+ 275	—	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 12	1,107	1,080	+ 27	- 412	23·63	23·63	—	—	—	—	—	—	—	
Birmingham Corporation	,, 3	6,642	6,461	+ 181	—	56 782	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 7	1,130	1,153	- 23	- 637	23 8	28 3	—	—	—	—	—	—	—	—
Blackpool Corporation	,, 8	1,694	1,692	+ 2	+ 778	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	Aug. 8	2,304	2,329	- 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	July 4	2,546	2,693	- 147	- 700	42	42	March 31	117,793	25,492 902	2,092,147	1 1	11·34	2,804	6·50
Bournemouth Corporation	,, 7	1,589	1,634	- 45	+ 72	29¼	29¼	,, 31	86,225	13,991,328	1 766 068	1 47	11·71	2,912	7·22
Bradford Corporation	,, 3	5,061	5,095	- 31	+ 931	98½	98½	,, 31	235,258	47,839,569	5,331 007	1 17	10·59	2 378	—
Brighton Corporation	,, 11	906	934	+ 32	+ 733	—	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	,, 9	5,970	7,722	- 1,752	—	57	51½	Dec. 31	265,762	46 652 389	5 756 842	—	—	—	—
Burnley Corporation	,, 10	1,259	1,231	+ 28	—	19½	19½	March 31	64,261	12 355,958	1,242,330	1·23	12 83	5,971	7·32
Burton Corporation	,, 11	275	286	- 11	—	10	10	,, 31	14,918	3,221.595	430,913	1·04	8 30	1,460	5 15
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	,, 31	109,979	25,058,146	2,497,169	—	10 57	—	—
Carlisle Tramways Company	June 19	170	175	- 5	- 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	July 10	5,608	7,225	-1,617	—	6 32	5·77	Dec. 31	350,150	41,838,373	1,476,781	2 01	5·769	55,404	30 27a
Charing X, Euston, & Hamp. Ry	,, 10	3 990	3,305	+ 685	—	—	—	—	—	—	—	—	—	—	—
City and South London Railway	,, 11	3,188	3,184	+ 4	—	—	—	—	—	—	—	—	—	—	—
Colchester Corporation	May 26	176	190	- 14	—	8	—	March 31	10,983	2,308,721	349,579	1·09	7 74	1,477	6 56
Cork E. T. and L. Company	July 8	623	575	+ 48	- 937	—	—	Dec. 31	24,044	5,737,478	896,945	—	6 63	—	4 43
Croydon Corporation	,, 2	1,464	1,607	- 143	- 65	11½	—	March 31	74,132	16,277,318	1,884,137	1 06	9 56	3,703	7 10 9
Darwen Corporation	,, 2	247	288	- 41	- 146	7·23	7·23	,, 31	13,593	2 557,654	245,584	1·30	13 68	1 922	9 80
Dover Corporation	,, 3	207	245	- 38	- 806	7	—	,, 31	11,593	2,697,672	316,754	·98	8 78	—	—
Dublin and Lucan Electric Ry.	,, 9	88	101	- 13	—	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	,, 9	5,693	5,836	- 137	- 341	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 7	1,213	1,218	- 5	- 383	—	26½	May 15	60,573	16,367 911	1,581,552	·875	1·9	2,371	7·46
East Ham Corporation	,, 10	1,043	951	+ 92	+ 2,171	15	15	March 31	47,430	15,355,703	1,091,586	·73	10 26	—	6·96
Glasgow Corporation	,, 3	17,125	18,715	-1,589	- 1,645	185½	179	May 31	907,494	226,948,290	20,756,722	·96	10 49	5,08	5 89
Gloucester Corporation	,, 7	302	307	- 5	+ 579	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton.	,, 10	5,675	5,420	+ 255	—	—	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	March 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	,, 3	1,663	1,681	- 18	+ 448	28½	28½	,, 31	84 704	6,200,020	1,960,129	1·29	10 37	2,021	5 10
Hull Corporation	,, 10	2,595	2,489	+ 106	+ 424	26	26	,, 31	128,722	30,964,254	3,022,844	1	10·22	—	6·04
Ilford Corporation	,, 3	531	510	+ 21	+ 595	10	10½	,, 31	25,328	5,385,466	634,446	·87	9 58	2,066	6·42
Ilkeston Corporation	,, 7	141	145	- 4	- 149	4	4	,, 31	7,214	1,968,850	198,415	9 1	7·9	1 803	7·04
Kirkcaldy Corporation	,, 7	267	265	+ 2	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	,, 7	2,123	1,400	+ 723	+ 171	39	39	Dec. 31	68,904	12,551,593	2,244,344	—	—	—	—
Leeds Corporation	,, 3	7,555	7,652	- 97	+ 3,270	96½	96½	March 31	340,768	75,734,083	7,694,989	1·06	10 62	3, 27	5·51
Leicester Corporation	,, 10	2,245	2,313	- 67	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 3	11,300	11,707	- 407	- 3,615	104	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11 24	5,503	7·94
Liverpool Overhead Railway	,, 11	1,443	1,411	+ 32	+ 78	6 65	2 40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	June 26	36,349	37,393	-1,042	+15,311	121	115½	March 31	1274,660	279,166,461	28,591,028	1 08	11·74	—	6·79
Lowestoft Corporation	July 4	190	222	- 32	- 666	3½	—	Sept. 30	11,399	2,645,206	370,32	1·03	7·36	2,279	6·12
Maidstone Corporation	,, 3	181	163	- 21	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 3	15,512	16,433	- 921	- 2,033	181	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	,, 10	10,348	9,422	+ 926	—	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 4	15,696	15,017	+ 679	+14,760	24½	24½	June 30	680,357	99 846,735	—	1·46	—	—	—
Nelson Corporation	,, 10	140	129	+ 11	- 84	2½	2½	March 31	7,362	2,060,712	204,714	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	,, 10	3,709	3,723	- 14	- 1,426	60½	59½	,, 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	,, 3	673	735	- 56	- 252	14½	14½	,, 31	35,531	8,174,003	798,029	1·04	9 89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	- 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	March 31	97,741	21,247,048	2,309,459	1·10	10·15	—	
Reading Corporation	July 8	645	680	- 35	+ 73	13½	13½	,, 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	,, 31	56,558	10,196.148	1,252,925	1·32	10 83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	- 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	June 28	4,378	5,137	- 759	- 222	78	74½	March 31	244,065	45,771,511	5,426,150	1·25	10·67	3,185	
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	July 4	5,718	5,706	+ 12	- 1,237	68½	66½	March 25	289,745	17,568,686	7,065 380	·696	9 842	4,225	5·04
Southampton Corporation	June 20	1,058	1,170	- 112	- 447	18	18	,, 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	July 7	580	508	+ 72	+ 972	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	March 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	- 26	- 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	July 7	127	162	- 35	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	,, 8	345	327	+ 18	—	5·16	—	Dec. 31	15,065	2,880.420	353,297	1·40	1 023	—	—
Wallasey U.D.C.	,, 3	988	1,008	- 20	+ 353	12 68	12·45	March 31	43,823	8,331,038	891,540	1·2	11·79	3,353	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	,, 1	2,269	2,368	- 99	+ 1,732	14·7	14·7	March 31	122,881	35,502,836	2,556,854	·789	10·96	4,417	6·79
Wolverhampton Corporation	,, 7	782	903	- 126	- 779	20½		,, 31	44,432	9,440,369	975,714	—	10·92	2,190	6·509

a Train miles. A Half-year's figures.

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ELECTRIC LIGHTING ACTS AMENDED.

It is subject matter for congratulation that the Electric Lighting Acts (Amendment) Bill, 1909, is now certain to be added to the statutes. After undergoing careful consideration in the House of Lords, the Bill passed through the Standing Committee of the House of Commons and has been reported to the House. Little, therefore, remains to be done before it becomes law. There can be no doubt that it is a genuine effort to remove certain anomalies and some hardships with which legislation has hampered the electrical industry in this country. Although it does not go as far as many would like, the measure of relief brought by the Amending Act will be substantial. While the Bill decidedly tends to extend the powers of the Board of Trade, it also largely simplifies and cheapens methods of procedure for obtaining permission to supply electricity. This is a boon that cannot fail to have a beneficial influence. For instance, formerly a supply company desiring to obtain powers to supply electricity in bulk had to proceed by way of promoting a private Bill—a lengthy and costly proceeding, often, too, inciting to vexatious opposition. But by Clause 6 of the Bill the Board of Trade is empowered to grant provisional orders to companies or authorities desiring to supply in bulk—a method up to now confined to electric lighting alone. This should foster healthy enterprise by removing difficulties and also by lessening the dead weight of preliminary expenses which crush so many existing concerns and consequently act as a deterrent in many cases. The so-called "fringe" clause, enabling the Board of Trade to grant powers for any undertaker to supply electricity to premises outside his district, is another step in the right direction. It is safeguarded in such a way that it should not encourage wasteful competition, but rather encourage the use of electricity in places not easily supplied from the "legitimate" centre. It may lead to useful exchanges of territory, thus contributing to the general prosperity. The clause is subject to the proviso that the consent of the local authority within whose district the premises are situated must first be obtained. Frivolous objections, however, may be over-ruled by the Board of Trade. In the Standing Committee stage Mr. Holt sought to amend Clause 5, dealing with the supply of electricity to railways, tramways, and canals partly outside the area of supply of the authorised distributor for the purpose of haulage or traction, so as to extend the privilege to dock companies. Rather unfortunately, in our opinion, Mr. Tennant (on behalf of the Board of Trade) opposed the amendment, declaring that the clause had been the subject of long negotiations with the various parties interested, and that any alterations might lead to fresh opposition. So the amendment was negatived. In the long run, however, such an extension could have only helped forward expansion, which is what we all want. Clause 16 is unquestionably a bone of contention, and may still lead to considerable friction. This clause gives authorised undertakers the right to supply electrical fittings. In the House of Lords an amendment made it compulsory for municipal authorities to so supply "through a contractor, but not otherwise." These words were obviously added with a view to prevent local authorities crushing out private traders and establishing a monopoly. In the House of Commons Committee, however, these words were struck out, with the tacit support of Mr. Tennant, although he warned the members that negotiations would have to take place with the House of Lords. Possibly the clause might be amended in such a way as to prevent any monopoly being established. Obviously, the privilege would be valuable, and sometimes of distinct benefit to the public, but the balance would be

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against the unamended clause unless open competition in this matter of electric fittings was maintained. A sub-section of this clause exempts fittings let on hire from distress, a provision which was really much wanted, and should tend still further to extend electric lighting in houses and flats rented at a moderate figure. Probably the greatest objection to the present Bill is that the local authorities are still permitted to retain their absolute veto over the granting of provisional orders to provide undertakings. That absolute veto has in the past been exercised rather too often in a dog-in-manger spirit, which is bad for the industry and for the public. It would have been well if this power could have been hedged about to prevent arbitrary objections being raised by authorities often having no immediate intention of themselves applying for an order. However, the Bill as it stands is something to be thankful for, and it is to be hoped that it will pass into law promptly practically as it stands.

THE GERMAN ELECTRICAL INDUSTRY.

Mr. Schwabach, the British Consul-General at Berlin, has already amply justified his right to be regarded as one of the most reliable authorities on German industrial conditions, and in his report (just published) dealing with the trade of Berlin and district for 1908, this acute observer affords us once more a keen insight into the economic conditions of our greatest commercial rival. The report may well serve as the basis for a series of articles discussing various aspects bearing upon German industry in which engineers are especially interested, and many valuable conclusions may be drawn from the carefully-compiled statistics so strikingly brought forward by Mr. Schwabach. Our interests naturally lead us at once to that section of the report dealing with the electrical industry. Mr. Schwabach's review of the situation is confined to the Berlin consular district, but as the electrical works situate within this district are the largest of their kind in Germany, they may be taken as typical of works of their kind throughout the country. It appears that depression is beginning to affect the electrical industry in Germany in the same way that it has affected us in this country, more especially in regard to the larger types of machinery, and it is not surprising to read that the submission to the Reichstag of proposals for the taxation of electricity has increased the general reserve observed by possible customers. Still, the output of the German electrical works has suffered no material check, even if the ratio of increase has not been maintained during the past year. Mr. Schwabach presents a table comparing the production of the A.E.G. works during the last three business years. In 1907-8, 47,726 machines (motors and transformers) were produced by these works, of a total horse-power capacity of 1,350,327; in 1906-7 the figures were 43,953 and 1,161,543 respectively; the total horse-power of the 37,424 machines produced in 1905-6 was 818,263. The value of the turnover, as well as the number of electrical fittings and accessories manufactured, steadily increased, and good progress was made in the construction and sale of heating appliances. Business in cables was satisfactory, but the value decreased in conformity with the abatement in the prices of raw materials; high-tension cables were especially in demand, and it is interesting to note that the newly-introduced enamelled wire found increasing favour. Space will not permit us to do more than note the movement during the past year in the leading electrical lines. In spite of the keen competition which subsists between the varied types of lamps, carbon-filament lamps seem to hold their own, for we read that these lamps "commanded the same extensive sales as in former years"—a record which we scarcely expect to see maintained. Large orders were received and carried out for the electrical equipment of blast furnaces and steelworks. Turbo-dynamos are being introduced on an ever-increasing scale in iron foundries and other important works throughout the country, while electrically-driven rolling-mills have, it is said, fulfilled all expectations. A number of electric hauling machines for main shafts, with a hoisting capacity of 81,000 tons per day shift, were constructed and supplied principally to mines having water-pumping works. The electrification of railways made further progress in 1908, during which year the Prussian Government ordered a fairly large number of accumulator cars. Of the 2,330 miles of tramlines in Germany at the end of 1908, 90 per cent. were driven by electricity, 2·5 per cent. by steam, 3 per cent. by horses, and the remainder by all three systems combined. Numerous orders for the erection of central electric power stations abroad were placed with German firms in the course of the year, steam-turbines being in almost every case preferred to ordinary reciprocating engines, while good contracts were obtained for a number of turbo-generators up to a capacity of 7,500 kw, and for five converters each of 9,000 h.p. and 70,000 volts. The consumption of electric current has increased in Berlin during the past three years, increasing from 128,103,848 kilowatt-hours in 1906 to 142,921,816 kilowatt-hours in 1907 and 155,115,135 kilowatt-hours in 1908. These figures, of course, relate only to Berlin, but from other evidence we may take them to be typical of the increase in consumption in other German towns. The most notable increase has been in manufactories, private lighting, and tramways, thus showing that Germany is rapidly overtaking us here also. A subject which has been much discussed in this country recently is the relation of German banks to the industry of that country. Mr. Schwabach reports that last year two establishments known as Elektrotreuhandbanken (electric trustee banks) were established under the auspices of the German electric companies. The principal object of these "trustee" banks is to advance to large consumers in the electrical industry the money they may require for beginning and carrying out costly works. The capital needed for the loans is to be obtained by mortgage bonds, secured, in the first place, by the stocks in hand, and, secondly, by the share capital which is to be invested in trustee stocks. As the shares, however, will most probably be retained by the electric works concerned, the entire business resolves itself into a transaction enabling these companies to raise the funds they need in order to assist and open larger credits to their customers. These advances are to be extended principally to municipalities and other public bodies, so that the bonds will be to all intents perfectly secure, while at the same time these authorities will be encouraged to proceed with any plans for the erection of new or the extension of old electrical plant which they may have under consideration, without the necessity of issuing new loans for that purpose. One more matter may be mentioned. Government and municipal authorities usually enter into contracts without depending upon market considerations. Indeed, in Germany they prefer to order in times of depression, when industrial concerns are not making large demands upon the money market. Another effect of this is that employment is provided at a time when the industrial market is depressed, and in view of the suggestions frequently made that Government and municipal authorities in England should regulate the placing of their orders and their expenditure to coincide with the cycles of industrial depression, the working of the German system deserves close attention.

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SOME ELEMENTARY CONSIDERATIONS OF HIGH-TENSION SWITCHGEAR.

BY J. H. S.

(*Concluded from page 67.*)

Such a wide field being open to the designer in laying out high-tension switchgear, it is almost impossible to give even a general idea of typical plants, but two designs are shown in Figs. 6 and 7, each illustrating a different arrangement. Fig. 6 shows switchgear suitable for a small generating or sub-station, its chief recommendations being its compactness and the utilisation of the space at command. The general design appears correct, inasmuch that all the connections are accessible from the front by merely opening the cell doors—a distinct advantage over some designs where slate and stone barriers have to be removed before the 'bus bars can be disconnected from the cell connections. The oil-switch operating rods are simple, and if the width of the cubicles is made the same as the width of the operating panels an ideal arrangement is secured. All the four doors shown must be separate, which will enable an oil switch or series transformer to be changed or repaired with pressure on the 'bus bars, providing the isolating switches, A and B, are open. The operating panels can either be on the same level as the switchgear cubicles or under them as shown. Fig. 7 illustrates the lay-out of a large installation with electrically-operated switches and duplicate 'bus bars. At the first inspection this design does not appear to have many points to recommend it, but on further inspection many advantages can be pointed out. The oil switch is isolated and there is no gear above it. As this is the most likely piece of apparatus to fire or arc, it will be seen that this is the correct position for an oil switch. Also, in many designs of switchgear with duplicate 'bus bars the two sets of bars are placed above one another, with their respective connections running up the wall side by side at the back of the 'bus-bar chamber. In the scheme shown in Fig. 7 the two sets of bars are entirely separate, and it is possible to clean or disconnect the back connections, attend to one set of bars, replace insulators, etc., whilst the other bars are carrying current.

As there are so many combinations of high-tension gear, descriptions of various types could be continued almost indefinitely, and the reader is referred to the various technical journals, where different installations are frequently described.

When the designs of the cells and cubicles are considered, the choice of materials is partly limited according to the locality and site. Concrete, ferro-concrete, brickwork, granolithic, slate, and soapstone are all used, either together or separate, for switchgear cubicle construction. The chief consideration when selecting the constructional material is its fire-resisting qualities, cost, and adaptability. For vertical divisions soft brickwork set in cement is an ideal material. It can be formed on the job, is easily and readily made to any shape and size, and can easily be cut for rag bolts, insulators, etc., and plugged for supporting tubing. For equal thickness it is as fire resisting as concrete, and, if the work is neatly carried out, brickwork has a much better appearance. For horizontal divisions a local stone should be used if possible, natural stone being more easily cut and formed than artificial stone or concrete, and if of selected quality, is equally strong and fire resisting. All horizontal stone or concrete slabs should be the same thickness as a course of brickwork in order to avoid unnecessary cutting, and the vertical walls must be 4½ in., 9 in., or 14 in., so as to use full bricks.

A very important point, although often neglected, is to pack all wall through insulators, or holes in horizontal or vertical barriers, tight up to the rod or cable passing through them. Asbestos or plaster can be used, and this precaution will effectually prevent an arc or flame spreading from chamber to chamber. A further necessary precaution is to anchor the conductors to a fixed object to prevent the rod jumping when an earth or a heavy short-circuit comes on the line. All connections must be effectually locked either by lock-nuts or set screws to prevent the electrical joints coming apart due to the constant vibration.

Immediately after the various switch and other cubicles are erected and before being made alive, it is necessary to obtain and erect in a prominent position suitable name plates in order to identify a particular cell or back of a cell without the laborious and somewhat dangerous method of counting. The practice of counting a cell from one end is liable to end fatally if the operator should have his attention drawn away during the counting process, and possibly commence work on a live cell or open an isolating switch that is carrying current. As a further precaution all cubicles within reach should be enclosed by means of sheet-iron or expanded metal doors. These doors should be fitted with keys and the keys kept under the charge of the shift engineers, who should be responsible for any work or cleaning being undertaken on the high-tension gear.

If any isolating switches have to be operated from a position where the oil switch cannot be seen, two lamps should be provided near these isolating switches—one red and one green. The green lamp to be alight when the

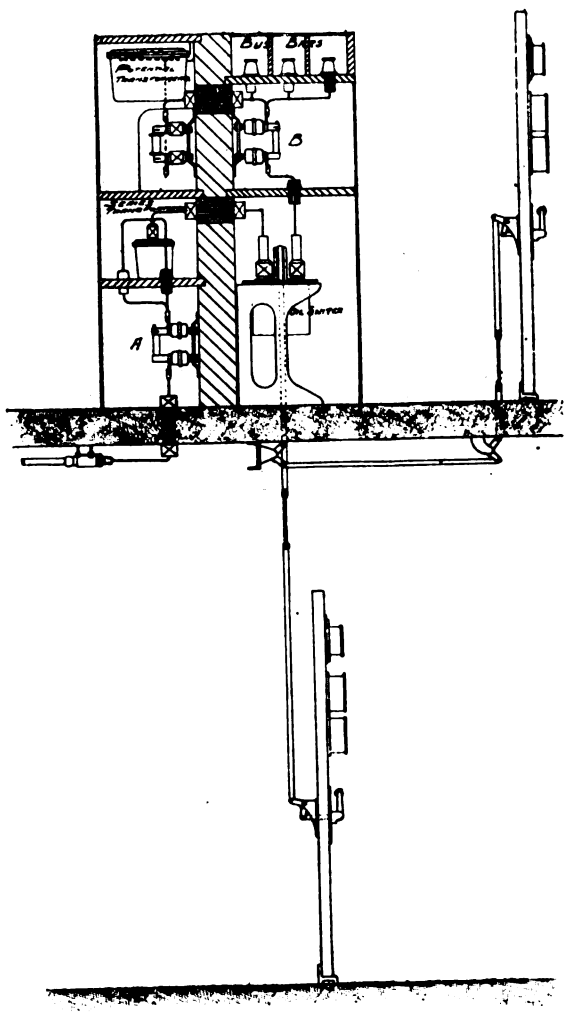

FIG. 6.

oil switch is open and the red lamp to be on when the oil switch is closed. These lamps can be operated by a small relay or switch mechanically worked by the movement of the oil-switch plungers.

Whilst dealing with the subject of precautions, the reader's attention is called to the rules and regulations recently issued by the Home Office, the particular regulations to be borne in mind when scheming out switchgear are as follows:

"The general arrangement of switchboards shall, so far as reasonably practicable, be such that: All parts which may have to be adjusted or handled are readily accessible. The course of every conductor may where necessary be readily traced. Conductors, not arranged for connection to the same system, are kept well apart, and can where necessary be readily distinguished. All bare conductors are so placed or protected as to prevent danger from accidental short-circuit.

Every switchboard having bare conductors normally so

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exposed that they may be touched shall, if not located in an area or areas set apart for the purpose thereof, where necessary be suitably fenced or enclosed. All apparatus appertaining to a switchboard and requiring handling shall, so far as practicable, be so placed or arranged so as to be operated from the working platform of the switchboard, and all measuring instruments and indicators connected therewith shall, so far as practicable, be so placed as to be observed from the working platform. If such apparatus be worked or observed from any other place, adequate precautions shall be taken to prevent danger.

7 ft., and a clear width measured from bare conductor of not less than 3 ft. Those constructed for high-pressure and extra high-pressure switchboards other than operating desks or panels working solely at low pressure shall have a clear height of not less than 8 ft., and a clear width measured from bare conductor of not less than 3 ft. 6in. Bare conductors shall not be exposed on both sides of the switchboard passage-way unless either the clear width of the passage is in the case of low and medium pressure not less than 4 ft. 6 in., and in the case of high and extra high pressure not less than 8 ft., in each case measured between

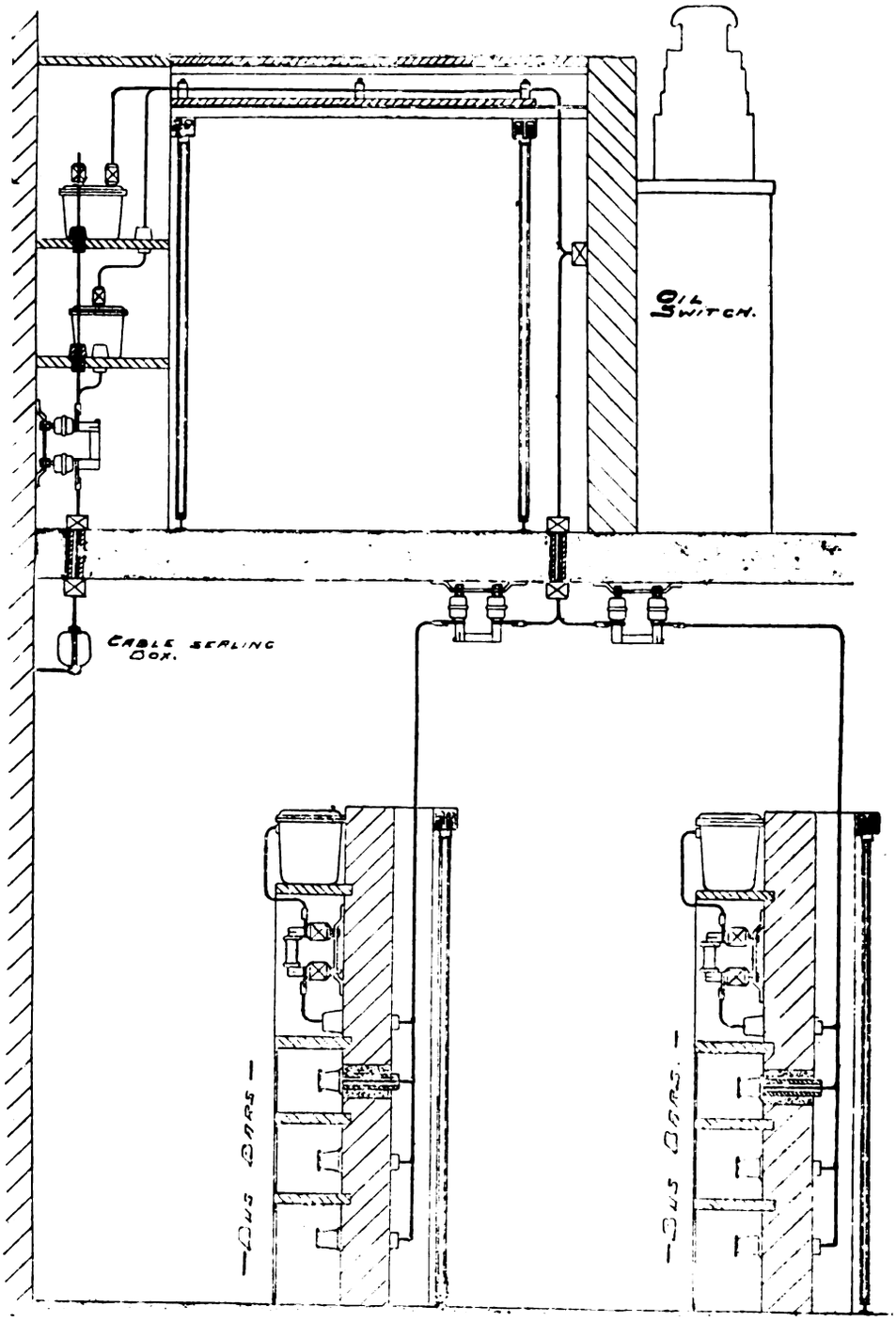

Fig. 7.

At the working platform of every switchboard and in every switchboard passage-way, if there be bare conductors exposed where live, so that they may be touched, there shall be a clear and unobstructed passage of ample width and height, with a firm and even floor. Adequate means of access, free from danger, shall be provided for every switchboard passage-way. Unless bare conductors are suitably protected in passage-ways by divisions or screens the following provisions shall apply.

Those constructed for low-pressure (not exceeding 250 volts) and medium-pressure (not exceeding 650 volts) switchboards shall have a clear height of not less than

bare conductors, or the conductors on one side are so guarded that they cannot be accidentally touched.

In every switchboard for high pressure (650 volts to 3,000 volts) and extra high pressure (exceeding 3,000 volts). Every high-pressure and extra high-pressure conductor within reach from the working platform, or in any switchboard passage-way, shall be so placed or protected as adequately to prevent danger. The metal cases of all instruments working at high or extra high pressure shall be either earthed or completely enclosed with insulating covers. All metal handles of high or extra high-pressure switches, and where necessary to prevent danger all metal

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gear for working the switches shall be earthed. When work has to be done on any switchboard it must be arranged to be carried out without danger, or the board must be made dead, or the switchboard must be made dead in sections and suitable screws must be provided.

These regulations come into force on July 1, 1909, except as regards such parts as were constructed before July 1, 1908, and in respect of which they will come into force on Jan. 1, 1910.

The instrument wires and operating leads between the high-tension cubicles and the operating panels are a frequent source of trouble. These wires are generally drawn into tubing, the tubes being buried in a concrete floor. Eventually condensation takes place in the tubing and the water is carried along the braiding of the wires to a disconnecting box, where the fault is discovered after causing some amount of damage. A great improvement on the conduit system is to have the various wires made up as multicore cables, either paper or rubber insulated and lead covered.

After the wiring is complete a thorough test should be made to ensure that the proper instruments are connected to the intended transformers. It is also necessary to very thoroughly trace and test out the synchronising connections and main cables to ascertain that phases A, B, and C of one machine are connected to phases A, B, and C respectively of the other.

THE SUN AS GENERATOR.

A solar electric generator, the invention of Mr. George H. Cove, of Somerville, Mass, consists of a steel framework, which is placed where it will receive the direct rays of the sun, says the American *Electrical Review and Western Electrician*. Short plugs of a secret metallic composition are set into this framework, which is divided into 16 12-in. squares, each containing 61 metallic plugs. These plugs are set with one end under glass while the sun shines on them. The other ends are exposed to the open air, and sheltered from the sun's rays. The difference in temperature of the two ends of the metallic plugs generates a thermo-electric current, charging a storage battery. If the sun goes under a cloud and the voltage drops below that of the storage batteries, an automatic circuit breaker breaks the circuit between the generator and the storage batteries. When the sun sets in the evening the circuit is automatically broken. Mr. Cove states that in the lighting installation he uses 10-volt 16-c.p. tungsten lamps, and that the apparatus will store in one sunny day sufficient current to light five 16-c.p. lamps for three nights, averaging four hours per night for each lamp.

LONDON COUNTY COUNCIL TRAMWAYS ACCOUNTS.

The Highways Committee presented a report at last Tuesday's meeting of the London County Council submitting the accounts for the year ended March 31, 1909, in connection with the Council's tramways undertaking. At that date the tramways system extended over a total length of 127⅝ street miles, being 85⅝ miles of electric lines and 42 miles of horse lines. The whole of the system is worked by the Council with the exception of a short length of ⅜ mile (double line) in Archway-road, Highgate, which is worked by the Metropolitan Electric Tramways, Limited, and a length of about ⅜ mile (double and single lines) in Lea Bridge-road, which is worked by the Leyton Urban District Council under agreement with the Council. The capital expenditure on the undertaking up to March 31, 1909, amounted to £9,483,561. 18s. 1d., of which £1,068,971. 2s. 2d. represents expenditure during the year 1908-9. The total debt repaid up to the same date amounted to £1,074,345. 4s. 11d. out of revenue and £282,519. 12s. 8d. from the proceeds of sales of horses and old materials, etc. The debt outstanding on March 31, 1909, was £8,126,697. 0s. 6d., or, deducting £83,558 for the value of surplus land, £8,043,139. 0s. 6d. The Council decided on June 23, 1908, subject to the approval of his Majesty's Treasury, to repay the debt (estimated at about £960,000) on the capital, which will be obsolete at March 31, 1914, owing to the electrification of horse tramways, within 15 years from that date. The present position with regard to this obsolete capital expenditure has accordingly been shown in the accounts for 1908-9. The amount of obsolete capital, less proceeds of sales, on March 31, 1909, was £1,344,093. 17s. 3d. Deducting the debt in respect of such capital repaid out of revenue—viz., £302,637. 13s. 5d.—the outstanding debt is £1,041,456. 3s. 10d. The total receipts from the undertaking during the year and the working expenses were as follows:

	Electric traction. £ s. d.	Horse traction. £ s. d.	Total. £ s. d.
Total receipts	1,572,251 8 7	275,199 1 7	1,847,450 10 2
Working expenses	896,286 4 7	305,402 0 2	1,201,688 4 9
Surplus on working	675,965 4 0	30,202 18 7 (deficiency)	645,762 5 5

The undermentioned charges have to be set against the surplus on working—namely:

	£ s. d.
Debt charges—interest (gross), £268,132. 11s. 4d.; repayment, £254,968. 6s.	523,100 17 4
Income tax, £21,000; less deducted and retained from interest on debt, £13,406. 12s. 7d.	7,593 7 5
Annual payment to London Street Tramways Company	7,078 17 6
Parliamentary expenses	1,463 19 10
Deficiency on Drake-buildings (rehousing obligation)	160 0 1
	539,397 2 2
Less net interest on cash balances, etc.	1,205 3 11
	£538,191 18 3
Leaving a net balance of	£107,570 7 2

Provision for renewals at the rate of two-thirds of a penny for each car mile on the total car mileage run on the electric tramways each year amounted for the year 1908-9 to £88,785, and the balance remaining of the surplus of £107,570—viz., £18,785—has also been transferred to the renewals fund towards deficiencies for past years. The committee report that if provision had been made on the present approved basis in each of the years of electrical working the fund would, with interest accumulations, have amounted at March 31, 1909, to £285,632 (after taking expenditure into account), as compared with £264,837 on the fund at that date. The shortage at March 31, 1909, was, therefore, £20,795. The general reserve fund (for the provision for general contingencies) which was established last year, and to which the sum of £34,634 was transferred at the end of March, 1908, was increased during the year 1908-9 to £35,270.

The total operating expenses for electric traction were £896,286. 4s. 7d., including £4,999. 2s. 2d. for special charges, or 6·74d. a car mile run, as compared with 6·79d. a car mile in 1907-8. The total working expenses in connection with horse traction amounted to £305,402. 0s. 2d., or 10·24d. a car mile run. Considerable loss was sustained during the reconstruction of horse lines for electric traction, as not only were some of the routes entirely closed, but sections of other routes had to be closed, and this disorganised the whole traffic on important through routes.

Some additional interesting facts were laid before the Council by the committee. Thus, the system in operation on April 1, 1908, included about 68 miles of electric tramways, and during the year a further length of about 17 miles was opened, making a total of about 85 miles. The total number of passengers carried and the car miles run during the year were as follows: Number of passengers—electric traction, 344,705,937; horse traction, 68,207,904; total, 412,913,841. Number of car miles run—electric traction, 31,962,784; horse traction, 7,156,688; total, 39,119,472. Of the total number of passengers 24·22 per cent. were carried at ½d. fares, 48·04 per cent. at 1d., 9·29 per cent. at 1½d., 9·89 per cent. at 2d., 1·49 per cent at 2½d., 2·15 per cent. at 3d., ·17 per cent. at 3½d., and ·04 per cent. at 4d. The number of exchange tickets issued amounted to 4·71 per cent. The average fare per passenger on electric traction was 1·07d. as against 1·08d. in 1907-8, and on horse traction ·93d. as against ·96d. in 1907-8. The committee point out, however, that the average fare per passenger on the whole system was 1·05d., the same as in 1907-8.

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HIGH-TENSION TRANSMISSION.*

BY PERCY H. THOMAS.

In the planning and carrying out of a large development work, the design, construction, and operation are properly functions of the engineer. But over and beyond these, the engineer has another important function, one that is in many ways more difficult than actual design and construction; for he must furnish the information or data upon which will be based the decision as to whether a particular work is a wise one. Here is involved the necessity of predicting construction cost, operating cost, returns, and general feasibility.

Broadly speaking, there is only a certain amount of capital available in a community for new works, and, from the point of view of the public, of the various possible projects only those that will be of the greatest general utility should be undertaken. In such cases its utility to the community is usually pretty well measured by the returns in the form of interest and dividends that a given work can earn. This measure is naturally not an ideal one, but is the only practical substitute, and is in the long run quite satisfactory. It is thus important that the engineer give an accurate estimate as to the earning power of any project that may be under consideration, for otherwise it may be undertaken with the initial expectation of a certain return and the actual trial prove the undertaking a losing one. Thus the responsibility of the engineer is very great, for the expenditure of the capital of the community, which is its wealth, is determined largely by his estimates of the probable costs and returns; and if these estimates are uniformly bad, the community will be to that extent impoverished. A bad engineering mistake may be as much of a real calamity as a great fire. While the engineer usually supplies the data on which new works are determined upon, he is not usually the person who makes the actual decision as to the particular work for which capital shall be used. This decision is usually made by the financier or the representative of the capitalist; for as a matter of actual experience the best of engineers occasionally make mistakes, and many engineers are biassed. The wise capitalist, therefore, usually prefers to reserve for himself the judgment of the more general and indefinite factors which are oftentimes of more ultimate importance in the success of a project than the construction cost and operating expenses. Such general factors would be the probable growth of population, where this element is important, the probability of legislative limitations, the competition of hostile rivals, and even the probable extent of the actual demand for the work undertaken.

The capitalist is usually in a difficult position on account of the large degree of uncertainty that surrounds most projected work. If he knew, or if his engineer could tell him with certainty what the result of any undertaking would be, there would be little difficulty in deciding what work to undertake. Experience has shown, however, that it is difficult to foretell the outcome. There often occur unforeseen contingencies and items of expense; estimates of cost often fall short of actual requirements; with the result that many projects that were undertaken with the expectation of satisfactory returns have proved disappointing. While, in the nature of things, a good deal of this uncertainty is unavoidable, yet it is unfortunately true that often engineers fall far short of their duty in making too favourable a report on a project that they investigate. In doing such work it should be the clear and constant aim of every conscientious engineer to foresee as many as possible of the dangers and disadvantages of the projects on which he reports, and not to paint the prospects more brightly than the circumstances really justify.

My plan is to discuss, of necessity briefly, the principal questions that will have to be considered by the electrical engineer in connection with a specific high-tension transmission project which may come to him. This discussion will come under three heads, the consideration of the general factors governing. First, the feasibility of the project; secondly, the earning power; and, thirdly, the actual design of an adequate plant.

* Paper read at a meeting of the Schenectady Section, American Institute of Electrical Engineers.

Feasibility.—The question of feasibility, strictly speaking, rarely arises except in very large work, since almost any plant can be constructed if the cost be not limited. There are, however, a number of conditions which virtually render some projects unfeasible. For example, in a hydraulic plant where only a very small head is available, it will sometimes happen that the variations of water-level above and below the dam will be so great that it is not practical to get an actual setting of the turbines where there will at all times be a sufficient head for operation. Large dams, and especially high ones, require good firm foundations, rock being preferred. Sometimes rock foundations cannot be obtained and the dam becomes impracticable, not only on account of the danger of sinking, but also on account of the difficulty of making the dam watertight. A leaky dam not only wastes water, but is liable to become undermined. Again, in some places relatively far north the effect of ice in winter would make the power unreliable. Some streams giving a good flow of water most of the time occasionally go practically dry. Since a system must usually undertake to supply reliable and continuous power, such a condition would make a project unfeasible. High cost can render any project, however satisfactory otherwise, unfeasible. There are few conditions except length that limit the feasibility of electrical transmission. These limiting conditions might be: very rough and inaccessible localities; localities subject to snow slides or land slides; and those favouring the rapid growth of tropical jungles—all these might be classed as impracticable. Small amounts of power cannot be transmitted to long distances economically except to mining camps and such places, where a very high price can be obtained for the power. Of course, also, a particular project may be unfeasible at a particular time because money to finance it cannot be obtained or because the returns will not be sufficient.

Earning Power.—The determination of the earning power of a projected plant is one of the most uncertain and unsatisfactory tasks that an engineer has to undertake. In the first place, it is very difficult to foresee just how much power can be sold in a given community. If it is a residential district that is to be lighted, there is not only the question of the presence or probability of gas competition, but also the temperament and habits of the people to estimate. If the community be a manufacturing one, it must be estimated how many manufacturers can be persuaded to recognise an advantage that may actually exist for them in the use of electric power. Then, again, the question remains as to the future growth of this particular community, whether it will be important or whether some discovery of new supplies elsewhere or a new railroad connection favouring some other place may not cause its decline. Once the plant is installed it is usually too late to transfer it anywhere else to follow a removing demand, so that probable future conditions must be considered and allowed for in the estimates. Fortunately, communities change slowly and important movements are seen some distance ahead. The phenomenon of temporary growth and prosperity followed by decline often occurs in mining communities; here great caution must be observed in estimating future earnings. Sometimes large plants are constructed at sources of cheap power with the expectation that users of power will be attracted to the neighbourhood, although none is there when the project is determined upon. This is a particularly precarious undertaking, as users of power are extremely conservative. Even at Niagara Falls, it was a long time before many industries were found to utilise the offered power. During recent years, however, there has been no trouble on the part of the original Niagara Falls Power Company in disposing of its large capacity. Again, what appears to be a good market at profitable prices may be turned into a losing one by a change in the cost of competing power, as by the discovery of oil fuel in the vicinity, or the building of a larger, more modern, and more efficient competing plant by hostile capitalists. On the other hand, all influences are not unfavourable; for most communities grow, and there are almost always many cases where electric power will be used regardless of other forms of power offered. And, too, new uses often arise not initially foreseen. All of

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these factors tend to protect and insure the ultimate success of a plant.

Cost.—The estimate of cost is usually arrived at roughly by a comparison with the cost of other similar plants, and more closely by making a careful design and estimating the cost of the individual items. The treatment of this subject will be omitted from this lecture so that fuller consideration can be given to the principles of design, which is, of course, one element in the determination of cost.

Underlying Principles of Design.—It is not my object to discuss the details of structures of apparatus such as transformers and switches, but to call attention to the most important principles governing the selection of the individual pieces of apparatus that shall combine to produce a coherent and harmonious whole. It is much more important that the various elements used shall be adapted to co-operate with one another, and to the specific purpose they are to serve, than that they should be of the most efficient or of the most highly developed form. I shall further limit this paper to the consideration of the high-tension portion of the system.

The Line.—The economy of a line is to be judged, not by its electrical efficiency primarily, but by the amount of annual charge that it makes upon the receipts of the system. When the plant is actually constructed and the capital expended, the net earning power of the investment is the total income less the total expenditures. In this statement account must be taken of all contingencies occurring over a number of years, so that any one year's statement is comparable with that of another—that is, maintenance must be regularly charged and depreciation allowed each year on all apparatus which has a limited life and will ultimately be replaced. Otherwise, a very heavy charge must be made during some one year while other years make too favourable a showing. In computing line losses, an appropriate full account must be taken of the load factor of the plant and of all other conditions affecting the total losses. The amount deducted as annual line expense from the gross plant income is made up largely of factors that are constant, regardless of the actual amount of power transmitted by the line. These factors are, for example, the interest on the capital actually expended in the line, the percentage of this amount allowed for maintenance each year and the further percentage allowed for depreciation, and certain smaller items, such as taxes and a portion of the administration expenses, as well as the largest part of the labour of linemen and inspectors. There are also some expenses proportional to the amount of power transmitted, which, however, do not amount to very much in a high-tension line. It is clear, as well, that since there is a certain amount of power lost in the lines that by putting in more copper this loss would be reduced. The lost power, if available, could presumably be sold at the same price as the rest of the power, so that, broadly speaking, the most economical line will be the one which is so laid out that an increase in the amount of copper would cost more in interest, etc., than the increased power could be sold for, and at the same time that a decrease in the amount of copper would reduce the interest charges a less amount than the added power loss would reduce the income. This is called Kelvin's law. This condition is found when the annual interest charge on the line copper is equal to the value of the lost power. But the practical determination of this condition is a difficult matter, as the plant is not operated at a given load at all times. The maximum number of kilowatts is lost at the time of maximum load, and as the load goes down the loss is less in absolute value. Thus the total amount of actual power that is lost will be determined by the average loss, not by the maximum loss. Again, if the loss be reduced and the power saved be sold, it will be necessary to have larger apparatus at the receiving station, which will increase the cost and investment charges somewhat. Furthermore, the full amount of the saved power cannot be sold for the full 24 hours. The interest charges on the copper investment are, of course, independent of the actual load on the line. As a result of these conditions it will usually be wise to interpret Kelvin's law conservatively—that is, to make the investment in copper as small as possible without clearly involving a loss of power which could in all probability be sold profitably. In such a case it is important to consider the possibility of a future increase in the plant capacity. By these considerations the expenditure in copper required for a given case may be determined.

The next question, considering the electrical characteristics, is the regulation of the line—that is, the voltage variation at the receiving end with different load conditions. A system in which the load voltage varies greatly from time to time is unsatisfactory for most purposes, and in commercial service is not generally acceptable. Thus it is necessary that the voltage drop in the line be not very great. But this drop is not the only loss of voltage between the generator and the load; the step-up transformers and the step-down transformers, as well as the secondary apparatus and distributing lines, all add to the total. There will be naturally from 5 to 10 per cent. drop at full load in the various parts exclusive of the transmission line, so that there will be naturally a very considerable total drop in any actual system. For the types of load sensitive to voltage changes there is often used some sort of feeder regulator which alters the voltage of a particular circuit to keep it constant regardless of the line voltage. These regulators are somewhat costly, cause additional losses, and introduce an element of uncertainty into the operation of the system, and are thus undesirable. The greater the range of voltage to be corrected the larger the capacity that must be provided in the regulating apparatus. All things considered, then, the variation of voltage should be made as small as is practicable, and as the line drop is the largest item in this drop it must be kept small. The actual most suitable values must vary with different cases, but usually the line drop should be kept below 10 per cent In long lines it is difficult to keep down this drop and larger values may be used. Where important receiving apparatus is connected at or near both ends of the line, the voltage variations are more difficult to control and the drop should be less than usual.

The calculation of inductive drop is an interesting problem, and usually it is not very difficult. In lines where the capacity current is not high—that is, in short lines with relatively heavy load—the problem is similar to that of calculating the drop of voltage produced by any current flowing in a conductor having resistance and reactance. In other cases where the capacity current is considerable the results given by this method are not sufficiently accurate, for there flows through the line and in the generator not only the load current, which will usually be lagging, but there also flows at the same time the line charging current. This current has a value of zero at the receiving end of the line, but it becomes gradually greater towards the generator, and until there it is equal to the total capacity current of the whole line. Thus it is clear that there is in such a line no single value of current by which to calculate the drop. However, a sufficiently accurate determination of the drop can be obtained for all but the longest lines by assuming one half of the line capacity connected as a condenser across the line at the generator and the other half at the other end. With this assumption the current in the line is the same at all points, and the drop calculation can easily be made. This is not the only method of approximation, but it is a good one. If preferred, the total capacity of the line can be considered to be concentrated at the centre. The numerical results will be about the same in the two cases. In making these calculations, it is important to remember that the charging current is not in phase with the load current, and these currents must be combined in the usual manner for currents not in phase. Since the line charging currents tend to balance the lagging component of the load current, it is helpful in raising the power factor at the generator and thus reducing its losses and its cost.

So far the calculation has been assumed to be for a single-phase circuit, while all commercial circuits are three-phase circuits. A convenient rule for calculating the drop in three-phase lines is as follows: the percentage line drop and percentage energy line loss of a three phase transmission

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circuit will be the same as the same percentage quantities calculated for a single-phase line transmitting one-half of the amount of power over two wires of the same size and with the same spacing as any pair of the three-phase wires. This assumes the three line wires to be arranged approximately at the apexes of an equilateral triangle.

The matters of copper loss and regulation are very closely linked to the voltage of transmission. The transmission voltage should be taken as the highest that can be used without too greatly increasing the cost of the step-up transformers, the high-tension switches, and the line construction. The additional cost of buildings and line outlets due to very high tension also becomes an important item with short distances. It is, of course, true that the line losses and the line drop are reduced in proportion to the square of the line voltage, so the advantage of the high voltage is great. If the voltage be raised so high that the cost of copper becomes much less than the cost of the rest of the line, the extra cost of the insulators, poles, etc., due to increased voltage, will much more than balance the saving in copper. Furthermore, it is sometimes possible to use so high a voltage that the economical size of copper will be too small to be safely used. As a matter of fact, lines are usually designed by working out the loss, the line drop, the cost of copper, and the cost of other parts of the transmission line for a given set of assumptions as to voltage and size of wire, and then finding the effect of varying one or the other element tried to see if a better condition can be found. An experienced engineer can reach conclusions very quickly, while a less experienced man might reach the same result only after many trials. The size of wires actually used range from No. 4 or No. 5 up to No. 0000, and the pressures up to 50,000 or 60,000 volts for distances from 50 miles up, and as much higher voltages for longer distances as the engineer dares to use. At the present time the 100,000 volts is about as high a pressure as can be safely undertaken.

All power transmission in America, leaving out of account the use of 15 cycles for railway work, will be at either 60 or 25 cycles. The great majority of plants now in operation are at 60 cycles. For small and moderate size plants giving miscellaneous service this is without doubt the better frequency of the two. The advantage of this frequency is that it is wholly satisfactory for arc and incandescent lamps, while 25 cycles is not at all adapted to arc lamps, and not generally satisfactory for incandescent lamps. The arc light load can, however, be carried satisfactorily from mercury rectifiers, at least as far as outdoor lighting is concerned, but no general solution of the difficulty with incandescent lamps is so far available. On the other hand, in making large motors it is of great advantage to have 25 cycles. For transformers 60 cycles is to be preferred. The transmission line drop will be much greater on long distances with 60 cycles than with 25. This fact will be almost a determining factor in long transmission. Again, many plants have to transmit power to actually existing 60-cycle plants, and must either thus transmit at 60 cycles or transform for these installations. This condition may determine the choice of frequency. It will usually be clear in any given case which frequency is the best one for a particular plant. With the frequency, size of copper, and voltage chosen, the electrical features of the line are practically determined. The problem then becomes one of a more or less mechanical nature—that is, the insulating and supporting of these conductors under the actual conditions in which they must serve. This problem is double. First, there is the insulation of the line wires; secondly, their mechanical support against the strain of the wind and the weight of snow and ice. The latter aspect will be considered first. The controlling factors here are cost and reliability.

The oldest pole lines followed the telegraph practice, and used wooden poles and wooden cross-arms supporting the wires from insulators on wooden pins. This method had and still has the advantage of relatively low first cost, flexibility, convenient accessibility of materials (this last consideration has now largely disappeared in most localities in the United States), and extreme readiness of construction. The wooden pole line has, however, the disadvantages of unsatisfactory mechanical reliability and rapid deterioration. As usually installed, the poles rot quickly, are easily broken by unusual strains, are readily burned off, and are not at all uniform in their mechanical characteristics. Furthermore, there was much trouble in the early days—in fact, until the present time—with the burning of poles and cross-arms and pins by current leaking over the insulators or passing through broken insulators. These things rendered it very difficult to maintain continuous service, and engineers tried to find some means to improve the mechanical reliability of the line. The natural method was the substitution of steel poles or towers for the wooden poles. At the same time the cross-arms and insulators were made of metal to prevent the burning that had been found so troublesome with the wooden parts. This was a radical change in construction, but was quickly accepted by engineers. The result of the use of steel construction is a gain in mechanical features, but an increase in the danger of shutdown of the plant from lightning and such disturbances and from broken insulators. With the old wooden structures, when an insulator was broken or lightning jumped around it there remained the insulation of the wood to protect the line; the wood burned off often, but not always, and the line frequently was not shut down. Nor was the generator completely short-circuited by such an accident. On the other hand, with pins dead grounded through the supporting structure, every failure at the insulator is a low-resistance short-circuit on the line, and all the harmful results that follow such a short-circuit happen each time that a disturbance occurs on the system. Again, those lightning or other static disturbances which are not of maximum severity do not as often cause a break at the insulator when it is mounted on a wooden pin and a wooden cross-arm. Thus there are advantages and disadvantages with either steel or wooden pole lines. Usually steel poles are preferred for large important lines, while wood is still often used in less important plants or in localities where it is plentiful and deterioration not rapid. In most parts of America at the present time it is difficult to obtain good wooden poles in large quantities at a reasonable price. Poles are occasionally constructed of reinforced concrete, but while they are permanent, strong, and flexible they are expensive. It is sometimes possible to lessen the severity of short circuits due to grounds on metal-pole lines by grounding the middle point of the high-tension circuit through a resistance. For then, when only one ground at a time occurs on the system, the current following this ground must pass through the resistance, and thus be limited in its severity. Line insulators are chosen to give an especially large margin of safety with the metal structures.

The fact that metal or steel poles cost many times as much as wooden poles means that fewer must be used, or the line costs would be prohibitive. Fortunately, steel poles, or towers as they have turned out to be, can readily be made very much stronger than wooden poles, and the use of long spans between towers reduces the number necessary. The limit of the length of span that can be used with steel towers is determined largely by the mechanical strength of the conductors, which will rupture if the span is too long. The heaviest strain on a wire is caused by an accumulation of ice. This is an unfortunate condition, for the occurrence of such thick ice or snow layers is a rare occurrence at any one point, so that the expense of the line may be greatly increased to provide for this exceptional condition when it will probably never occur. In calculating actual line structures it is customary, however, to assume a considerable thickness of ice on conductors. This ice layer may weigh much more than the wire itself. But the ice situation is still further complicated by the presence of wind. A considerable strain is added on the suspended conductor by the wind, which tends to deflect it. When wind and ice come together the strain is, of course, much increased This condition may easily occur, though as a matter of actual fact it is seldom seem. There is a great deal of variation in the margin of safety used by engineers in this matter of ice and wind, since there is no way but

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pure assumption of arriving at what the maximum condition will be in any given case. Some engineers take 0·5 in. of ice on the conductors all the way round as the worst condition, while actual instances of ice more than twice as thick have been observed. There is also a considerable variation in the maximum wind velocity, values from 40 to 75 miles an hour being used. As the wind pressure varies as the square of the velocity, roughly, this variation in velocity means a much greater variation in actual pressure. A velocity of 70 miles an hour corresponds to about 20 lb. pressure per square foot on a flat surface. It has been found by experiment that the pressure on a cylindrical surface is only from one-half to five-eighths as much as on a flat surface. But the conductor is not the only part of the structure that must support those strains. The towers must stand the dead weight of the conductor with its weight of ice and the wind strain. They must withstand this strain in any direction that it can be applied. It must further support the strain due to the breaking or the melting off of one or more of the conductors at any point. Such an accident brings a severe strain on the tower, tending to twist it when only one or two wires of three are broken or to pull it down in the direction of the line when all are broken. It is relatively easy to get the necessary mechanical strength in the steel structures, but often in details the design or construction may be found inadequate. For example, the strains just spoken of are applied at three or six points on the structure according as it carries a single or a double line, and there may not be sufficient strength to bear the strains locally at these points. Furthermore, twisting strains are not easily provided for in some types of tower structures. In addition to the matter of the strength of towers, there follows the necessity of so firmly setting them in the ground that they will not be upset by the various strains to which they are subjected. With the old wooden poles the spans were much less, and a pole well set in firm earth was stable enough to stand any load without coming out of the ground. But with towers which have many times as much strain to support no such hold on the earth will serve to keep them in position. Either foundations must be put several feet down in the earth or heavy foundations used, holding by dead weight, or the structures must be guyed to prevent overturning. Insulators must, of course, be strong enough to support the mechanical strains, but as each line wire has its own insulator it is feasible to get sufficient strength here even though porcelain is not mechanically well adapted for this purpose.

There are many special problems and difficult details of line construction that might be discussed, but the main considerations of the mechanical structure of the line have been considered.

The forcing of current to remain on the line is one of the very troublesome high-tension problems. The insulator must first of all hold normal potential and all the unusual voltage variations, static or other sort, up and down. So much is not particularly difficult to secure, and does not usually mean more than two or possibly two and one-half times normal potential. But there remains the question of lightning with several times normal potential applied locally to the line with the generator voltage ready to follow any break to ground. This danger and the danger of mechanical failure in the line are the two most important threats of interference of operation. The danger of lightning may to advantage be a little more fully discussed.

Lightning affects not only the line itself, but also the apparatus connected to the line, such as the step-up and step-down transformers. The latter are protected by some one or more of a number of commercial types of arrester which are suitable to discharge static disturbances freely to ground, and, at the same time, to suppress the flow of current from the generator. This apparatus is now fairly well understood. The effect of a lightning disturbance on the line proper is somewhat different from that on the terminal apparatus. For the purpose of illustration the line may be considered a long, narrow trough with high sides partly filled with water. A lightning stroke may then be taken as the dropping of a large quantity of water upon the trough at some particular point, which then overflows at this point, the surplus being spilled over on the earth. In view of the fact, however, that the trough has high sides a certain portion of the water will be retained, and this portion will spread in both directions and send two waves along the line. If these waves find any weak spots in the trough they will cause a spillover. Similarly with the direct lightning stroke. The water or the electric waves passing along will finally come to the end of the trough, where they will be reflected and sent backwards into the line At this point of reflection the height of the wave will be doubled momentarily, thus tending to cause a spillover at this point. The reflected wave will gradually dissipate itself and the excess water be distributed along the trough. When the line or trough divides into two parts, the wave will likewise divide into two waves which will have but half the height of the original—that is, a divided line tends to reduce the severity of the wave. Thus every lightning stroke reaching a line wire will cause a violent discharge to ground at this point, and will likewise send waves of "static current" through the line in both directions, which will traverse and spread over the whole system, being reflected at the ends of lines with the production of double the potential of the wave at the moment and at the point of reflection, and gradually becoming dissipated and uniformly distributed over the system. It is these waves when actually reaching the ends of the lines and the terminal apparatus that are discharged by the station lightning arresters. But a line may be affected by electromagnetic or electrostatic induction from a lightning discharge which does not actually reach the line. This effect is similar to the effect on the trough of water produced by a gradual raising or lowering followed by a sudden lowering or raising the level of the trough at some point. This may cause a spillover and will cause the production of travelling waves as in the other case. It is clear that the absolute protection of a transmission line from lightning is difficult. The best available method at the present time is the use of overhead ground wires, which, if properly grounded at very frequent intervals and well spaced from the transmission wires, will shield the line from direct stroke and to some extent from inductive action. Similarly, a roof over the trough of water would protect it from a discharge that would otherwise cause a spillover.

THE ELECTRIC LIGHTING ACTS (AMENDMENT) BILL.

Committee Stage Passed.

This Bill was considered by a Standing Committee of the House of Commons, and disposed of on Tuesday. Sir F. A. Channing presided over the committee. The Bill is a Government measure, and was in the charge of Mr. H. J. Tennant, parliamentary secretary to the Board of Trade.

On Clause 5, which deals with the supply of electricity to railways, tramways, and canals partly outside the area of supply of the authorised distributor for the purpose of haulage or traction, an amendment was moved to add words giving the same privileges to a dock company, but this was negatived. Another amendment, to omit a subsection of the same clause under which power is given to the Board of Trade by provisional order to authorise any local authority, company, or person to supply electricity to be used for purposes incidental to the working or lighting of the railway, tramway, or canal, was likewise negatived. Mr. Tennant, in opposing the proposal, said it would obviously be to the convenience of a railway or canal company to be able to take its supply of electricity from the one source, and he did not think it was a reasonable thing to ask that a company which got its electrical power from one source for haulage purposes should be obliged to go elsewhere for a supply for its workshops.

An amendment was moved to strike out certain words inserted in Clause 16 in the House of Lords, which prohibited local authorities who own electrical undertakings from supplying lamps, meters, and other fittings except through a contractor. Mr. Tennant said the clause, as it was originally introduced, was intended to embody in this Bill a model or standard clause. He stated that 75

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local authorities, including all the London boroughs, possessed this power of supplying fittings, and the Government proposed in this Bill to give all local authorities in future similar powers. They considered that the amendment introduced by the House of Lords was a very unfortunate one. It prejudiced the supply of electrical fittings by local authorities for all time; even if a Select Committee were disposed to grant these powers, they would not be able to do so. He, therefore, accepted the amendment, but the committee must realise that the Government might have some difficulty, and it would be their duty to try and negotiate the matter. Mr. R. D. Holt said that what they had to fear was that the municipalities would turn their trading powers into monopolies, as they were now doing in regard to electric power. If the local authorities wanted to have municipal trading extended, they must be ready to face competition. The amendment was agreed to, and subsequently the words conferring power on the local authorities to supply meters were struck out.

On the motion of Mr. Tennant the following new clause was inserted: "Money borrowed under the Electric Lighting Acts shall not be reckoned as part of the total debt of a local authority for the purpose of any limitation on borrowing under the enactments relating to borrowing by the local authority." Mr. Tennant also proposed a new clause empowering the Board of Trade to make returns to Parliament giving particulars of their auditors' reports on the accounts of electrical undertakings, and the action taken thereon. The auditors, he said, were at present quite powerless, and they could only make representations, which might or might not be carried out by the company. The clause was agreed to, and the Bill as amended was ordered to be reported to the House for second reading.

MUNICIPAL ELECTRICAL SUPPLY.

To some extent the report of the West Ham Corporation electricity supply department serves as an instructive commentary on the Electric Lighting Acts (Amendment) Bill, discussed elsewhere. Certainly the report is favourable enough, with its credit balance of £3,900 placed to reserve. But it shows the wisdom of generating in bulk. The increase of revenue, amounting to £8,500, as compared with last year, is due to the fact that the power disposed of increased from four million to eight million units. Four years ago there was a loss of £740, now there is a surplus of £3,900, notwithstanding the fact that the average charge to consumers is now 1d., as against nearly 2½d. in 1905, while the charge for power has been reduced to one-third. The greater bulk supplied has reduced the cost of production from nearly 1¼d. per unit to ½d. All is in favour of large bulk production and reduction of charges as low as possible, within reason, in order to encourage consumption. The following details as regards revenue and expenditure are worthy of careful study.

The total expenditure amounted to £39,123, as compared with £39,326 for the previous year, and at the same time over four million units more have been sold. The total cost per unit is ·52d., a reduction of nearly 33⅓ per cent. upon the previous year, and it is about the second lowest in the whole country. As regards the revenue account, the most noticeable item is the reduction in the receipts from private lighting, which are only £22,784, as compared with £23,996 for the previous year. There is an increase in revenue from power to the extent of nearly £8,200.

A comparative summary of the results of the undertaking in 1905 and for the past two years is shown in the following table:

—	Year. 1905	1908	1909
Maximum load, kilowatts	2,600	5,500	6,100
Number of consumers	995	1,978	2,245
Units sold—private lighting	1,815,000	2,123,000	1,929,000
Units sold—power	300,000	4,161,000	8,190,000
Capital expended	£318,300	£419,300	£438,600
Average price charged—light	3·66d.	2·58d.	2·72d.
Average price charged—power	1·65d.	0·69d.	0·59d.
Total working cost	1·23d.	0·72d.	0·52d.

THE SUCHOSTAWER STUD SYSTEM OF ELECTRIC TRACTION.

We have already described the system of surface-contact traction patented by Mr. David Suchostawer (*Electrical Engineer*, May 8, 1908), and in previous remarks respecting this invention we have drawn attention to its salient features, besides enumerating the advantages laid claim to by the inventor and the tramway experts who have helped him to develop his idea, and to make it practical. The chief point claimed in favour of this system is the entire absence of live studs under ordinary conditions of use. This has always been the difficulty with surface-contact systems, and notwithstanding that this difficulty is being gradually eliminated, and that the means of detecting live studs after the car has passed over them are nearing perfection, it will always remain a ground of mistrust with the

Fig. 1

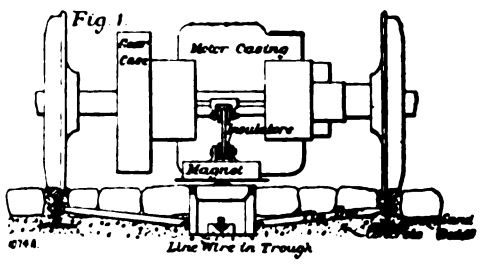


Fig. 2

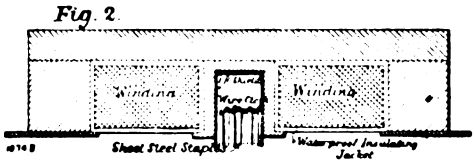


Fig. 3

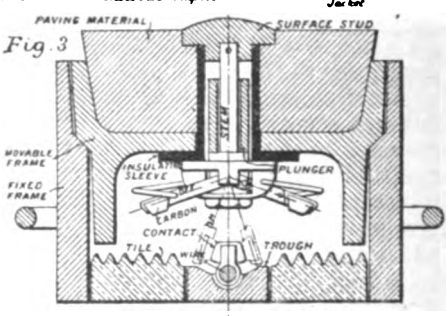
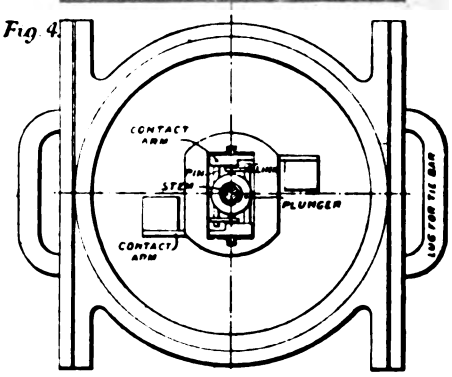


Fig. 4



public until they are convinced that a system has been evolved in which it is inherently impossible for a stud to remain alive after use. Recent trial runs have shown that in the Suchostawer system this claim has been carried out to a remarkable extent, and at a demonstration given on Saturday last at the company's experimental track at Southall this claim was still further proved. The stud is worked by magnetic attraction from the car, where a large electromagnet placed underneath is excited by a current of about 25 amperes from a battery of accumulators. The accumulators are connected so that the working current both excites the magnet and keeps the accumulators charged when the car is running, hence they are always ready for use directly the working current is cut off. The electromagnet runs along the whole length of the car at some distance above the street level. One pole runs along the centre while the other surrounds it as a ring. Partly in and partly underneath the central pole is suspended a flexible iron-wire skate, designed so that the contact

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portions can easily carry the whole working current. The skate is magnetic and flexible, so that it can remain out of the way until required, and then be attracted down to the stud.

Fig. 1 shows the general arrangement of the car and the studs in the street. Fig. 2 is a cross-section of the electro-magnet and skate at any part of this excepting the extreme ends. Various forms of skate have been devised for different working conditions, but the one shown is typical of the principle of all. Suppose that the magnet is over a stud and that the magnet is excited by allowing the current to flow through it. The inner pole will try to push the skate outwards, and it will be attracted by the iron stud so that it will come into contact with this. As the stud becomes magnetic it will attract the soft iron plunger (Fig. 3), and as this is free to move it will move up as far as it can go. The plunger fits loosely on a brass stem, and is protected on the outside by an insulating sleeve. At the bottom of the brass stem are pivoted the elbows of two brass elbow arms, the shorter arm pivoting on the iron plunger while the longer is free and is faced with a carbon contact piece. This is so arranged that when the plunger is at its highest point, nearly touching the lower side of the stud, the carbon contacts are pressed on the opposite sides of a lug screwed on to the live wire. This permits of accurate adjustment and removal, if necessary, without disturbing the live wire, which is laid in an earthenware trough filled with bitumen, and is only exposed at the lugs. The joints are made very loose to avoid jamming. To prevent them from carrying a current of any size, a flexible wire is connected between the carbon ends of the arms and the brass stem. The skate is also insulated electrically from the magnet and is connected to the motor system, so that, when it is in contact with the stud, current passes from the live wire to the motor through the stud and skate, and only meets two uncertain contacts—at the lugs and the stud surface.

The studs are set at a distance of about 6 ft, and the skate is nearly twice this length. Suppose that the car is drawing current from one stud and is moving forward, just coming into contact with another, the centre pole magnetises skate and stud, brings them into contact, draws up the plunger, and thus brings the arms in contact with the live wire. At the same time the outer poles magnetise the iron frame of the stud box (Figs 3 and 4), thus making a nearly complete magnetic circuit, which increases the magnetisation of the plunger, and hence the force drawing it up. It will be noted that the actual electrical contact between the car and live wire takes place at the wire in this case, but, as current is then flowing by the back stud, there should not be much sparking. But this still leaves much to be desired. The car continues to move forward until the skate leaves the back stud, when contact is broken at the stud surface this time and, as before, sparking is not serious, as current is now passing by the front stud. The former magnetising force not only goes, but the outer ring exerts an opposite effect, which tends to destroy the former magnetisation and to repel the plunger from the stud, thus assisting its weight to make it fall. Hence the plunger falls with a sharp click, the arms spring sharply away from the live wire, and, as the circuit is already broken, there can be no flame. When the break occurs, if the track is solidly laid so that the plunger remains vertical, it is nearly impossible, owing to its easy working, for the mechanism to jamb and thus for the arms to remain in contact with the live wire. At the back of the car a metal brush is hung a foot or so behind the skate, so that it will just touch the studs after the skate has left them. This brush is connected to an electric bell on the car, which will ring if any current passes through the brush as a consequence of its touching a live stud. Thus a live stud is immediately indicated, and it can be as easily removed and replaced. A reference to Fig. 3 will show that the movable frame rests on the fixed frame along a machined edge. When this is covered with thick grease an almost perfectly watertight joint is made, and yet the movable frame can be taken out at once even if alive. As the occurrence would be extremely rare, the car would be stopped and a sound stud inserted. It will be seen from Fig. 1 that the total depth of the stud boxes is little more than that of the rails, so that this system can be used wherever rails can be laid. The stud boxes are held firmly in place by the tiebars and forms a part of the road surface, being at least as resistant and lasting as any other portion. On the track at Southall more than 30 miles were run at all speeds up to 15 miles per hour during a recent special trial. As the studs occur at every 6 ft., it will be seen that over 26,000 studs were passed without any sign of either a live or a dead stud, and this on a roughly-laid track.

This system is in the hands of the S.P. Syndicate, Limited, 88, Fenchurch-street, London, E.C. At the demonstration on Saturday last Mr. S. A. Lehman, the chairman of the company, made some reference to difficulties which confronted the inventor in developing his idea. The visitors were very much interested in the system, which worked during the whole of the afternoon without the slightest hitch. It is clear that this system is one which is well worthy of the serious attention of tramway engineers, if only for its extreme simplicity and economy, and if further trials on a properly constituted track should confirm the reliability and safety which extensive trials on the roughly-laid Southall track have manifested, the future of the system should be assured.

POWER CHARACTERISTICS OF THE TUNGSTEN FILAMENT.

An interesting record of a series of tests by Dr. Charles P. Steinmetz on the power characteristics of the tungsten filament incandescent lamp appears in a recent issue of the *Electrical World* (New York). Dr. Steinmetz has investigated experimentally the manner in which power consumption increases with increase of voltage. He has taken the readings of a series of tests on a number of modern tungsten lamps extending over a wide range of candle-powers, and he has found it possible to reach ten times the rated candle power of the lamps, without any appreciable impairment or change of the filament or blackening of the globes, as evidenced by the lamp showing its original candle-power and efficiency after the test.

Analysing the relation between the power consumption and the impressed voltage, the interesting result was found that the power consumption varies proportional to the 1·6 power of the voltage—that is, follows a law analogous to that of the hysteresis loss in iron in an alternating magnetic field, and thus can be expressed by the equation $w = c\, e^{1.6}$.

The following table gives in the first three columns the observed values of candle-power, L, impressed voltage, e, and current, i, of one of these lamps—a 32-c.p. 40-watt lamp. The fourth column gives the watts, w, derived by multiplying volts and amperes. The values of this column can be expressed by the equation $w = 0{\cdot}0235\, e^{1.6}$. In the fifth column of the table are given the values calculated by this equation of the 1·6 power, and in the last two columns the differences between observed values of power, w, and values calculated by the 1·6 power law. As will be seen, the difference in no case reaches 1 per cent.:

L C.P.	e Volts.	i Amperes.	w Watts.	Watts calculated.	Difference.	Per cent.
2	49·6	·247	12·25	12·14	− ·11	− ·9
4	59·6	·274	16·33	16·26	− ·07	− ·4
8	70·6	·302	21·35	21·40	+ ·05	+ ·2
12	79·0	·324	25·60	25·55	− ·05	− ·2
16	85·3	·339	28·91	28·89	− ·02	·1
20	90·4	·350	31·64	31·70	+ ·06	+ ·2
24	95·7	·361	34·55	34·70	+ ·25	+ ·7
28	100·5	·371	37·29	37·47	+ ·18	+ ·5
32	103·3	·380	39·26	39·25	− ·01	− ·0
36	106·6	·389	41·47	41·30	− ·17	− ·4
40	110·9	·398	44·14	44·00	− ·14	− ·3
44	113·3	·401	45·42	45·50	+ ·08	+ ·2
48	115·6	·407	47·05	47·20	+ ·15	+ ·3
64	126·6	·429	54·31	54·40	+ ·09	+ ·2
96	142·9	·460	65·73	65·95	+ ·22	+ ·3
128	157	·489	76·77	76·68	− ·09	− ·1
192	180	·529	95·24	95·45	+ ·21	+ ·2
256	196	·556	109·00	109·4	+ ·40	+ ·4
288	206·5	·571	117·9	118·9	+1·00	+ ·8
320	212	·580	122·9	124·0	+1·10	+ ·9
32	103·8	·380	39·45	—	—	+ ·9

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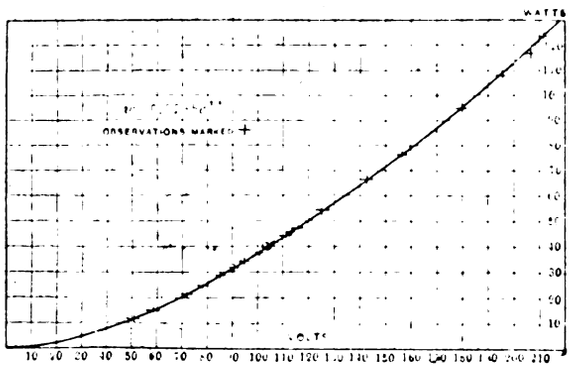
In the accompanying illustration is shown the curve of 1·6 power, with the observed values of power marked by crosses. As will be seen, the coincidence is so close as to give no noticeable deviation in the scale of the curve. It is especially interesting to observe the law of the 1·6 power,



EXPONENTIAL CURVE, 1.6 POWER

showing the relation between the consumption and voltage of tungsten lamps, particularly as in the tungsten lamp the law of the 1·6 power is not only an empirical law, but can rationally be derived as a theoretical conclusion from the temperature law of metallic resistance, $r = a\,T$, and the normal radiation law, $R = b\,T^4$, where T = absolute temperature and R = total radiation power.

NEW YORK TRAFFIC PROBLEM.

In New York, as elsewhere, the question of solving the traffic problem has for years occupied much attention. But with the opening of the two tubes for electric trains under the River Hudson, uniting the cities of New York and New Jersey, an important step towards the solution has been made. From particulars of this great work, costing in all about £14,000,000, sent over to the *Daily Telegraph* by its New York correspondent, it is evident that everything possible has been done for the convenience of the travelling public. The cars on the new lines are made entirely of steel, absolutely fireproof. They have large sliding side doors in the middle, as well as at either end, and the platforms are so arranged at the stations that passengers may enter and leave the cars at the same time; those leaving go out at one side, and those entering the cars come in on the opposite side. This does away with the congestion and crowding experienced at terminal stations on other metropolitan railroads. All station platforms throughout the system are built so that there is no dangerous space between the cars and the platform. The doors of the cars are operated by compressed air, and no signal bells are used. When the last door in the train is securely closed, the motorman receives an electric flash signal and starts the train. The automatic adjustment is such that the signal to start cannot be given so long as any door in the train remains open the fraction of an inch. The cars are brilliantly lighted and very comfortable. They have only side seats, and are equipped with steel rods set vertically at frequent intervals, and these aid passengers to steady themselves when the cars are crowded. Throughout the system, which comprises about 20 miles of under-river and underground railroad, the stations are designed with a view to comfort, permanency, and beauty. They are made large enough not merely to accommodate the metropolitan traffic of to-day, but to receive comfortably the greatly-increased multitudes sure to travel by underground routes in the decades to come. Every part of the stations is constructed either of concrete or metal, so that, like the cars and the tunnels, there is no possibility of fire. In the tubes under the river the atmosphere is always cool and delightful, as each train that goes through acts as a piston, forcing the air ahead of it and drawing in a fresh supply from the surface as it proceeds.

An announcement is made by the *Electrical Review and Western Electrician* to the effect that W. R. Willcox, chairman of the New York State Public Service Commission, has received from the Bradley-Gaffney-Steers Company a series of plans and offers to construct and operate subways in various parts of New York City and Queen's County, the contract costs to be over £20,000,000. When completed it will make a complete circuit of subways, all operated on a one-fare system, issuing transfers to and from all points. The Corporation offers to build one part providing the city constructs the other, but in the event of the city's refusal, A. J. Bahn, representing the Bradley-Gaffney-Steers Company, says the company will build all if necessary.

ELECTROLYTIC LIGHTNING ARRESTERS.

An interesting paper on this subject was presented at the recent convention of the Canadian Electrical Association by Prof. L. A. Herdt and Mr. N. J. Dalemont. After referring briefly to some of the well-known types of lightning arresters, the liquid electrode arrester and the aluminium-cell arrester are described in detail. The former consists of two metallic electrodes, either dipping in an electrolyte of high conductivity placed in an earthenware vessel or arranged with a small air gap between the electrolyte and the electrodes. As current passes, in either case it throws the electrolyte away from the electrodes, thereby increasing the resistance in the path of the discharge, breaking the arc and also the dynamic current, and finally automatically resuming contact with the electrodes upon return of normal conditions. Experiments have shown that this action is so rapid that little deformation of the E.M.F. wave of the line takes place, even when the discharge occurs when the E.M.F. is at or near its highest value. This arrester has a well-defined critical voltage, below which arcs are suppressed, and above which passage of the dynamic current is interrupted. The aluminium-cell arrester described consists of aluminium discs stamped in the form of annular cups and covered with a thin film of oxide, which are placed one on top of the other to form a column, and separated by insulating discs or washers. The cups are filled with an electrolyte, consisting of an acid solution, either citrate of magnesium or citrate of aluminium; the whole combination is placed in earthenware jars, a certain amount of insulating oil being placed on top of the electrolyte to prevent evaporation. A number of such arresters can be placed in series in case of high line voltages. Critical voltage per disc varies from 380 to 400, depending on the voltage used when the discs are formed. At a high potential, due to static discharge, the film of oxide of the aluminium is punctured, but when the voltage becomes normal the film is re-formed automatically, and the arrester is again ready to operate. Aluminium cells are built for 4,000 volts up. When the line voltage is higher than about 13,000 volts, multigap arresters are used placed in series, and for still higher voltages horn-gap lightning arresters are used.

Some experiments with aluminium-cell batteries are described as follows: In a bath containing 6 per cent. of bicarbonate of ammonia two plates of aluminium were used as anodes, and a plate of nickel as cathode. The two aluminium plates were electrically connected together, and current was obtained from a storage battery. The film of oxide formed on the plates was at first thin, but thicker formations were obtained by increasing slowly and gradually the voltage, and again later by lowering it to smaller values than at first used. The ohmic resistance of the film of oxide was found as high as 21 by 10^5 ohms per square centimetre. It is not constant and diminishes when the applied voltage is increased. The resistance, however, depends on the voltage used when the plates were formed, so that at a given voltage the higher the voltage of formation the larger will the resistance be. In experiments made with such plates used as condensers, the film of oxide weakened after operating continuously for some time, and finally gave out. It was found necessary in such cases to provide a formation circuit in the shape of direct current to form the oxide film again. In view of the above facts, the authors advise the use of horn-gap or other type of air-gap protection in series with this type of arrester, as when placed directly between wire and ground a condenser action must necessarily take place.

INSTITUTION OF MINING ELECTRICAL ENGINEERS.

Meetings of the Yorkshire and Notts branches of the newly-formed Institution of Mining Electrical Engineers will be held on Saturday next, July 24, at the Victoria Station Hotel, Sheffield, and the Welbeck Hotel, Nottingham, respectively, both at 5 p.m. The business on the agenda at each meeting will be the appointment of local officers, etc., and all those locally interested in the formation and progress of the institution are invited to attend.

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THE BRUSSELS EXHIBITION.

It is the intention of the Royal Commissioners and the Board of Trade to make the British exhibit of machinery unrivalled. More than a third of the whole Machinery Hall, which covers 222,670 square feet, has been secured for this country in two central bays.

At recent exhibitions this country has been placed at a disadvantage in comparison with foreign rivals, and there is some impression abroad that this is a sign of weakness. It will be remembered, for example, that, while we made an unsatisfactory show at Paris in 1900, a very beautiful and effective display was arranged by the German and American engineering trades. At that time foreign Governments were in more direct association with manufacturers than our own was, and firms like Krupp's of Essen and Schneider of Creusot were liberally assisted. Again, at Milan the British engineering exhibits were not displayed to full advantage. At the last Brussels Exhibition 12 years ago an excellent collective exhibit was made by the Cleveland Ironmasters' Association with business results, but it was impossible to get space for a good exhibit of machinery. In the present instance the case is altered. There being a permanent department of the Board of Trade dealing with exhibitions, it was not necessary to wait for the appointment of a Royal Commission in order to apply for space. As soon as the exhibition was announced, Mr. Wintour, the director of the new department, went over and secured the best positions for British exhibits next to those retained by Belgium herself.

The cost of exhibiting at Brussels can be estimated with certainty, and the exhibitions branch protects exhibitors from extortion, delay, and annoyance. Delivery of packages will be received by its officials at the entrance to the exhibition, which they reach by rail, and they will be placed on the proper site, unpacked, and the packing cases stored till the close of the exhibition. The necessary crane power and unskilled labour will be provided. These services are to be rendered free of any charge but the 2s. 6d. per square foot for space. Prior to this—as soon, in fact, as exhibitors care to furnish specifications—estimates for the laying of foundations and the erection of shafting will be obtained by the Exhibition Branch from Belgian contractors, and the work supervised by a competent engineer. In view of the great efforts to be made by France, Germany, Italy, the United States, and Belgium itself to display up-to-date machinery in a striking way, the Royal Commissioners have also resolved to defray half the cost of motive power charged by the Belgian administration, though the charges in the first instance are to be normal.

Full particulars of the arrangements may be had on application to Mr. U. F. Wintour, Board of Trade (Exhibitions Branch), Queen Anne's-chambers, Westminster.

TRADE IN ELECTRICAL MACHINERY IN PORTUGAL.

Some interesting statistics relating to the imports of electrical machinery into Portugal are given in the London Chamber of Commerce *Journal*, and these show that, in spite of the high duty of 30 per cent. *ad valorem*, there is a good field for the supply of electrical machinery and apparatus in Portugal. The importation during the year 1906 amounted to £30,200, of which £13,670 came from Germany, £8,700 from the United Kingdom, and £4,320 from France. The detailed figures for 1907 are not yet published, but the summary shows that the total imports increased to 453,109 kilos in weight and £37,100 in value. Electric batteries pay a duty of 300 reis per kilo. The imports amounted in 1906 to £1,400, of which £603 were from France, £530 from Germany, and only £172 from England. In 1907 the value of the total imports of batteries was £1,010. The customs duty prevents the importation of electric batteries, which can be manufactured more cheaply in the country. Metal wire covered with rubber or guttapercha is subject to a duty of 40 reis per kilo. The total imports in 1906 were £11,203, of which £7,710 were from Germany, £2,036 from England, £588 from France, and £403 from Austria. Electric cables pay the same duty of 40 reis per kilo.

The following are some particulars of the electric tramway undertakings in Portugal. The "Carris de Ferrode Lisboa" is a Portuguese company with its offices at Lisbon: rua S. Joaquim ao Calvario. It is assisted by English capitalists who have founded an English company with the name "Lisbon Electric Tramways Company, Limited." All the rolling stock, which is solid and comfortable, comes from the United States. The installation is excellent, the rails strong and heavy, and the winding and hilly streets of the city are provided with a satisfactory service. At Oporto the "Companhia Carris de Ferro," with a capital of 1,500 contos of reis (about £300,000) carries on an electric tramway with the overhead system. The office of the company is Avenida do Boa Vista 130, Oporto. An electric tramway on the trolley system connects the station at Cintra with the sea, a distance of about 10 km. The company owning the line is the "Cintra ao Oceano," with a capital of £40,000. The service is carried on in the fine season, from June to the end of October. The office of the company is at Lisbon, rua do Paco des Negros 156.

The principal electric lighting undertakings are (1) the United Gas and Electricity Companies of Lisbon, rua da Boa Vista 27. This is a Belgian company with an office at Brussels—rue Marie de Bourgogne. The company is stated to be about to install a new electrical station. The last machinery bought was obtained from Belgium. The power produced with the new installation will be 10,000 h.p., which is expected to meet the needs of the capital for several years to come. The use of electricity spreads steadily. In 1905-6 the joint companies sold 1,507,721 kw., and in 1906-7 2,274,543 kw. (2) The Oporto Gas Company has been absorbed by the above companies, which have had for some years the monopoly of the gas and electricity supply in Setubal to the south of Lisbon. (3) "Eclairage intensif au Portugal." This is a Belgian company which is also dependent on the United Gas and Electricity Companies. (4) The Light, Heat, and Motive Power Company is a Portuguese company assisted by French capital. Its address is: rua Nova do Almada 225, Lisbon. The works are at Ponta Delgada.

The Anglo-Portuguese Telephone Company, 31, Budge-row, Cannon-street, London, E.C., has the telephone monopoly for the whole of Portugal.

The names of the principal agents and importers of electrical goods in Lisbon and Oporto can be supplied to inquirers on application to the Statistical and Information Department of the London Chamber of Commerce.

CONSULAR NOTES.

A report from Tientsin (China) states that within the last two or three years the system of tramways worked by the Compagnie de Tramways et d'Eclairage electriques de Tientsin, a Belgian company, has been considerably extended. Originally designed only to make a circuit round the Chinese city along the boulevards formed by the demolition of the old city walls, with an extension along the Chinese Bund, the system was carried across the river to the Austrian concession by a bridge opened in November, 1906; and in May, 1907, an agreement was concluded with the Japanese concession for running the line through the main street of that concession, and thus providing a direct route between the foreign settlements and the Chinese city apart from the route through the Russian, Italian, and Austrian concessions on the other side of the river. Until this extension was carried out the tramways did not pay, but it is now believed that their success in the future is assured. There are between eight and nine miles open to traffic, nearly all double tracks. The receipts from the tramways alone are given as £13,120 in 1907 and £19,400 in 1908, but the cost of working is unknown.

The lighting of the town of Corunna is undertaken by two companies, La Société d'éclairage de la Corogne et Vigo and the Sociedad Co-operativa Electrica, which both receive their power from the same source—a stream near Puentedeume, near Ferrol. Great competition existed between these two companies by which the consumer benefited, but they have now come to an arrangement and work together. The lamps and fittings employed all come from Germany and are supplied by agencies in Madrid. The number of lamps used annually is about 55,000, and they are nearly all of the bayonet-holder pattern. The existing tramway lines in Corunna are worked by mules and run very indifferently, working expenses being very heavy. It is proposed to convert the whole system (four miles) into an electric tramway and to extend the existing line some five miles on the road to Betanzos, so as to open up communications with the many villas and estates to the west of the town. Negotiations with a Belgian syndicate have fallen through, and correspondence is now going on with British and other groups with a view to the speedy settlement of this scheme.

The tramways at Gijon have been taken over by one of the Thomson-Houston Companies, and are now being converted from horse to electric traction. No extension of the line worthy of mention is to be made at present, but as soon as the new Government road from Gijon to the port of Musel is open it is proposed to run a line to that harbour.

During the year 1908 the Municipality of Porto Alegre (Brazil) completed the installation of an electric lighting system principally for the public illumination of the suburbs and parts of the city not lighted by gas. A very limited number of private consumers is also supplied where gas cannot be obtained, but the installation is not large enough to supply electric lighting in a general way. A concession for supplying electric light to private consumers within a limited zone of the city, included in the part also supplied by the gas company, is held by a native company (Fiat Lux), but the concession expired in April, 1909, and the whole of the town and suburbs are now open to all comers, as the Municipality does not reserve any monopoly for itself.

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SIEMENS NOVELTIES AT THE BRITISH MEDICAL ASSOCIATION'S ANNUAL EXHIBITION, BELFAST.

Messrs. Siemens Bros. and Co., Limited, of Caxton House, Westminster, S.W., are showing some interesting novelties and improvements in electro-medical and other appliances at the above exhibition. The most recent advances in X-ray work have been instantaneous radiography and the production of unidirectional high-tension current without the aid of induction coils and interrupters. Both these functions are fulfilled by the new Siemens X-ray outfit with rotary high-tension rectifier, which is described in our publicity columns this week. Messrs. Siemens are also showing one of their new "G. P." X-ray outfits, which has been designed to bring the price of such apparatus within the means of the general practitioner, whilst the workmanship and material are very high class. The outfit consists of a 16-in. spark induction coil, spark-gauge, switchtable, and Wehnelt interrupter. All the apparatus is mounted on a protective screen lined with lead and provided with a lead-glass window.

Second only to the efficient production of the X-rays is their proper application, and the company are exhibiting their so-called universal and safety protective tube stand, which is a general utility apparatus for holding the patient securely in the standing or sitting position, and protecting him and the radiographer from the harmful effects of the X-rays, and also for permitting the free movement of the fluorescent screen or dark slide in any direction in relation to the patient. The tube is fitted in a protective box at the back of the stand, and its distance from the patient, as well as its movements in a horizontal direction, can be read off and controlled by a hand-wheel in the front. All live parts are effectually insulated or kept outside the reach of the patient and practitioner.

Another electrical novelty exhibited by Messrs. Siemens Bros. is their clinical temperature recorder. The outfit comprises a platinum spiral in a quartz glass tube, known as the "resistance thermometer," which is inserted into a suitable part of the human body, a four-volt accumulator battery, a regulating apparatus, and a recording milli-voltmeter of the well-known Siemens type, as used for thermo-electrical measurements, etc. The instrument is supplied in two patterns—*i.e.*, with suspended or pivoted moving coil—and both of these patterns can be provided with slow or quick recording device. The charts are graduated longitudinally into units of time and transversely into degrees of temperature from about 85 deg. to 115 deg. F. With this apparatus investigations can be made over periods of several days and continuous curves obtained in order to demonstrate the progress of pathological cases and the effects of the administration of drugs, etc.

Messrs. Siemens Bros. and Co. also exhibit radium, radio-active substances with applicators for treatment, and radioactive earth for local application, etc.

ELECTRIC PLANT IN ITALY.

A report just issued by the Department of Industry and Commerce for the year 1908 gives details regarding the concessions which were granted in connection with 238 electric plants, this figure being an increase of 12 over the number authorised in 1907. The greatest number of installations—64—have been constructed in the province of Lombardy; then come Piedmont with 48, Venice 22, Abruzzi and Molise with 17, and Emiglia and Romagna 14. The remainder is spread over the provinces of Marche, Lazio, the Campana, Puglie, and Liguria. There are 94 entirely new plants. Of these plants 56 utilise hydraulic power, 28 gas or steam, while 10 use combined systems. Those worthy of special mention are: Upper Italy—Società Generale di Elettricità dell' Adamello, for the transmission of energy for power and light to the boroughs of the provinces Brescia, Bergamo, and Milano, with 3,000-kw. generators, tension of line 60,000 volts, greatest distance covered 160 km. (99 miles); Società Elettrica Riviera di Ponente, with 2,300 kw., conveyed over 165 km. (102 miles); Società Elettrica Eridane at Cremona, having 3,000 kw., Cotonificio Udinese with 620 kw., and Angelo Ferrarin with 589 kw. Central Italy—Società Elettrica della Sicilia Orientale, in the province of Syracuse, has 3,000 kw. at 30,000 volts line tension, transmitting over 128 km. (79 miles); Società Meridionale di Elettricità, in the provinces of Salerno and Napoli, with 1,200 kw., tension 30,000 volts, over 81 km. (50 miles); Società Idroelettrica del Medio Calore and Società Idroelettrica Ligure, with respectively 200 kw. and 600 kw., over 32 km. and 54 km. (19 and 33 miles). Among noteworthy extensions of plant may be mentioned that of the Società Imprese Elettriche Conti and Novara, which now conveys power to a distance of 115 km. (71 miles), and that of the Società Elettrica Bresciano, which now covers a distance of 85 km. (53 miles). During the three years 1906, 1907, and 1908 703 concessions were granted for 307 new generating stations, and 396 for extensions to existing plants.—*The Times.*

POPLAR ELECTRICITY ACCOUNTS.

The annual report of Mr. J. Horace Bowden, borough electrical engineer and manager, records an increase in the net balance available as compared with the previous year. The total income for the year ended March 31, 1909, amounted to £37,810, an increase of 7·08 per cent. over the corresponding amount for the previous year. The working expenditure amounts to £19,467, which shows an increase of 5·85 per cent. over the figures for the previous year. The gross profit for the year was £18,342. Of this amount, interest on and repayment of loans absorbed £14,662, leaving a balance on the year's working of £3,680. After deducting certain minor charges there is left a net balance of £3,217, which shows an increase of 20·5 per cent over the previous year. To this sum must be added £665 unappropriated balance from last year, making a total available surplus of £3,883. Of this sum £2,189 was applied to meet certain capital charges payable out of revenue, leaving an unappropriated balance of £1,703—an increase of £1,037 over the previous year. The capital value of the undertaking at the end of March last stood at £252,523. The total cost per unit sold amounted to 1·420d., which was made up as follows:

	d.
Generating expenses—Coal, including carriage, etc.	0·354
Stores, water, etc.	0·016
Wages at works	0·089
Repairs and maintenance	0·060
	0·519
Distributing expenses	0·054
Rents, rates, and taxes	0·100
Management charges	0·126
Total	0·799
Capital charges	0·621
Total cost (including capital charges)	1·420

The units generated during the year reached a total of 7,164,208, compared with 6,464,497 in 1908; the quantity sold amounted last year to 5,845,692 units, a substantial increase compared with 5,296,040 units in the previous year; the quantity used on works was 428,965, compared with 413,906. The total maximum demand last year was 2,800 kw., against 2,600 kw. demanded in the previous year. In his preceding report Mr. Bowden submitted a typical load diagram showing the morning peak at 1,360 kw., afternoon at 1,340 kw., and evening 960 kw. A recent typical curve now indicates 1,620 kw., 1,590 kw., and 1,190 kw. respectively, showing that the proportions are fairly well maintained, notwithstanding the adverse effect of the new-type lamp upon the lighting demand. The proportions of increase in actual output are as follows—viz.: private lighting, 6¾ per cent.; power, 15¼ per cent., while public lighting has decreased 6⅝ per cent., making a net increase of 10½ per cent.

Some idea of the progress made by the undertaking since 1904 may be gathered from the following figures: output increased by 165 per cent.; total cost per unit reduced by 41 per cent.; average price per unit sold reduced by 36 per cent.; redemption increased by £4,500; net profit increased by £1,361. The increase of 165 per cent. in the volume of business has been gained by a reduction of 36 per cent. on prices charged. This increase has enabled the cost of production to be reduced by 41 per cent., and the undertaking placed in a position to provide £4,500 more for redemption, and at the same time increase the net profit by £1,361.

With regard to public lighting, it is now possible to compare the actual result of the change over from carbon to metallic filament lamps. In the year prior to changing over, the cost for current supplied was £5,343. 18s. 3d., and last year £4,935. 11s. 3d., a saving of £408. 7s. The cost of lamp renewals was in the first instance £162. 8s., and in the second instance £497, an increase of £334. 12s., thus showing a net saving to the borough of £73. 15s., without taking into consideration the number of lamps converted from gas in the interval. By the change the borough has gained in efficiency of street-lighting from an initial 24 c.p. per post and a steady diminution during use, to 50 c.p. per post without any material reduction during life of lamps.

HENRY SAXON SNELL PRIZE COMPETITION.

The Royal Sanitary Institute have appointed Prof. Henry Adams, M.Inst.C.E., F.S.I., Dr. Louis C. Parkes, M.D., D.P.H., Prof. W. Napier Shaw, D.Sc., M.A., F.R.S., and Mr. A. Saxon Snell, F.R.I.B.A., as the adjudicators for the next Henry Saxon Snell prize competition, the subject set being "The Principles of Heating and Ventilating Public Buildings." The essays have to be delivered at the institute, 90, Buckingham Palace-road, by Aug. 31.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

QUESTIONS.

1,200. At a certain works in the Midlands there is a steam pump working in connection with a hydraulic accumulation. This pump is a source of trouble, and is also very inefficient as regards steam consumption. There is within a few feet of it the main shaft of one of the machine shops, whose motor (a 50 h.p.) is but half loaded. It has been suggested that the steam pump, which absorbs 10 h.p. to 12 h.p., should be replaced by a three-throw belt-driven pump worked from the shop shaft, the belt being moved over the pulleys by means of a solenoid energised from a 220-volt circuit and brought into operation by means of a separate circuit connected with the pressure gauge. It is suggested that the solenoid should pull the belt on to the driving pulley against a spring, which, as soon as the solenoid is de-energised, draws the belt back on to the idle pulley. The above operation would be taking place about eight times per hour. Is the above idea workable? If so, give the best method of putting same into practice, with necessary sketches, and setting forth the calculations necessary for arriving at size of solenoid, and also particulars as to best size of belt, etc.—F. R.

1,201. Describe the principle of action and the advantages and disadvantages of the wireless "detectors" now used (*excepting* the simple Marconi magnetic and coherer types). Indicate the ideal requirements, and show how nearly they are satisfied by the sets described.—L. C.

ANSWERS.

Question No. 1,190.—It is intended to make a series of tests upon telegraph poles to determine the "deflection" at various strains. What precautions should be taken regarding wind pressures, variation of temperature, and area affected due to wind pressure? Also give formulæ for these.

Answer to No. 1,190 (awarded 10s.).—The manner of testing telegraph poles is clearly shown in Fig. 1, these tests being best effected when the pole is held horizontal and strained as below. It would clearly be very difficult to satisfactorily test poles *in situ*. The apparatus required for tests sufficiently elaborate and accurate for all practical purposes (deflections being measured to within $\frac{1}{100}$ in.) is very simple. At any convenient spot in the pole storage yard or elsewhere four stout wooden piles, A, B, C, D, are driven deeply into the ground and stayed to make them as rigid as possible. The pole is rather differently clamped according as it is a single pole or an A pole. If the former, the method of clamping is very simple (see Fig. 2), but if A poles have to be tested, a rather more elaborate arrangement is necessary. The pole is placed as shown with its feet bedding firmly on the cross-piece, R S. Cross timbers, E F, are bolted to the top and bottom of the pole respectively, and the ring, G, is clamped on below E F to prevent slipping. A wedge strut, H, completes the fixing. A telescope, T, fixed on M N and sighted on O enables the detection of and allowance for any slipping in the housing of the pole. A chain is then secured to the pole about 2 ft. from its top, and a gang of men haul on this as required, the force applied being measured by the dynamometer, D. This pull being applied in the direction shown by the arrows, it will be clear that the method of clamping adopted secures a maximum of rigidity at the base of the pole with a minimum of labour and materials for securing the same. To take the weight of the pole itself a vertical chain runs over a pulley suspended from a cross pole, P P. A certain amount of sag in the length of the pole is then inevitable, it being impermissible to support the whole length, or even part of the pole, near the centre on account of the friction errors so introduced. This sag considerably lowers the

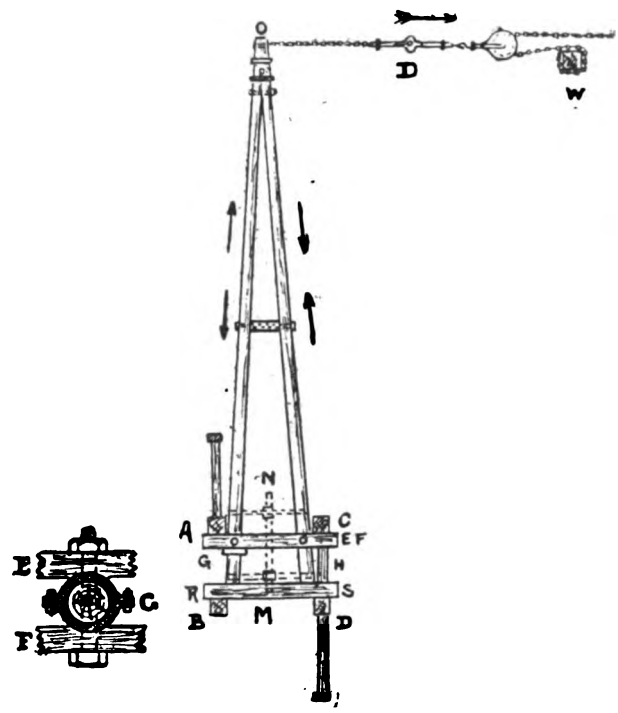

FIG. 1.

critical load at which the compression leg of the tested pole fails—*i.e*, reaches its crushing load as a strut. Once the compressed lag has buckled thus no further increase of load on it is possible, any attempt to increase the load simply buckling the pole further till the breaking point is reached. (This theoretical result is very closely attained by simple

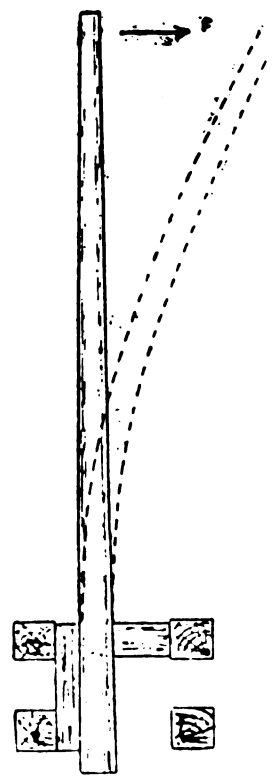

FIG. 2.

struts in pure compression, but the peculiar form and loading conditions of A poles in the present case naturally causes some departure from such a simple law.)

The form and approximately the proportionate extent to which a single pole may be expected to bend is shown in Fig. 2. (As a rough rule the maximum deflection of single

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wooden poles that can be reached without permanently injuring the material is about l to $\frac{l}{2}$ inches, where l = over-all length of pole in feet.) Fig. 3 is reproduced from a photo of an A pole under full test load, and shows the remarkable effect of the weight sag in the compression lag, and also the yielding of the top joint of the pole. The twisting resulting from the "give" of the scarfed joint is shown by the inclination of the oak cross-arms.

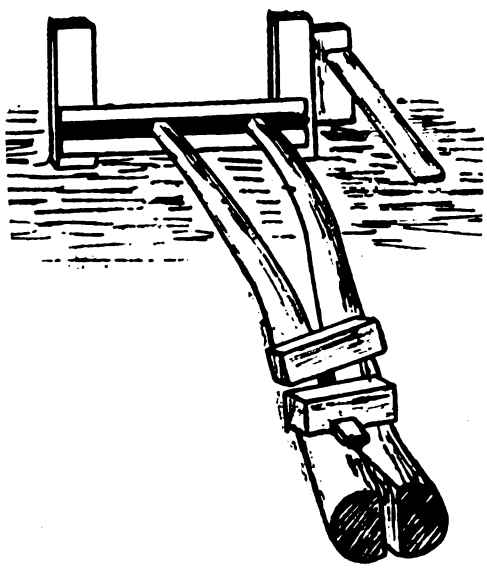

FIG. 3

The data to be observed during such pole tests as the above are: the free length of pole, the distance from the pole top to the loading chain, the diameter of the pole at the top and at the point where the pole leaves the clamps, the deflections produced by various loads and the maximum safe load (the latter being judged by the observer, and by noticing that the deflections begin to increase with greater rapidity than is consistent with previous readings; experience soon teaches the approximate limit to which the poles may be deflected without being permanently injured, and enables this load to be recognised from the general behaviour of the pole). These data being obtained the modulus of elasticity can be at once deduced if required. It is usually of more importance, however, to construct standard curves, obtained by actual experiment, giving the deflection of various poles under known conditions, approximating as closely as possible to the conditions of practice. On the latter point it may be remarked that by the method of clamping suggested in Fig. 1 far greater rigidity of base is obtained than would exist in practice, which enables test loads to be raised to values which would uproot the pole if applied to it as ordinarily erected. If for no other reason than this, testing in the maker's yard would be preferable to testing *in situ*. Fig. 4 shows the standard deflection curves plotted from Mr. Christopher Wade's results obtained during his researches on pole strengths and deflections, etc Single poles and A poles are included by these curves as shown. A similar very interesting and valuable curve is that given in Fig. 5, which shows the slip in the top scarfed joint of A poles for various loads applied 2 ft. from the pole tip. This, of course, depends to a very large extent

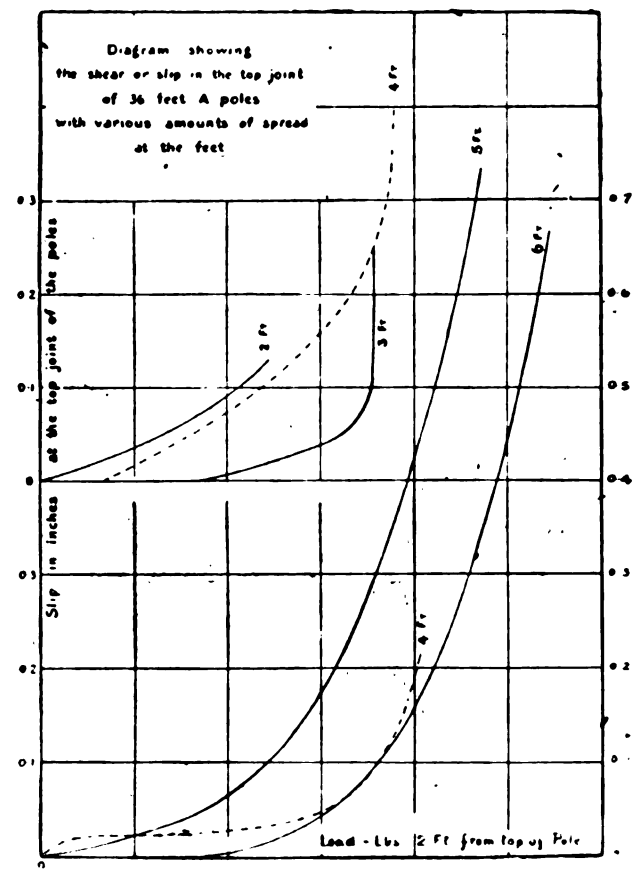
Diagram showing
the shear or slip in the top joint
of 36 feet A poles
with various amounts of spread
at the feet
Slip in inches at the top joint of the poles
Load - Lbs 2 Ft from top of Pole

FIG. 6.

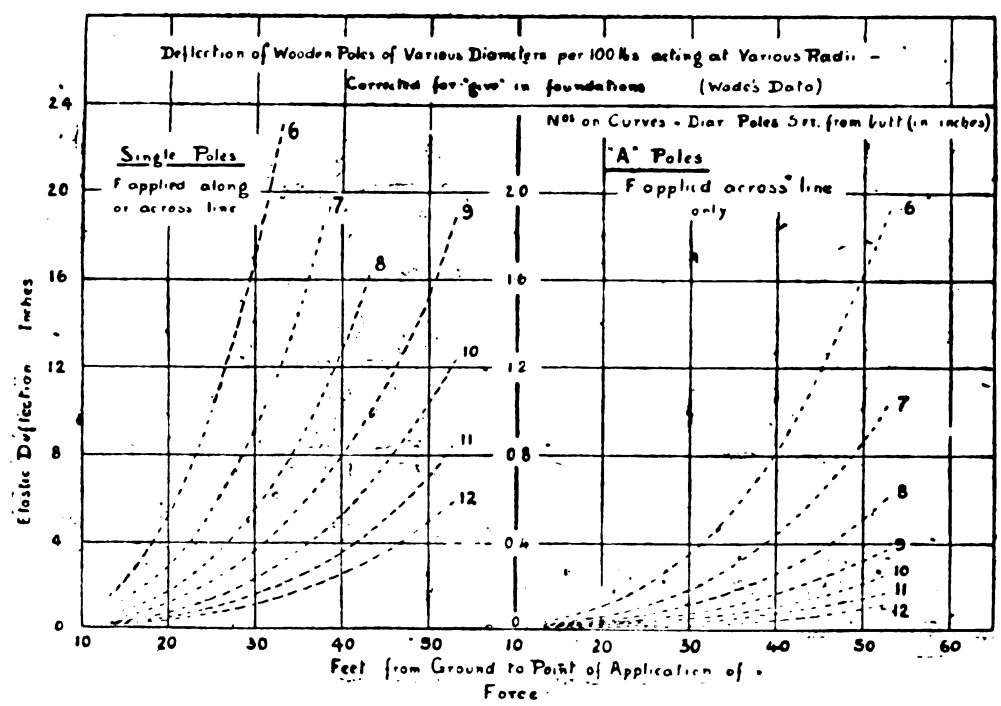
Deflection of Wooden Poles of Various Diameters per 100 lbs acting at Various Radii -
Corrected for "give" in foundations (Wade's Data)
Nos on Curves - Diar Poles 5ft. from butt (in inches)
Single Poles
F applied along or across line
"A" Poles
F applied across line only
Elastic Deflection Inches
Feet from Ground to Point of Application of Force

FIG. 4.

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on the spread of the pole butts, particularly for small spread. For spreads of more than 6 ft. or 7 ft. the slip becomes very small; for smaller spreads the slip is greater the more acute the angle between the pole axes. This slip should not exceed 0·2 in. to 0·75 in. on the application of the maximum safe load to the pole.

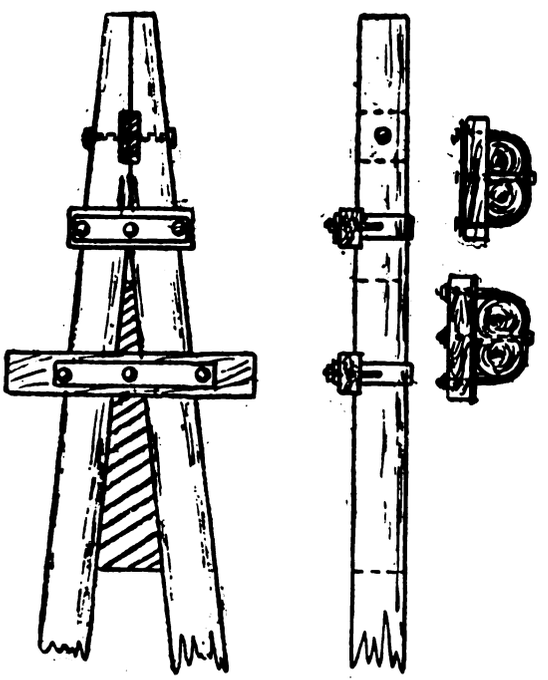

FIG. 6.

The construction of a pole head of the A type is shown in Fig. 6. The block of oak, *o*, greatly strengthens the joint, and should be about 6 in. deep and not wider than indicated. (*Depth* resists slipping and twisting, width rather aids it.) If the block be too shallow vertically, the joint will probably fail, as shown exaggerated in Fig. 7, the effect being that already referrred to in Fig. 3.

The calculation of the deflection of the top of the pole may be effected by using the ordinary beam formula,

$$d = \frac{1}{8} \cdot \frac{W l^3}{E I},$$

in which W = total load, l = length of cantilever, E = modulus of elasticity, I = moment of inertia of beam section considered, and d = required deflection. This assumes a uniform section of pole, whereas the wooden poles used in practice have invariably their natural taper—about $\frac{1}{10}$ in. per foot. Metal poles are usually parallel. It is convenient, however, and sufficiently accurate for practical purposes, to work out a table of deflections for various diameters of parallel poles. The true deflection of

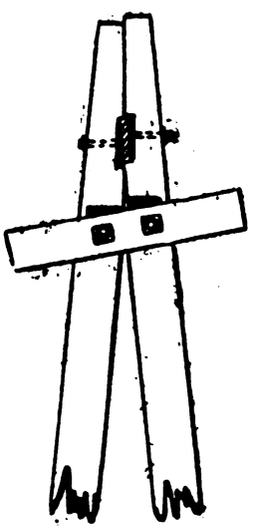

FIG. 7.

the tapered pole must *not* then be taken to be the mean of the deflections of parallel poles of diameters respectively equal top and bottom diameters of the tapered pole, since the deflection $\propto \frac{1}{(\text{diameter})^4}$; but the curves plotted in Figs. 8 and 9 give results from 20 to 30 per cent. higher than the observed experimental deflections (see Fig. 4), and hence err on the side of safety, and make a reasonable allowance for the "give" of pole foundations in practice. If desired, a curve could be constructed showing the diameter of parallel pole equivalent to poles of various tapers, but since a factor of safety of 10 must be allowed in any case such refinements are unnecessary.

The values of d for various diameters of parallel single poles have been calculated from the above formula for various free lengths of pole, and the results obtained are

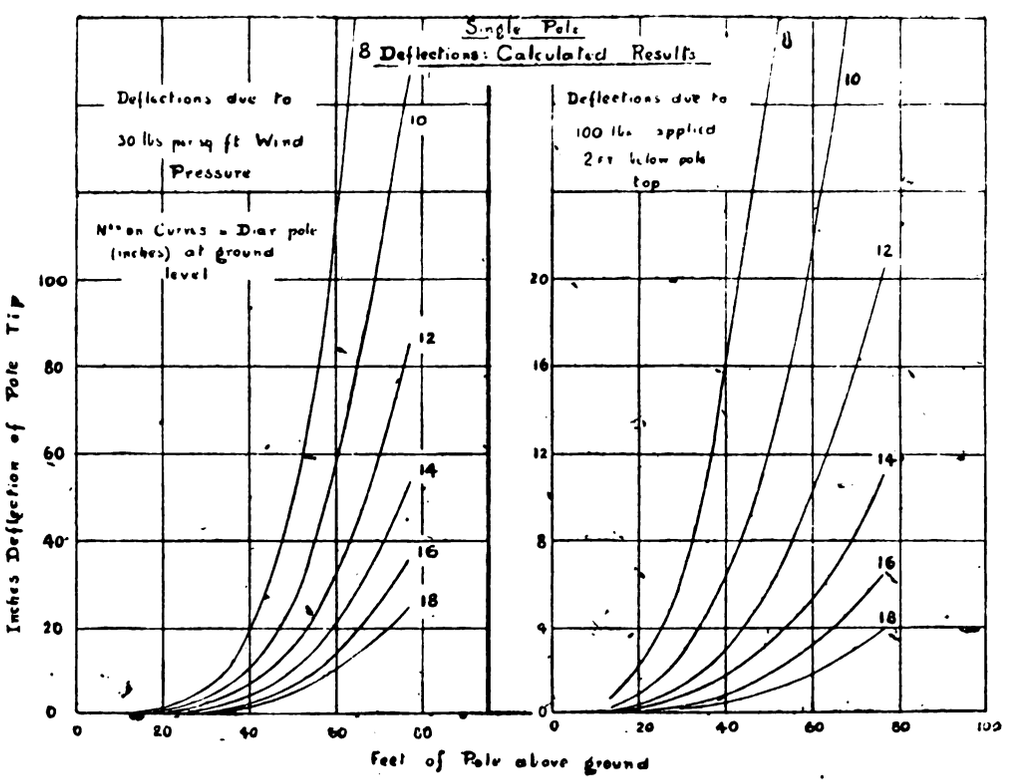

FIG. 8.

FIG. 9.

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presented in Fig. 8. In calculating these curves it has been assumed that the cylindrical pole surface offers half the wind resistance of a flat surface equal to its projection, this being in close agreement with experimental results (for wires a coefficient of two-thirds is generally admitted). In Fig. 9 are similar deflection curves to those given in Fig. 8, except that as the basis of calculation is now taken a pull of 100 lb. at 2 ft. from the pole top. Parallel poles are again assumed, the corresponding results for poles of any taper being obtained by approximation as before. From the curves of Figs. 8 and 9 the total pole deflection to be expected from a known wind pressure and a known side force on the cross-arm (say that due to wind pressure on the wires) is at once obtainable, the two deflections being practically additive. It is clear from Fig. 9 that a pole of 8 in. diameter could not be used for heights greater than, say, 30 ft. if a side force of 100 lb. had to be withstood at the cross-arm. The curves of Fig. 8 may be corrected to suit other wind pressures than that assumed by direct linear proportion, and similarly the deflections in Fig 9 vary directly with the load applied at 2 ft. from the head. (N B.—In calculating the data for Fig. 9 the deflection has been calculated at 2 ft. from the pole top, and allowance made for the extra deflection due to the projecting 2 ft. of pole, which is unbent, but tangential to the curve made by the pole at the point of application of the load. The deflections plotted are, therefore, the correct deflections of the pole tip.) The deflections vary inversely with the modulus of elasticity, E, so that by allowing for this Figs. 8 and 9 can be used for metal poles. The E assumed in this case is 1,300,000 lb. per square inch. It is clearly preferable to evaluate such tables for parallel poles, since a fresh set would otherwise be required for every taper were the latter allowed for in calculation, whereas by the assumptions made a sufficient accuracy can be obtained over a very wide range of conditions, and by the use of two sheets of curves only. It is found that if a wooden pole be strong enough to withstand the pressure on itself and the wires it carries, and is sufficiently elastic in the direction of the line, it is adequate from all other mechanical points of view, so that *the weight of the wires carried need not be considered.* The method of making wind pressure calculations has been explained above, while the elasticity data relating to the pole are determined by the experimental means already described. Such refinements as temperature effects and wind pressure in the test yard need not be considered within normal limits of these factors. The pole being low and horizontal, and usually sheltered by piles of timber when tested in the yard, is not appreciably affected by wind pressure, the effects of the weight sag of the pole in reducing its apparent strength being far more important, but causing errors always on the side of safety.

If one commences to study the effects of the weight of the wires on the stresses in the pole, great complications are arrived at. Thus, suppose a pole to be deflected by wind pressure, the weight of the lines it carries make it, in effect, an eccentrically loaded bracket of very complex form, but the difficulties involved in calculations relating to such structures can fortunately be avoided owing to the fact that other conditions suffice to determine the safety of a pole. For further information regarding the testing of telegraph poles and poles in general, "Overhead" may be referred to the paper on this subject read at the Institute of Electrical Engineers on May 2, 1907.—WREN.

[Other replies to Question No. 1,190 will be given in our next issue.—ED., *E. E.*]

THE FARADAY SOCIETY.

A meeting of the Faraday Society was held on Tuesday, June 29, at the Institution of Electrical Engineers. Dr. N. T. M. Wilsmore occupied the chair.

Dr. HENRY J. S. SAND read a paper entitled "Apparatus for the Rapid Electro-Analytical Separation of Metals." The paper contains a description of some developments made in the apparatus, first described by the author about two years ago, for the rapid electro-analytical deposition and separation of metals. This apparatus for the first time combined in a practical manner the use of an auxiliary electrode and very rapid stirring of the electrolyte, and made it possible, as has been shown so far, to deposit and separate from each other for purposes of chemical analysis the metals silver, mercury, copper, bismuth, lead, cadmium, zinc, antimony, and tin. The times required for these depositions varied in the majority of cases between five and fifteen minutes. Apart from the very high stirring efficiency of the electrodes the apparatus is believed to be superior to others of similar type in the exceedingly great simplicity of the method of making and undoing the electrical connections on a single stand, in the fact that the electrodes may be used with ordinary beakers, and in the simple manner in which the electrodes may be washed and dried. No alterations in principle have, therefore, been made to the apparatus, but the following additions and simplifications are described. As hitherto, a mercury contact has been employed in the electrolytic stand to make the connection between the stationary and the moving parts; a special screw cap has, however, now been provided, which may be screwed down when the apparatus is not in use, making it possible to transport it without taking out the mercury. A clutch arrangement has been added which enables the operator to start or stop the rotation of the anode without stopping the motor. Such an arrangement will be found of advantage if it is desired to actuate several sets of apparatus from one shaft driven by a single motor; or if the current is obtained from a small motor-generator which is also employed for rotating the electrode, the clutch making it possible to stop or start the stirrer without stopping the current; or, lastly, if a hot-air or water motor is employed which cannot be stopped instantly during the washing of the electrodes. A very considerable simplification has been obtained by fitting all the apparatus required for the measurement of the potential of the electrode in a single box. The arrangement has been designed so that by depressing a key it will also allow the potential difference between the anode and the cathode to be read directly. It was thought very desirable to retain the capillary electrometer as a zero instrument, but it became necessary to design a new portable form suitable for the purpose in view. It may be described as a closed evacuated form developed from the Ostwald horizontal capillary electrometer. It is provided with an enclosed scale, and if observed by a lens of small magnification it will readily indicate one millivolt.

Dr. B. BECKETT DENISON communicated a paper entitled "Researches on the Relative Rates of Migration of Ions in Aqueous Solution." The author has determined by the method of direct observation of moving ionic boundaries the transport numbers of the halide salts of the metals of the alkalies and alkaline earths. The concentrations of the solutions were 0·1 to 0·02 normal. It is pointed out that the study of transport numbers by the direct and indirect methods has been shown to afford a means of determining the degree of hydration of the ions, although in the present paper no degrees of hydration were calculated.

Prof. R. ABEGG (*communicated*) congratulated the author on having succeeded in filling the gap of electrochemical constants of so important a group of ions as the halides.

Mr. S. FIELD read in abstract a paper on "The Conditions which Determine the Composition of Electro-Deposited Alloys. Part I.: Copper-Zinc Alloys." As the result of a large number of experiments on the electrolytic deposition of brass, the author has, by the analysis of the deposits, shown the regular manner in which the composition changes with such varying conditions as (1) proportion of copper and zinc compounds in the solution; (2) strength of the solution; (3) temperature; (4) current density; and (5) the presence of free cyanide. It is thus shown that the proportion of zinc is increased (*a*) at lower temperatures; (*b*) with more dilute solutions; (*c*) with increased current density; and (*d*) by the absence of free cyanide. With a large proportion of zinc compound copper is still freely deposited. The author incidentally draws attention to a number of important conditions which primarily affect the composition of the solution and ultimately the character and composition of the deposit. The work is being continued on other binary alloys.

BENTLEY SEWERAGE.

The Bentley Rural District Council at their last meeting approved of a scheme of main sewerage for Bentley Colliery village, and decided to apply to the Local Government Board for a further loan to carry out the work. There will be several miles of sewers to lay, which will be of cast-iron pipes on a concrete foundation, necessitated owing to the wet nature of the subsoil, as well as the construction of an underground storage tank, which will be of reinforced concrete, sunk to a considerable depth, from which the sewage will be pumped by electric motors and centrifugal pumps to the existing sewage-disposal works.

It is proposed to obtain the current from the Bentley Coal Company. The engineers for the scheme are Messrs. D. Balfour and Son, of London and Newcastle-on-Tyne.

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CONTENTS.

Electric Lighting Acts Amended	85	The Faraday Society	100A
The German Electrical Industry	86	Bentley Sewerage	100A
Some Elementary Considerations of High-Tension Switchgear	87	Electric Plant in Italy	98
The Sun as Generator	89	Poplar Electricity Accounts	98
London County Council Tramway Accounts	89	Henry Saxon Snell Prize Competition	98
High-Tension Transmission	90	Correspondence	99
The Electric Lighting Acts (Amendment) Bill	93	Magnetic Tests of Common and Silicon Steel	99
Municipal Electrical Supply	94	Corona Phenomena	100
The Suchostawer Stud System of Electric Traction	94	Rail Corrugation	100
Power Characteristics of the Tungsten Filament	95	Institution of Mechanical Engineers	100
New York Traffic Problem	96	American Notes	100
Electrolytic Lightning Arresters	96	Electric Supply in India	100
Institution of Mining Electrical Engineers	96	Imperial Cables	101
The Brusse's Exhibition	97	The Thwaite Fund	101
Trade in Electrical Machinery in Portugal	97	Telephone and Telegraph Rates	101
Consular Notes	97	Legal Intelligence	101
Technical Problems, with Solutions by Practical Men	97A	Companies' Meetings and Reports	101
Siemens Novelties at the British Medical Association's Annual Exhibition, Belfast	98	New Companies Registered	103
		Lighting Notes	103
		Traction Notes	104
		Personal	105
		Contracts for Electrical Supplies	106
		Provisional Patents, 1909	109
		Specifications Accepted	110
		Companies' Stock and Share List	110
		Traffic Returns	112

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "THE EDITOR, *139-140, Salisbury Court, Fleet Street, London, E.C.*" *Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC LIGHTING LEGISLATION.

SIR,—Referring to my letter which you were good enough to insert in your last issue, I am now glad to be able to report that, as a result of the efforts which have been made, substantial amendments have been obtained in the Bill now passing through Parliament. Clause 6 has been altered so as to make it quite reciprocal between local authorities and companies. Clause 13, relating to audit of accounts, has been struck out, and the following clause has been substituted: "The Board of Trade shall from time to time make a return to Parliament giving such particulars as they may think proper with regard to the reports made by any auditors appointed by them to audit the accounts of any undertakers and any action taken on such reports by the Board and by the undertakers." Clause 2 has also been amended with regard to sub-stations.

The Bill passed the Standing Committee yesterday, and until we see a revised print we cannot be sure that all points have been satisfactorily met, but it is believed that there will be no further necessity to oppose the passing of the Bill. The Bill is not entirely satisfactory, because many important matters referred to by the Select Committee of 1898 have not been dealt with, but the Bill contains some good points, and the particularly dangerous clauses have, it is hoped, been satisfactorily amended.—Yours, etc.,

E. GARCKE.

July 21, 1909.

RATING AND TAXING OF ELECTRIC MOTORS.

SIR,—I shall be much obliged if you or your legal contributor can give me some information as to the proper and legal rating and assessing of motors, steam and gas engines, and how the respective horse-powers are calculated for this purpose. At the present time, no sooner have I got an electric motor installed in a consumer's premises than he is met with a demand for the local rate on it, followed up shortly after by the surveyor of taxes with further demands, and if the unfortunate user has kept his engine connected up to the gas or steam supply for stand-by, as is often done for the first few months at any rate, he finds his rates and taxes doubled.

Again, take another case where it is desired to replace a 30-h.p. steam-engine by nine motors on nine separate drives of 10 h.p. each. In this case, owing to the large diversity factor, the average total horse-power required is well under 30, but the motor for each group cannot take account of this, and, therefore, the total horse-power for assessment is 90. Taking the assessable value as £1. 5s. 6d. per horse-power, the rates here are at present 5s. 6d. in the £, and on a 10-h.p. motor the rates levied are £3. 8s. 9d. per annum. This, consumer, therefore, having by his conversion to electric driving increased his available horse-power by 60, is now met by an additional rates bill of £20. 12s. 6d., plus taxes, over and above his previous rates, all of which he has to save before he can get any monetary advantage from his electric driving. I am further informed that a steam-engine user can get an engine assessed at, say, 20 h.p. which, with a little speeding up and, perhaps, increase of pressure, will give 30 b.h.p. to 35 b.h.p.

The rates departments are so keen on their pound of flesh that, unless I can find some relief from this difficulty, power supply in this town is likely to come to a stand-still just at a time when the outlook appears most favourable. I can hardly imagine my difficulties here to be unique, and, therefore, hope that through your paper I may obtain some useful information.—Yours etc,

S. B.

MAGNETIC TESTS OF COMMON AND SILICON STEEL.

A circular recently issued by the Bureau of Standards, Washington, on the subject of magnetic testing sets forth the scope of the Bureau in this line of work, and includes a description of the methods employed, which are dealt with in the columns of an American contemporary. Two tables are printed in the circular, which give the results of the magnetic tests of ordinary steel and of silicon steel. It is pointed out that ordinary sheet steel in common use varies very widely in its magnetic qualities, and that the quality is not closely related to the cost. While the watt loss when tested with alternating current varies in the case of ordinary steel from 1·25 to 2·36 watts per pound for sheets of No. 29 gauge, at a frequency of 60 cycles and a magnetic induction of 10,000, silicon steel varies only from 0·66 to 1 watt per pound under the same conditions. In addition to this variation there is a great difference in the constancy of magnetic properties with time. Some metals show very decided ageing, which in one case amounted to as much as 67 per cent. in 500 hours; other specimens, including most silicon steels, show little or no variation with use.

As to the commercial significance of the tests, the design of a 5-kw. transformer is taken for an illustration. If instead of material showing a core loss of 45 watts another showing a core loss of 32·2 watts is taken, the saving in operation for 8,760 hours, or one year, amounts to 112 kilowatt-hours. At a cost of one halfpenny per kilowatt-hour, this amounts to 4s. 8d, which at 10 per cent, allowing for depreciation as well as interest, represents a capital of £2. 7s. 6d.; in other words, the buyer could, with advantage, pay any amount up to the sum just mentioned, more for the sake of getting better material in his core, and the manufacturer could pay 1s. 2d. per pound more for the 40 lb. of material used. If the better silicon steel were to cost 1½d. more than the other (which is improbable) the difference in cost of the steel would be 4s. 8d., and the user would each year save 100 per cent. of extra cost.

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The comparison between the power silicon steel and the ordinary steel is even more marked. In a case cited the difference in core loss would be the equivalent of 10s. 4d. per year, thus practically reducing the value of the transformer by £5; yet the difference in cost of the material is only 5s. if the price of silicon steel delivered at the factory is taken at 3¼d. per pound and that of ordinary steel at 1½d. per pound, assuming 40 lb. to be necessary.

CORONA PHENOMENA.

At the annual convention of the American Institute of Electrical Engineers, held early this month, Messrs. W. S. Moody and G. Faccioli, of the General Electric Company, presented a paper containing much interesting information concerning certain unexpected results obtained while investigating corona phenomena in air and oil. When between a conducting rod and metallic disc there was impressed an E.M.F. of sinusoidal time-wave shape corona appeared at 57,000 volts; when a conducting cylinder was placed around the centre of the rod the corona appeared at 62,300 volts, but when insulating type was wrapped on the centre of the rod the corona was formed at a lower E.M.F. A certain rod, ¼ in. in diameter, which glowed at 57,000 volts when its length was 45 in., required 83,500 volts to form a glow when its length was decreased to 12·0 in., the distance to the metallic plate remaining constant at 12·0 in. In all of the experiments reported the shape of the "ends" of the rods had no effect upon the character of the phenomena. In fact, similar results were obtained whether the rod ends were spheres of large or small diameters or mere ends of cylinders. Moreover, the distances between the rods and the metallic plates, as well as the size of the plates, affected only the voltage to produce corona, and not the general character of the phenomena.

The authors concluded from their experiments that the voltage at which corona appears in apparatus not only depends upon the dimensions of the apparatus itself, but is also a complex function of several qualities and conditions. In discussing the effect of oil, they express the opinion that oil does not eliminate corona. For example, when two needles 12 in. apart were submerged in oil no glow is noticeable when the E.M.F. is raised to 100,000 volts, but at 101,000 volts the glowing is very perceptible in the shape of a small, steady brush, noiseless and green in colour. When the needles were separated by only 6 in. the glow was established at 78,000 volts, while for 3-in. separation the required E.M.F. was 72,000 volts. The above-mentioned phenomena are of predominating importance in the design of transformers for very high voltages.

RAIL CORRUGATION.

The *Official Circular* of the Tramways and Light Railways Association contains in its July issue a translation of the paper on rail corrugation read by the chief engineer of the Great Berlin Tramways before the International Tramway Congress held at Munich last September. Among other matters bearing on the same subject are the experiences of 19 tramway managers and engineers. The experience of Mr. Blain, of West Ham, may be quoted as typical. He states: "Rail corrugation developed rapidly on practically every route. They appeared especially on short lengths of single lines, which are frequently traversed by cars at a high speed. Several lengths have been ground out, some by hand filing and some by carborundum blocks fixed on a National Rail and Tramway Appliances Company's machine under one of our water-cars, the latter being the least expensive method. The corrugations, however, appear to show themselves again after about six months."

INSTITUTION OF MECHANICAL ENGINEERS.

The annual summer meeting of this institution will be held next week in Liverpool. The meetings will be held on Tuesday and Wednesday, July 27 and 28, in the lecture hall of the Municipal Central Technical School, the chair to be taken at 10 a.m. on each day. Among the papers to be read we may mention the following: "Indicating of Gas-Engines," by Prof. F. W. Burstall; "The Electrical Operation of Textile Factories," by Mr. Herbert W. Wilson.

AMERICAN NOTES.

The Westinghouse Electric and Manufacturing Company has been kept extremely busy of late. June proved a record month, the turnover being rather over half a million sterling. Among the orders taken was that for switchboards and apparatus for the New York terminals of the Pennsylvania Railroad Company, the cost being over £100,000. The Inter-State Investment and Construction Company, of Syracuse, N.Y., has also come to the Westinghouse people for the full equipment of four tramway power sub-stations, including equipment to a total of 20,000 h.p. for cars. The cars will have four motors each of 125 h.p. This is rather a new departure, as it gives 600 h.p. per car, as against the usual equipment of 100 h.p. (two motors of 50 h.p. each). Other business includes the supply of electric locomotives for several large mining companies.

A very extensive scheme for the electrification of the Long Island Railroad system has been practically adopted. This year it is proposed to put in hand the electrification and double tracking of all passenger lines west of Hempstead, electric trains to be operated through the Pennsylvania tunnels to the New York City terminals. This will involve an expenditure of upwards of £700,000. Two years hence the electrification and double tracking of the remaining portions of the system will be taken in hand.

An important new incorporation is that of the Cincinnati, Louisville, and Indianapolis Electric Railroad Company. Its mission is to provide street railways and interurban railways, linking up the following cities: Greendale, Aurora, Lawrenceburg, Risen Sun, Patriot, Florence, Markland, Vevay, Lamb, Brooksburg, Kent, Blocker, Madison, and Scottsburg. The headquarters are at Aurora, Ind.

Another incorporation is that of the De Kalb and Western Railway, De Kalb, Ill., to build an electric railway from Chicago to Rock Island, Ill. A third new company, the Independence, Siletz, and Pacific Railway, Salem, Ore., will build an electric line from Simpson through the Siletz reservation to the coast.

ELECTRIC SUPPLY IN INDIA.

A prosperous future lies before the electrical industry in India, where existing enterprises are receiving most gratifying support. The Calcutta Electric Supply Corporation, Limited, has found it necessary to issue 80,000 cumulative 5 per cent. cumulative preference shares at £5 each, the balance of its share capital, in order to extend the mains, with a view to supply the constantly-increasing demand for current. The company, which was registered in 1897, works two licences: one for the supply of electricity for all purposes in the city of Calcutta, and the other for the supply in the suburb of Howrah, which may be purchased respectively in 1918 and 1923 as going concerns by the local authorities. The net profits of the undertaking have increased from £5,400 in 1900 to £58,200 last year, and the dividends on the ordinary shares have risen in the same lapse of time from 3½ to 8½ per cent. It is now proposed to purchase a site in the northern district of Calcutta and erect and equip a high-tension generating station and to greatly extend the mains. The Madras Electric Supply Corporation, Limited, appears to be marching on to a like prosperous career. It is true that the directors have had to report a disappointing delay in completing the equipment of the main generating station. However, matters were sufficiently advanced in April to allow a commencement of the supply of electricity to the public from the permanent plant, the temporary (and uneconomical) plant being dismantled. The sub-station at Mylapore and the tramway sub-station are also very nearly completed. The supply to the public commenced with an equivalent of 5,200 8-c.p. lamps, and many applications have since been received, and some already satisfied. A large demand for electric fans is anticipated. Agreements for the supply to the Port Trust and to the Government buildings have been drafted and are under consideration, while the tramway company has undertaken to purchase a minimum of one million units of current per annum. The Corporation, by the way, has invested £20,000 in the Madras Electric Tramways, and has received a dividend of 5 per cent. on its investment. Further extension is contemplated, as new licences for the supply of current to Fort St. George and to the Port Trust are expected to be issued immediately.

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IMPERIAL CABLES.

Probable Reduction in Press Rates.

At a committee meeting of representatives of telegraph administrations transmitting telegraph traffic "*viâ* Eastern" and "*viâ* Teheran" between Great Britain and India, Australasia, and South Africa, the following resolution, says Reuter, was approved viz.: "That, provided the British, Indian, and Colonial Governments are prepared to take their rateable share of the reduction, the Press rate between Great Britain and India, Australasia, and South Africa be reduced to 9d. per word from Aug. 1 next." In connection with this it is interesting to find that the quarterly interim dividend announcement of the Anglo-American Telegraph Company for the three months ending June 30 shows an expansion of business. The usual dividends at the rate of 15s. on the ordinary shares and 30s. on the preference stock were declared after placing £5,000 to renewal account, but the significant fact is that the carry forward was £24,400—that is, £17,500 more than at the same period last year.

THE THWAITE FUND.

We learn that the committee of the B. H. Thwaite fund has now received from Mr. Carnegie a cheque for his generous contribution of £500. The conditions which were attached to Mr. Carnegie's offer—namely, that a further £500 should be forthcoming from subscriptions from those who recognised the value of the services rendered to certain departments of science and industry by the late Mr. Thwaite—have not been complied with up to the hilt, it is true, as the subscriptions did not reach a quite equal sum; but Mr. Carnegie has not allowed the actual cash shortage to stand in the way. He was doubtless influenced in his decision by the successful efforts of the committee in regard to Mr. Thwaite's son, aged nine, who has been elected to the Yorkshire Society School. If this benefit could be capitalised it would represent many times the shortage in the subscription total. We understand that arrangements are in progress for placing Mr. Thwaite's daughter in a suitable school. The committee are desirous of expressing through our columns their gratitude to Mr. Carnegie for his generosity and kind consideration, to all who by their subscriptions have helped to make up the required sum, and to those who have so substantially assisted by placing the deceased gentleman's son in the above school. In the last-named connection special thanks are due to Mr. George Mellor, the secretary of the Association of Yorkshiremen in London, of which association the late Mr. Thwaite was a founder.

TELEPHONE AND TELEGRAPH RATES.

The Associated Chambers of Commerce of the United Kingdom, in accordance with a resolution passed at the annual general meeting, sent a memorial to the Postmaster-General relating to telephone rates. The resolution stated that the scale of charges adopted and put into force on Jan. 1, 1907, by the Post Office and the National Telephone Company was much too high, and that the association was of opinion that the action of the Postmaster-General in consenting to increased charges being made by the National Telephone Company was opposed to the public interests, and called for a searching inquiry by Parliament. A reply has been received setting forth that the Postmaster-General's aim had been to adopt such rates as would cover the working expenses of the system, including sinking fund and an allowance for the depreciation of plant, together with a reasonable return on the capital expenditure involved. At the present time, owing to the special circumstances under which nearly the whole of the local telephone service of the United Kingdom—the most profitable portion of the service—was in the hands of the National Telephone Company, it was impossible to say what rates of charge should be adopted when the whole service was transferred to the Post Office. In Mr. Sydney Buxton's view, no final settlement on the question could be arrived at until some experience of the results of that transfer had been obtained.

As regards cheapening the telegraph rates between England and France, Mr. Buxton replied, if the rate was reduced to 1d. per word, each administration would, of course, receive ½d. only for each word transmitted or received. The cost of the service performed exceeded ½d. per word, and, therefore, if the reduction were carried out, the service would, as in the case of the inland telegraph, be carried on at a loss. A reduction to 1½d. only did not appear to be regarded as sufficiently advantageous or acceptable to be worth the sacrifice of revenue involved. He could not help feeling that when the financial position should hereafter permit, the public interest would be better served by a reduction in the letter postage rate to France than by a reduction in the telegraph rate.

LEGAL INTELLIGENCE.

ELECTRICAL RADIATORS.

How Long does "Sale or Return" Last?

In the City of London Court on Friday last, before his Honour Judge Lumley Smith, K.C., the Armorduct Manufacturing Co., 6, Farringdon-avenue, E.C., sued Mr. A. Fearnhead, 354, Caledonian-road, for £8. 5s. 11d. electrical goods and fittings supplied. The claim was admitted, but the defendant counterclaimed for £6. 13s. 6d. for the price of electrical radiators supplied to the plaintiffs. Defendants said that in February, 1908, he saw the plaintiffs' sales manager about the radiators, and he agreed to take them. They were sent as samples on sale or return, but plaintiffs must pay for them now, because they kept them for 10 months and sent them back damaged. Judge Lumley Smith said he supposed if the plaintiffs had returned the radiators in a fortnight the defendant would have taken them back. The defendant thought he might. Plaintiffs' traveller said they were waiting for months for invoice in respect of the radiators. That was why they kept them so long, as they did not know what they were to be charged. They had never given a specific order for radiators. It was quite a well-known practice in the electrical trade for goods to remain as long as 12 months in shops on approval. The defendant said that was not so as applied to radiators. Had the goods been electroliers he would have been willing for the plaintiffs to have kept them for nine months and then taken them back. The sale of radiators was a season's trade. Counsel for the plaintiffs said it was very useful for men like the defendant to show their radiators in the showrooms like the plaintiffs'. Judge Lumley Smith said that when goods were sold on sale or return the property passed to the buyers if they did not send them back within a reasonable time or give notice that they would not have them. There was a little difference where goods were sent in to be shown. He was satisfied that the goods were sent in to be looked at to get orders from and not bought or sold. The counterclaim therefore failed. Judgment for the plaintiffs on claim and counterclaim, with costs.

METHUEN v. DUNDEE, ETC., TRAMWAY CO.

Judgment was on Tuesday last issued by Sheriff Campbell Smith in an action in which James Cox Methuen, The Cottage, Lochee, sought to recover £124. 15s. 10d. from the Dundee, Broughty Ferry, and District Tramway Co. The action was the result of a collision which occurred in February between pursuer's motorcar and a tramcar belonging to the company. Pursuer contended that as he was approaching Dundee burgh boundary a tramway car at the crossing there backed into his car, and that the accident was due to the carelessness of the driver and conductor. The tramway company contended that there had been contributory negligence, and that the collision was really due to pursuer's chauffeur having driven too fast. The Sheriff found that reckless driving on the part of the motorcar driver had not been proved. In giving his evidence the chauffeur had filled him (the Sheriff) with confidence on his professional skill and expertness. He gave decree for £55, with expenses.

COMPANIES' MEETINGS AND REPORTS.

VICTORIA FALLS AND TRANSVAAL POWER.

The annual general meeting of this Company was held last week, Mr. H. Birchenough presiding.

The CHAIRMAN, in moving the adoption of the report, said there was a surplus of £48,177, compared with a surplus last year of £36,685. An immense change had taken place in the position and magnitude of their undertaking. They had now acquired from Mr. Harper a conditional agreement made by him with the Rand Mines, Limited, under which, when the agreement became definite, 15 mining companies controlled by the Rand Mines and Eckstein groups would contract to take the whole of their power requirements from a company to be formed for the purpose of supplying them with electricity and compressed air. This agreement was originally for 12 years, but they were successful in negotiating an extension of the contract from 12 to 20 years, without any right on the part of the Rand Mines of terminating it at an earlier period. The annual power requirements of these mines were estimated by the Rand Mines, Limited, at 270,000,000 units. In addition to this agreement, negotiations had been successfully carried out for the prolongation of the contract with the Consolidated Gold Fields of South Africa from 10 years to 12 years, and important contracts had been entered into with other mining groups, including the Johannesburg Consolidated Investment Co. In order to take advantage of the Harper agreement, it became necessary to raise additional capital. Accordingly an agreement was negotiated and entered into with the German banks for the subscription of £900,000 5 per cent. debentures, and subsequently, in accordance with arrangements made with the banks, a prospectus was prepared and £900,000 preference shares were issued in London. The result of that increase was that the capital that day stood as follows: £1,000,000 ordinary shares, £1,700,000 preference shares, and £1,700,000 debentures. A company had been formed and registered in the Transvaal, entitled the Rand Mines Power Supply Co., Limited, to operate the Eckstein contract, and to supply power in bulk to their company. It had a capital of £1,500,000—namely, a share capital of £500,000 in shares of £1 each—and it would have borrowed capital of £1,000,000. The problems that would confront them in the future were problems of cheap production and of careful and efficient manage-

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ment—not problems of propaganda and sale. Since their last meeting two directors—Sir Lewis Michell and Mr. Henry Wilson Fox—had, to the regret of their colleagues, resigned their seats upon the Board. Sir Lewis Michell had returned to South Africa to resume his residence there. The Board had appointed Mr. R. G. Fricker and Mr. Amandus Brakhan to be directors of the Company.

Sir CHARLES METCALFE, in seconding the resolution, said he had just returned from visiting the works in South Africa. They had now something like 12,000 kw. in active work, and at that time next year they would have more than double that. The question of transmission of power from the Victoria Falls, which was what they originally thought of, was rendered enormously difficult owing to the hostile attitude of the people in the Transvaal, who were having their coal used by the various companies, and also of the railway authorities, who depended a great deal for their income upon the carriage of coal. This Company had to meet that hostility by deferring the long transmission, though it would give him the greatest gratification to carry it out.

The resolution was carried unanimously.

CROMPTON AND CO.

The annual report for the year ended March 31 last, to be presented at the meeting of shareholders at Salisbury House London-wall, on July 26, states that the depression in trade in almost all parts of the world in which the Company does business, and the resulting keen competition, has rendered the obtaining of remunerative orders during the financial year a matter of very great difficulty, and a certain amount of work has had to be undertaken at a very small margin over cost. The net profit for the year amounts to £10,051, as compared to £31,320 for the year ended March 31, 1908. After providing for debenture interest, and other charges, there remains, with the sum brought forward from last year, an available balance of £7,827. The directors propose out of this sum to set aside £1,500 for doubtful debts and contingencies, and to carry the balance forward. The number of additional lamps connected to the mains of the Electric Supply Corporation undertakings during the year ended Dec. 31 last represents an increase of approximately 20 per cent., which is satisfactory. The guarantee as to the earnings of the Electric Supply Corporation, which expires in December next, will not, so far as the directors can foresee, necessitate any further increase in the Company's interest in the guaranteeing company. The dulness of trade still continues, although there are some indications of improvement. The directors have in view some important orders which it is hoped will be secured at satisfactory prices; they also have pleasure in reporting that during the financial year a patent has been obtained for a new auto-converter, invented at the Company's works. Orders for these machines are now being executed, and it is anticipated that the invention, for which there is a large field, will prove of considerable importance to the Company's business. With a view to obtaining fresh capital until such time as the Company can profitably reduce its holdings in other concerns, an offer of short-term notes was made to the shareholders in February last. The directors are now offering elsewhere the balance unapplied for. In order to prevent the possibility of delay in the issue of the Company's annual accounts, it is proposed in future to close the accounts of the Company's foreign branches at Dec. 31 in each year, instead of March 31, as at present. This course has the approval of the Company' auditors. Mr. John Trotter retires from the board of directors by rotation, but offers himself for re-election.

ELECTRIC CONSTRUCTION.

The annual meeting of this Company was held on the 17th inst., Mr. Walter S. B. McLaren presiding.

In moving the adoption of the report, the CHAIRMAN stated that the accounts showed a marked improvement upon those of the previous year. Having regard to the general depression in trade and to the continued strenuous competition in the electrical manufacturing industry, he thought that they had every reason to congratulate themselves. The electrical manufacturing industry was suffering severely from over-production. During the present decade about £7,000,000 had been invested in this branch of the business, the greater part of which was earning no dividend. Throughout the whole period of the depression the closest attention had been given by the Board and the management to economical production, and they had not hesitated to keep the Company's works up to the highest state of efficiency by installing the most modern labour-saving appliances. They had every reason to expect that, in the absence of any further slump in trade or serious cutting of prices, they would be able to submit the shareholders next year results as favourable as these now reported. The net profit for the year, after paying £10,250 for debenture interest and crediting £5,000, as formerly, to depreciation account, was £10,730, which compared with £5,932 for 1907-8 and with a loss of £1,442 for 1906-7.

Mr. P. E. BEACHCROFT seconded the motion, which was carried unanimously.

GENERAL ELECTRIC.

The ordinary general meeting of this Company was held last week at 71, Queen Victoria-street, E.C., Mr. G. Byng (the chairman) presiding.

The CHAIRMAN, in moving the adoption of the report, said there was larger profit this year than last year. They had written off more for depreciation at their works, and had placed to the credit of the reserve fund a larger sum—over £16,000. The resources of the Company and the security of the preference shareholders had thereby been materially strengthened. The pressure of competition at home forced them to seek orders more and more abroad. Unfortunately, customs duties were against them—not only on account of their stiffness, but also on account of their uncertainty—and it would be of enormous assistance to them if the British Government could enter into commercial treaties with Continental nations instead of relying upon the so-called "most favoured nation" clause—a clause which had often acted against them. They were continually influenced by the tariff fighting of foreign nations among themselves. The position of a great country waiting for the outcome of disputes between others was exceedingly ludicrous, and put them at a disadvantage compared to their foreign competitors. After having spent money in pushing their manufactures the duties were suddenly raised against them. At present the alterations of customs duties in France were making the Company very anxious, and they hoped for an early settlement one way or another. From a purely technical point of view all their works had done well—the engineering staff at Witton had especially distinguished itself. They had installed a larger number of big plants—they had proved very successful, and had greatly enhanced the reputation of the Witton electrical engineering works, strengthening their position in the foremost rank of electrical engineering firms. The carbon works were largely occupied with making flame arc carbons. Theirs was the only factory in England where such carbons were made; they had succeeded in competing with Continental firms. For this great credit was due to the energy and skill of the manager and staff of that factory. All their batteries, porous pots, and dry cells were now made at Witton. They had added a large welding plant to their tube works, and the art metal works at Sherlock-street, Birmingham, were making heating stoves and radiators in addition to electric light fittings. They had considerably extended the telephone factory at Peel Works, and he was pleased to record that the telephone equipments produced at these works had been adopted by their own and colonial governments, and were considered an advance upon those made by the most prominent manufacturers in America and on the Continent. The sale of Osram lamps had been large, and experience had proved that the marvellous economy and durability claimed for this invention was entirely justified. The factory at Hammersmith was completed, and was turning these lamps out equal in quality in every respect to those produced on the Continent. The process of teaching workpeople in this new industry was proceeding rapidly, and soon they hoped to employ over 1,000 skilled hands. They had had exceptional opportunities of comparing the capacity of their English staff and workmen with that of similar German and American organisations. He was pleased to state that Englishmen had learned as quickly and as well as their foreign competitors, and in some respects had surpassed them. This was not a biassed opinion of his own, but the actual experience of the engineer who had taught both here and abroad. Generally speaking they could not be dissatisfied with the year's working. While their profits might compare favourably with those of other English concerns they not did come up to the standard of profits obtained by foreign electrical companies working under certain conditions. The conditions of the country and the outlook were, to his mind, far from bright, and it would be wrong for business men to overlook the present symptoms. They had mainly felt them in their efforts to fill the works with sufficient orders, so that they could be run at their full working capacity.

Mr. H. HIRST seconded the motion, and it was carried unanimously.

EDMUNDSON'S ELECTRICITY.

Mr. P. D. TUCKETT presided at the ordinary general meeting of this Company, held in London on the 17th inst. In moving the adoption of the report he said that the gross trading profit had fallen to the extent of £5,234. The main cause of the decline was the reduced capital expenditure of the sub-companies. The private lighting department had not done so well this year as it did last year, when it had in hand the completion of a large Government contract. All expenditure on advertising was discontinued three or four years ago, and the Company was undoubtedly now suffering from the results of that policy. Another cause that had adversely affected the trading profits arose out of what he could only describe as bad book-keeping by one of the Urban Company undertakings a few years ago. Since the accounts were made up he had reason to fear that a similar state of affairs would be disclosed in the case of another Urban Company undertaking. Apart from these there was no reason to suppose that the accounts of the sub companies had been improperly kept.

The motion was unanimously adopted.

METROPOLITAN RAILWAY.

The report of the directors of this Company for the half-year ended June 30 last, to be submitted to the meeting on the 28th inst., states that the total receipts for the half-year amount to £379,487 and the expenses to £193,243, leaving a profit of £186,243. Compared with the corresponding half-year of 1908 the receipts show an increase of £22,700 and the expenses a decrease of £6,536. The expenditure is at the rate of 56·25 per cent. of the total traffic receipts, as compared with 60·36 per cent. in the corresponding period. The net revenue account, after providing for the interest upon the debenture stocks and other fixed charges, and for electrical depreciation, shows a balance of £137,075, which will permit of the payment of the dividends upon the preference stock and leave a balance of £32,564 available for dividend upon the ordinary stock. The directors recommend a dividend upon the ordinary stock at the rate of 1 per cent. per annum, and to carry forward the balance of £3,904. The Surplus Lands Committee announce that the dividend on the surplus lands stock for the past half-year will be at the rate of £2. 15s. per cent. per annum, as in the corresponding half-year. The development of the passenger traffic resulting from the improved train services and through bookings with the tube railways has been well maintained, while the new express parcels service,

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which was brought into operation at the beginning of the year, has also been very successful, and has attracted a large amount of new business.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY.

The *Financial Times* states that Mr. M. Snow, secretary of the Newcastle-upon-Tyne Electric Supply Co., has issued the following circular to the shareholders: "I am instructed by the directors to inform you that the profits for the first six months of the current year, as shown by the cost sheets, amount to £47,759, which, after including the balance brought forward from last year, and deducting interest on loans, debentures, etc., represents a net sum of £41,704. Out of this the directors have decided to pay on the 31st inst. an interim dividend on the preference shares of 2½ per cent., absorbing £17,187. The balance—namely, £24,516—though subject to deductions for depreciation and a sum to be carried forward, would, in the ordinary state of business, permit the declaration of a small interim dividend on the ordinary shares. In view, however, of the critical position of the coal trade and the possible stoppage of and damage to other trades which may follow therefrom, the directors do not think it prudent to deal with the balance before the end of the Company's financial year."

CITY AND SOUTH LONDON RAILWAY.

The report for the half-year ended June 30 last, to be submitted to the meeting on July 27, states that the receipts from all sources for the past half-year have amounted to £89,553, and the cost of working has been £39,975, leaving a profit of £49,588. Inclusive of the balance brought forward from Dec. 31 last, the net revenue account shows an aggregate total of £50,542. After making provision for the debenture stock interest, rent charge, and the transfer to the renewal fund of £1,500, a balance remains available for dividend of £34,662. The directors recommend a dividend at the rate of 1¾ per cent. per annum on the consolidated ordinary stock for the half-year, leaving a balance of £1,411 to be carried forward. The directors report increase in the receipts from all sources during the half-year. This result is the more satisfactory in view of the constantly progressing electrification of tramways which connect with and feed those already competing with this company's line. It has also to be remembered that as 1908 was Leap year, the half-year now under review was shorter by one day than the corresponding period.

EAST LONDON RAILWAY.

The report for the half-year ended June 30 states that the electrification of the South London section of the London, Brighton, and South Coast Railway is approaching completion, but the time when it will be opened for public traffic has not yet been officially announced. No data are therefore available as to the comparative cost of working the overhead and the third-rail systems, or of the facilities they respectively offer to the travelling public. Consequently the directors are unable for the present to make any suggestion of a practical nature on the important question of electrification.

CHATHAM AND DISTRICT LIGHT RAILWAYS.

The report for the half-year ended June 30 last states that the result of the half-year's working is as follows: Receipts £20,363, expenses £12,820, leaving £7,452. After deducting rent of Rochester Corporation lines, interest on debentures and adding balance brought forward there remains a balance of £4,669. The directors recommend a dividend at the rate of 5 per cent. per annum on the preference shares, carrying forward £1,729. The traffic receipts show an increase of £1,137 over those for the corresponding period of last year. This, however, is almost entirely accounted for by the fact that the extensions to Strood and Frindsbury were not open for public traffic for the full half-year of 1908.

NORTH MELBOURNE ELECTRIC TRAMWAYS.

The accounts of the North Melbourne Electric Tramways and Lighting Co. for the year to Sept. 30, 1908, show a loss of £7,388, increasing the debit balance at profit and loss account to £16,285.

NEW COMPANIES REGISTERED.

Charlestown Electric Light and Power Co., Limited.—Registered June 16 in Dublin. Capital, £1,500 in £1 shares. Objects as indicated by the title. Registered office: Charlestown, co. Mayo.

United Sua Betong Rubber Estates, Limited.—Registered July 15. Capital, £70,000 in £1 shares. Objects: to acquire the property known as Seng Kang, Sua Betong, and Passir Panjang estates, in Negri, Sembilan, Federated Malay States; to adopt agreements (1) with H. Caldicott and J. A. Macgregor, (2) with J. A. Macgregor, and (3) with Guthrie and Co., and to carry on the business of planters and cultivators of rubber and other produce, etc.

Beam Co. (British Electrical and Mechanical Co.), Limited.—Registered June 8. Capital, £1,000 in £1 shares. Objects: to take over the business of an electrical, telegraph, and general engineer and contractor carried on by A. Lawes at 35, Devonshire-chambers, Bishopsgate-street Without, E.C., as the Beam Co. (British Electrical and Mechanical Co.). Private company. Registered office: 35, Devonshire-chambers, Bishopsgate-street Without, E.C.

Bakap Rubber Plantations, Limited.—Registered July 8. Capital, £60,000 in £1 shares. Objects: to acquire certain estates in the province of Wellesley, Straits Settlements, known as the Sungei Duri Rubber Estate, together with the buildings, plant, machinery, tools, and equipment belonging thereto; to adopt an agreement with the Melentang Syndicate, and to carry on the business of planters and cultivators of rubber, guttapercha, and other produce, etc.

Kamuning (Perak) Rubber and Tin Co., Limited.—Registered July 9. Capital, £200,000 in 950,000 A shares of 2s. each and 105,000 B shares of £1 each. Objects: to acquire from the Linggi Plantations, Limited, the Kamuning Estate, Perak, for £132,500 (£105,000 to be satisfied by the allotment as fully paid of the 105,000 B shares and £27,500 to be paid in cash out of the proceeds of the issue of the A shares), to adopt agreements (1) with the said vendors, and (2) with Guthrie and Co., and to carry on the business indicated by the title. Registered offices: 5, Whittington-avenue, E.C.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Nenagh.—The Urban District Council have decided to advertise for plans, specifications, etc., for the installation of electricity in the district.

Chelsea Electricity Supply Co.—The Board have declared an interim dividend of 2s. per share on the ordinary shares for the past half-year.

Yarmouth.—The Town Council have decided to seek sanction to the borrowing of £2,000 for the purposes of laying mains and providing house services.

West Ashford.—Mr. Mark Parker has notified the Council of his intention to apply under the Electric Lighting Acts, 1882-1899, to supply the rural district of West Ashford.

Aylesbury.—Messrs. Foote and Milne have notified to the Urban District Council their intention of applying for a provisional order to supply electricity within the area of the Council.

North Berwick.—At the last meeting of the Town Council notice was received of the intention of Messrs. Crompton and Co. to apply for a provisional electric lighting order for the burgh.

Saffron Walden.—The town clerk has received notice from Mr. Mark Parker of his intention to apply to the Board of Trade for a provisional order to supply electricity within the borough.

Launceston.—Messrs. Foote and Milne have notified the Town Council of their intention to apply to the Board of Trade for a provisional order to supply electricity within the Council's area.

City of London Electric Lighting Co.—The directors have declared an interim dividend of 5 per cent. per annum (5s. per share), less income tax, on the ordinary shares for the past half-year, payable Aug. 4.

Ayr.—The Town Council have decided to apply £900 of the surplus on the lighting account to the general assessment account for the relief of the rates. The profit earned from electric lighting for the year amounted to £1,424.

Montreal Light, Heat, and Power Co.—The directors have declared a dividend of 1¾ per cent. on the paid-up capital stock, being at the rate of 7 per cent. per annum, for the quarter ending July 31, first, to shareholders of record on the 31st inst.

St. James and Pall Mall Electric Light Co.—The amount of electricity sold by the company for the half-year ended June 30, 1909, is returned at 4,826,663 units, estimated to produce £60,697, as against 4,802,560 units, which produced £61,635, for the corresponding period of last year.

Lowestoft.—The Electric Lighting Committee have directed the clerk to effect the fire insurance of the buildings, offices, and machinery with the Municipal Mutual Insurance Co. at the rates quoted by them, and the Council have decided to pass an order on the treasurer for payment of £19. 17s. 3d., being the amount of the premium.

Dundee.—As a result of the recent explosion and fire which occurred at the electric station damage to the extent of £1,400 has been done. Fully 6,000 yards of copper wire was destroyed and two Siemens engines and generators, which were, however, not in use at the time, were considerably damaged. All the damaged cables have been replaced by temporary ones.

Carlisle.—At the Town Council meeting last week Mr. Johnstone, in moving the adoption of the minutes of the Electricity Committee, which showed a net profit of £2,222, against £235 the previous year, said the manager's report of the year's working was clear and needed no comment. He would only say that the committee were delighted with the result. The Council adopted the report.

Neath.—A meeting of the Rural District Council was held last week, when Mr. J. H. Moore, on the report of the Electric Lighting Committee, said that the Council had purchased from the South Wales Distribution Co. the power station at Neath, which originally cost £45,000, for £7,000, including a length of cable which cost £3,000. The district was being well lighted at a minimum cost.

Doncaster.—The revenue from sale of current at the Corporation works during the year ending March 31 was £8,935. 17s. 7d., as compared with £8,820. 1s. 9d. in the previous year. Of the current sold, the tramways took 578,423 units at a cost of £3,615. 2s. 11d. (1½d. per unit), as compared with 591,131 units at a cost of £3,694. 11s. 4d. The generating expenses were £3,456. 15s. 10d. as com-

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pared with £3,462. 12s. 11d. The cost of distribution was £573. 4s. 1d., as compared with £374. 13s. 10d.

Blackpool.—The returns for the month of May show an increase in the total works output over the corresponding month last year of 9,889 units, made up as follows: private lighting, May, 1909, 98,149 (May, 1908, 100,804); public lighting, 11,181 (10,227); Corporation trams, 127,773 (116,831); Lytham and St. Annes, 9 598 (8,950)—total for month, 246,701 (235,812). For the two months, April and May, 1909, as compared with the corresponding two months in 1908, the output has been as follows: private lighting, two months, 1909, 203,105 (two months, 1908, 207,207); public lighting, 25,534 (22,813); Corporation trams, 244,432 (228,343); Lytham and St. Annes, 18,885 (17,190)—total for two months, 491,957 (475,553).

Taunton.—The electricity accounts for the year show a gross profit of £4,096. 16s. 6d., to which must be added the sum of £25 received in respect of pupils' premium, and also the sum of £43. 12s. 10d. brought forward from the last account, making together £4,138. 9s. 4d. This sum has been disposed of as follows: interest on loans, £1,708. 9s. 7d.; redemption of loans, £2,354. 18s. 6d.; transferred to capital account to balance in respect of amount overpaid on sanction for pump, etc., £9. 10s. 6d.; transferred to reserve account, £46. 3s. 6d.; and carrying forward a balance of £19. 7s. 3d. to the next year's account. The committee have also expended the sum of £496. 3s. 6d. out of the reserve account in the purchase of a new 150-b.h.p. engine and meters, leaving a credit balance on this account of £1,650.

Darwen.—The electricity works revenue account for the year ending March 31 shows a gross profit of £3,922. 10s. 11d. This is reduced, after making provision for interest and sinking fund instalments and repayments of principal to the Public Works Loan Commissioners, to a net profit of £627. 5s. 10d. The adverse balance of £1,265. 19s. 9d. standing to the debit of profit and loss account at March 31, 1908, together with £726, preliminary expenses disallowed by the Local Government Board, have been written off by a transfer from general district rate of a sum equal to these two amounts—*i.e.*, £1,991. 19s. 9d., leaving the above sum of £627. 5s. 10d. standing to the credit of profit and loss account. The number of units generated was 863,000 as compared with 838,814 for the previous year. The number of units sold and used on works has been 847,281, as compared with 821,111 for the previous year, being an increase of 26,170, or 3·08 per cent.

King's Lynn.—At the last meeting of the Electricity Committee the engineer reported that since the previous meeting applications had been received for 22 additional private connections, making a total of 632; the additional lamps numbered 240 of 8 c.p., or equivalent, making a total of 30,987. Tenders for the supply of from 1,500 to 2,000 tons of coal during the 12 months ending June 30, 1910, if required, were received, and that of Messrs. Myers, Rose, and Co. for the supply of Bestwood nutty slack was accepted. The committee further considered the statement of accounts for the past year, and it was resolved that the net surplus of £442. 19s. 9d. be carried forward to the next year's account. The engineer submitted the following statement: Units generated, May, 1909, 26,993 (May, 1908, 36,369); total units sold to private consumers (light and power), 18,432 (21,554); units sold at lighting rates, 6,718 (7,227); units sold at power rates, 11,714 (14,327); cost of fuel, stores, repairs, and wages at station, £122. 5s. (£137. 17s. 10d.); cost per unit generated, 1·0869d. (0·9099d.); wages of lamplighters and repairs of lamps, meters, and mains, £28. 13s. 3d. (£26. 12s. 6d.).

Bursiem.—At the last Town Council meeting the Electricity Committee reported the receipt of a letter from the Collieries Electric Power Development Syndicate offering terms for the supply of electricity in bulk to the Corporation, and it was recommended that the town clerk be instructed to state that the Town Council are not prepared to continue the negotiations. The committee had further considered the question of the collection of the accounts for electricity, and recommended that Mr. J. W. Steele be appointed to collect and keep the accounts at the electricity works, at a salary of 30s. per week. Tenders for extensions at the electricity works were submitted, and it was recommended that the chairman and vice-chairman and Mr. S. Gibson be appointed a sub-committee to open the tenders and report to the next meeting of the committee. The committee had considered a letter from Mr. Bremner, electrical engineer, applying for an increase of salary, and recommended that his salary be increased from £350 to £400 per annum. The report was adopted by the Council, with the exception of the recommendation respecting the engineer's salary, which was referred back for further consideration by the committee.

Sheffield.—Councillor Bennett, in presenting the annual accounts of the Electric Lighting Committee at the last meeting of the City Council, said, having regard to the state of trade in the city and the reduction in revenue arising therefrom, and from the introduction of the new metallic lamps, the accounts were satisfactory, and the committee could congratulate themselves on the result. There were times—anxious times—during the year when it seemed possible that they would have to meet the Council with a deficiency, but he was glad to say that was not so, and that they had a net profit of £2,422. 16s. 5d. The accounts had been presented in the form required by the Special Inquiry Committee, which was appointed last year, and they showed that if it had not been for the interest and sinking fund on unproductive capital the profit would have been £12,327. 7s. 10d., instead of £2,422. 16s. 5d. only. The committee had endeavoured to carry out the terms of the report of the Special Inquiry Committee, and, as would be seen, had carried to the renewals fund the sum of £10,000, as recommended by them, making the total amount which had been so applied £20,000. As regarded their suggestion that the further sum of £5,000 per annum should be carried to the renewals fund, they had pointed out that as the net profit was only £2,422. 16s. 5d., and the total available surplus, after carrying over the £10,000, only 8,751. 14s. 9d., it would be inadvisable to reduce this further this year, as the last-mentioned sum was not more than sufficient to meet the needs of the undertaking. The committee were, however, fully alive to the necessity of carrying the annual sum mentioned to the renewals fund whenever there were sufficient funds in hand to do so. The units sold during the year amounted to 9,029,741, being an increase of 728,993 over the previous year, and the lighting connections had also increased by an equivalent of 60,605 8-c.p. lamps. The output for power purposes had grown satisfactorily, showing an increase of 880,909 units over the preceding year. Having regard to the state of trade, this must be considered very satisfactory. Mr. Bennett called attention to the great saving to the consumer by the introduction of the new metallic lamps, as the more this was realised, he said, the more and more would people substitute the electric for other methods of illumination. He quoted the difference in the cost of lighting at the town hall to show the saving effected by the use of the new metallic lamps. From Jan. 9 to March 25, 1908, the cost of lighting was £175. 19s. 7d., and for the corresponding quarter this year £121. 2s. 7d., a reduction of £54. 17s. For the quarter March 25 to July 6, 1908, the expenditure on lighting was £94. 13s. 11d., while from March 25 to June 23 this year the cost was £49. 6s. 11d., a reduction of £45. 7s. After allowing for the few days short in this year's figures, there was a saving of at least 33⅓ per cent., while statistics also showed that the new lamps gave at least 100 per cent. more candle-power. In conclusion, Councillor Bennett referred in appreciative terms to the work done by the general manager and the staff of the Electric Light Committee during the year.

TRACTION.

Bacup.—The public opening of the electric tramways has been fixed for to-day, while the Board of Trade inspection is expected next Tuesday.

London Street Tramways Co.—The directors have paid an interim dividend of 2s. per share, free of income tax, on the ordinary shares for the past half-year.

Madras Electric Tramways.—The traffic receipts for the fortnight ending July 15 totalled Rs.19,829, against a total of Rs.17,817 for the corresponding period last year.

Morecambe.—The Town Council have decided to purchase the tramway undertaking from the old company, and the trams will pass into the possession of the Corporation on July 25.

Lowestoft.—At the last Council meeting the Tramways Committee reported that the receipts from Oct. 1 to June 22 had been £5 605, as compared with £6,210 in 1908, but there had been a decrease in expenses of £705. 10s.

Ayr.—The tramway takings for last week amounted to £375. 14s., showing an increase of £75. Cs. 1½d. as compared with the previous week, and an increase of £36. 1s. 4½d. as compared with the corresponding week last year.

Whitworth.—The Bill promoted by the Urban District Council, in which the authorities seek power to construct electric tramways to connect with the Rochdale tramways at Ending, has received the sanction of a committee of the House of Lords.

Darlington.—At the last meeting of the Rural District Council a letter had been received from the Board of Trade stating that after careful consideration they had extended the period for the making of the tramway line from the Round House in Darlington to Haughton-le-Skerne by two years.

British Columbia Electric Railway Co.—On July 31 next a dividend at the rate of 5 per cent. per annum will be paid on the 5 per cent. non-cumulative preferred ordinary stock for the half-year ended June 30, 1909, together with an additional dividend at the rate of 1 per cent. per annum for the same period.

Portland.—The Weymouth Town Council have appointed a deputation to confer with the Portland Urban District Council as to the desirability of a system of tramways between Weymouth and the Isle of Portland. Such a system would be in competition with the railway service, but would, it is believed, be a great public convenience.

West Bromwich.—A fatal tram accident occurred at Spon-lane, West Bromwich, last week, the victim being a little boy whose parents live in Arthur-street, Spon-lane. It appears that about nine o'clock the child ran right in front of the tram. Before the driver could pull up the car ran over him, inflicting injuries which must have caused his death immediately.

Bath.—At the last meeting of the Rural District Council the clerk stated that the Bath Tramways Co. had sent formal notice through their solicitors of their intention to apply for an extension of time for the construction of certain works in the Keynsham district, including the extension of the tramlines. The company obtained an order three years ago to construct an extension line to Saltford, but the time within which they were authorised to do the work was nearly expired, and they had not yet carried it out.

Kilmarnock.—At the last meeting of the Town Council a report was submitted from the electrical engineer and tramway manager which showed that during the past year there was a profit of £147. 14s. on the electric light and a deficit of £2,009 on the cars. A long discussion took place in regard to car fares and stops, and with the view of increasing the revenue it was agreed to issue return tickets between Kilmarnock and Hurlford at 3d. instead of 2d. either way. The question of rearranging the route from Riccarton to Beansburn was left over till September.

Oswaldtwistle.—The District Council have appointed Messrs. Hindle and Usher as a deputation to wait upon the Blackburn Corporation with reference to the introduction of ½d. fares between

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Spread Eagle and Church, and also for cheap tickets for children attending the day schools. The Council, after receiving the petition from the residents of West End district, wrote to the Blackburn Corporation on the matter, but the Corporation wrote expressing their inability to establish reduced fares. Hence the Council have appointed the deputation with a view to making further representations to the Corporation.

Laurieston.—As has been previously stated, the extension of the Falkirk and District Tramways to Laurieston goes on apace. The roadway has been prepared the entire length to Mary-square, Laurieston, for the reception of the rails, which are now forward. The British Insulated and Helsby Cables are proceeding with the overhead equipment, and a number of rosettes have already been attached to the buildings in High-street. In Falkirk Sheriff Court on Monday a petition at the instance of the Falkirk and District Tramway Co. for warrant to erect a rosette on a building in High-street owned by Mrs. Ferguson was presented. The owner objected to the warrant being granted, but on the Sheriff stating that evidence would require to be led the objection was withdrawn, and the application granted.

Bournemouth.—At a recent meeting the Corporation decided to place eight time recorders at various points on their tramway route to record the times the cars pass on both the up and down lines. The order was accordingly given to the International Time Recording Co., 151, 153, 155, City-road, London, E.C. Their tramway recorders are already in use by numerous corporations and private companies throughout Great Britain, and naturally enough the Bournemouth Corporation did not decide on their purchase without full investigation. The improved time keeping and more satisfactory service which become possible by the use of these tramway recorders, combined with the fact that they undoubtedly increase the number of fares, were considerations which brought the Council to decide that they were warranted in making the necessary expenditure for the machines.

Doncaster.—For the year ending March 31 the traffic receipts from the Corporation tramways were £12,477. 0s. 3d., as compared with £12,410. 4s. 11d. in the previous year. The cost of current was £3,615. 2s. 11d., as compared with £3,694. 11s. 5d. Traffic expenses amounted to £3,365. 11s. 2d., as compared with £3,437. 1s. 6d. The expenditure on permanent way was £910. 14s. 6d., as compared with £857; on cars £560. 15s., as compared with £528. 4s. 7d. The number of car miles run was 479,825, as compared with 494,548; the number of passengers carried was 2,866,912. as compared with 2,825,486; the average traffic revenue per car mile was 6·24d., as compared with 6·02d.; the percentage of working expenses to receipts was 81·0, as compared with 85·5; the total expenses per car mile were 7·20d., as compared with 7·05d.; and the average number of passengers per car mile was 5·9, as compared with 5·7.

Newcastle.—A special meeting of the Tramways Committee was held on Tuesday under the presidency of the chairman, Sir Joseph Ellis. The question of advertising on cars was dealt with and fully discussed. Tenders were received. The highest amounted to £3,750 on lease for seven years and the lowest to £2,100; while three tenders were sent in offering to work the advertising of the tramcars on commission, giving to the Corporation the income after deducting the commission. A long and animated discussion took place, and eventually it was proposed by Mr. C. C. Elliott and seconded by Mr. Binks that they recommend the Council to advertise upon the cars. On a vote being taken, the motion was carried by eight votes to seven. The question will now go to the Council to be finally decided upon. It was stated that by the time the rates and taxes had been paid, and taking the net advertising basis of the highest tender, it would leave a net income to the Tramways Committee of £2,840.

Light Railways Act, 1896.—The Board of Trade have recently confirmed the undermentioned orders made by the Light Railway Commissioners: (1) Lampeter, Aberayron, and New Quay Light Railway (Amendment) Order, 1909, authorising the abandonment of part of the light railway authorised by the Lampeter, Aberayron, and New Quay Light Railway Order, 1906, and the substitution of a new railway in the county of Cardigan, and for other purposes; (2) County of Middelsex Light Railways (Extension of Time) Order, 1909, reviving the powers granted and extending the periods limited by the County of Middlesex Light Railways (Lands) Order, 1903, the County of Middlesex Light Railways Order, 1903, and the County of Middlesex (Waltham Cross and Enfield) Light Railways Order, 1906, for the compulsory purchase of certain lands, and extending the periods limited by the last-named order of 1903 for the completion of certain of the light railways thereby authorised, and reviving the powers granted, and extending the periods limited by the said order of 1906 for the completion of part of the light railway thereby authorised.

Ilford.—At the last Urban District Council meeting the Tramways Committee presented the abstract of accounts to March 31. The deputy clerk read a report by the chairman of the Tramways Committee dealing with the accounts. In it Mr. Stroud expressed regret that for the first year since the tramways had been laid down the working had resulted in a loss, brought about, not through any fault of the Tramways Committee or of the management, but through circumstances which prevailed during the financial year. They had the motor-'bus competition to contend with, and to deal with that competition an increased service of trams was run on the High-road and Ilford-lane routes. They could not have an increased service without an increase in the running cost, and that, coupled with the fact that there was not a proportional increase in the traffic receipts, explained broadly the result of the year's working. He found that the expenditure for 1909 exceeded that of 1908 by £1,020, caused solely by the increased service. As to the traffic and other receipts, the decrease in 1909, as compared with 1908, had been £526. Those two figures showed exactly how the net profit in 1908 of £114 had gone and a net loss of £1,430 in 1909 had appeared.

Bradford.—The income from the working of the Corporation tramways shows a profit of £15,318 for the year ending March 31, as compared with £17,238 for the previous year, and this amount is carried to the reserve and renewals account. The total income for the year has been £246.489, against £246,110 in the preceding year—an increase of £379. There is an increase from the parcels department of £1,327, and this branch of the undertaking shows a surplus of £1,028, as compared with £1,200 in the previous year. The motor garage department shows a surplus of £39 and the Bowling shingle hill a surplus of £108, as compared with deficits in both cases of £155 and £203 respectively in the preceding year. The income for traffic is less by £331 and for advertising on cars by £718, the figure for the latter item being £2 469, as against £3,187 in the previous year. The most noticeable items on the expenditure side are the increased expenditure for current (£1,938), decreased expenditure on repairs and permanent way (£2,169), and for compensation in respect of accidents (£2,039). The actual amount paid in compensation during the past 12 months was £1,964, against £4,002 in the preceding year. The traffic income per car mile has been 10·33d., compared with 10·43d. in the previous year, and the working expenses have been 7·221d., against 7 262d. in the previous year.

Lincolnshire Light Railway Scheme.—Mr. E. H. Godson and Mr. H. Pattinson, J.P., met the members of the Sleaford Tradesmen's Association last week and entered upon full explanations as to the course of the proposed new line, and the estimated revenue and expenditure. Mr. Godson explained that not a penny subscribed would go in expenses unless the line were constructed, and he proceeded to give estimates of traffic, ascertained from returns made by residents. They expected to carry 45,000 tons of goods and 250,000 passengers yearly, and, judging by the Horncastle line, they could reasonably expect to pay 4 per cent. They were informed by expert authority that any line through a good agricultural district, which could be made at £10,000 per mile, was bound to pay, but the proposed line would not cost quite £7,000 per mile. The light railway would shorten the distance for all who wished to get from South Lincolnshire or the Midlands to the Louth district of the county, and would open up Woodhall Spa and Horncastle, the residents of which had both favoured the scheme. In reply to a question by Mr. Lawrence, Mr. Godson said he thought the residents should subscribe at least one-sixth of the capital (£20,000) before they could go to outside financiers. They did not anticipate any difficulty in getting the land. Mr. Pattinson said the order had been obtained cheaply, and the light railway would take the place of the navigation which they had lost. The cost of working this railway would be light, and no district needed one more than the country through which it would pass. He was convinced that the line would pay, and prove a great benefit to the towns connected with it. A resolution approving of the scheme was unanimously passed, and a committee was formed to canvass for support.

Darwen.—The revenue account for the Darwen section of tramways shows a gross profit of £3,574. 13s. 5d., and for the Hoddlesden section a gross profit of £49. 7s. 8½d., equal to 4 23 per cent. on a capital outlay of £85,565 at March 31, 1909, as compared with 5 per cent. for the previous year. The above is after allowing £900 for the Darwen section and £150 for the Hoddlesden section for depreciation. The Darwen section, after making provision for interest and sinking fund charges, and repayments of principal to the Public Works Loan Commissioners, shows a net loss for the year of £183. 4s. 4d., as compared with a net profit for the previous year of £242. 10s. 9½d. The Hoddlesden section, after making provision for interest and sinking fund instalments, shows a net loss for the year of £752. 13s. 8½d., as compared with a net loss for the previous year of £605. 9s. 1½d. The net loss standing to the debit of net revenue account for the Darwen section at March 31, 1908, was £1,196. 9s. 10d., to which has to be added the loss for the past year of £183. 4s. 4d.—making a total debit to profit and loss account for the Darwen section of £1,379. 14s. 2d. The net loss standing to the debit of net revenue account for the Hoddlesden section at March 31, 1908, was £722. 14s. 10d., which is increased by the loss for the past year of £752. 13s. 8½d., making a total debit to profit and loss account for the Hoddlesden section of £1,475. 8s. 6½d.; or a total debit to tramways profit and loss account of £2,855. 2s. 8½d. The total traffic expenditure for the past year for the Darwen section, including depreciation, has been £8,342. 8s. 5d., as compared with £8,145. 6s. 7d. for the previous year; and for the Hoddlesden section, including depreciation, the total traffic expenditure has been £1,582. 13s. 11d., as against £1,474. 4s. 1d. for the previous year.

PERSONAL.

Mr. Calvert, electrical engineer at Finchley, is to have his salary increased from £475 to £500 per annum.

The Epsom Urban District Council have appointed Mr. A. C. Gilling, who for some time has had charge of the electricity undertaking as acting engineer, to the position of resident electrical engineer at a salary of £200 per annum, with annual increments of £10 each to £250.

We learn that Mr. A. Henderson (late of Messrs. John Brown and Co., Clydebank) has been appointed electrical engineer to Messrs. Scott's Shipbuilding and Engineering Co., Greenock, to organise a new electrical department and to carry out all the electrical work on the new "Dreadnought" battleship H.M.S. "Colossus," which the firm is building. As we understand he has had considerable experience in this class of work in the famous Clydebank works of Messrs. John Brown and Co., we have no doubt but that he will be able to perform this work with credit to the firm he now represents.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

Altrincham.—Tenders are invited for an electrical installation at the new higher elementary school, Hale (deposit £1. 1s.). Particulars from the Clerk, Education Department, Altrincham, Cheshire. Tenders by July 30.

Saddleworth. — The Committee of the Saddleworth Mechanics' and Literary Institute invite tenders for relighting large hall. Particulars obtainable from Mr. C. W. Platt, secretary. Tenders must be sent in by July 26.

Pontypridd.—The Urban District Council invite tenders for the supply and delivery of one 500-kw. steam dynamo for the electric light and tramways department. Specification, etc., from the Clerk upon receipt of a deposit of £1. 1s. Tenders by July 27.

Manchester.—The Tramways Committee require a supply of lighting cable. Specifications and forms of tender obtainable from Mr. J. M. McElroy, general manager. Endorsed tenders must be sent to the Chairman of the Tramways Committee, 55, Piccadilly, Manchester, by July 27.

London, W.C.—The Postmaster-General invites tenders for creosoting telegraph poles. Forms of tender, containing all particulars, obtainable from Mr. G. Morgan, controller of stores, Stores Department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders must be sent in by Aug. 9.

Barnstaple.—The Board of Guardians invite tenders for installation of the electric light at the workhouse and cottage homes. Specifications and particulars obtainable from the Master, Union Workhouse, Barnstaple. Tenders must be sent to Mr. W. H. Toller, erk, Boutport-street, Barnstaple, by July 28.

Sunderland.—Tenders are invited for the supply of mackintoshes for motormen to the Corporation (Tramways Department). Particulars obtainable of the General Manager, Tramways Offices, Monkwearmouth, Sunderland. Tenders to the Chairman of the Tramways Committee, Town Hall, Sunderland, by July 29.

Manchester.—The Waterworks Committee invite tenders for the supply of about 940 tons of cast-iron water-pipes, 24 in. diameter, with about 20 tons of special castings. Specifications, etc., obtainable from the Secretary, Waterworks Offices, Town Hall, Manchester, on payment of 10s. (returnable). Tenders by July 31.

London.—The Directors of the Burma Railways Co. require 2,270 spoke wheels. Specifications and forms of tender obtainable at the Company's Offices, 199, Gresham House, E.C. For each specification a fee of 20s. will be charged, which will not be returned. Endorsed tenders, in sealed envelopes, must be sent in by July 27.

Bradford.—The Tramways Department invite tenders for eight automatic point controllers. Tender forms and further particulars obtainable from Mr. C. J. Spencer, tramways general manager, Tramway Offices, 5 and 7, Hall Ings, Bradford. Tenders to the office of Mr. Frederick Stevens, town clerk, Town Hall, Bradford, by July 30.

Blackburn.—The Electricity Committee invite tenders for the supply and delivery of steam coal for the 12 months ending Aug. 31, 1910. Specifications and forms of tender obtainable at the Electricity Works, Jubilee-street. Tenders, addressed to the Chairman of the Electricity Committee, must be sent to the Town Hall by July 26.

Londonderry.—The Commissioners invite tenders for the supply of ironmongery, ropes, oils, etc., for 12 months from Aug. 1, as per list to be had on application. No tender received unless on the prescribed form, to be obtained at the Secretary's Office. Tenders to Mr. James Stewart, secretary, 21, Shipquay-street, Londonderry, by July 27.

Keighley.—The Corporation invite tenders for two 1,000-kw. turbo-alternators with condensers and two water tube boilers. Specifications obtainable at the Borough Electrical Engineer's Office, Coney-lane, Keighley, on deposit of £1. 1s. (returnable). Tenders, addressed to the Chairman of the Electricity Committee, Town Hall, Keighley, must be sent in by Aug. 7.

Leicester.—The Tramway Committee invite tenders for the supply of motormen's, conductors', and parcel boys' overcoats for delivery in September. Sample coats can be seen on application to and tender forms obtained from Mr. A. F. Lucas, manager. Tenders, addressed Chairman, Tramways Committee, 20 and 22, Humberstone-gate, Leicester, must be sent in by July 26.

Bury.—The Corporation invite tenders for the supply and erection of three water-tube boilers, each capable of evaporating 25,000 lb. of water per hour. Copy of the specification and form of tender obtainable from Mr. S. J. Watson, M.I.E.E., engineer and manager, Electricity Works, Bury, on a deposit of £2. 2s. (returnable). Tenders to the Town Clerk, Bury, by Aug. 16.

Rotherham.—The Corporation invite tenders for the supply and erection of an electric motor and air compressor, to be fitted at the depôt in Rawmarsh-road. General specification and plan obtainable from the borough engineer, Mr. Ernest B. Martin, A.M.Inst.C.E., on a deposit of £1. 1s. (returnable). Tenders to Mr. W. J. Board, town clerk, Town Hall, Rotherham, by July 27.

Hull.—The Corporation invite tenders for the necessary electric and gaslight fittings required for the new public hall. Plans of the building can be seen and specifications obtained at the office of Mr. Joseph H. Hirst, city architect, Town Hall, Hull. Tenders and designs, addressed to the Chairman of the Property Committee, must be sent to the Town Clerk's Office, Hull, by July 28.

Dublin. — The Corporation require a 12 months' supply of machinery oils for the electricity works, Pigeon House Fort, Dublin. Copies of the specification, with conditions of contract (price 5s.), obtainable from Mr. H. Campbell, town clerk. Tenders, addressed the Chairman, Supplies Committee, City Hall, Dublin, must be sent to the Town Clerk's Office, City Hall, Dublin, by July 26.

London, W.—The Directors of the Great Western Railway Co. invite tenders for the supply of 110 tons of steel bridge girders and other iron and steel work of British manufacture. Plans and specification can be seen and forms of tender and bills of quantities obtained at the office of the Engineer at Paddington Station. Tenders to Mr. G. K. Mills, secretary, Paddington Station, London, by Aug. 2.

Small Heath.—The Directors of the Great Western Railway Co. invite tenders for the reconstruction of Golden Hillock-road Bridge, at Small Heath Station, near Birmingham. Plans and specification can be seen and forms of tender and bills of quantities obtained at the office of the New Works Engineer, Paddington Station. Tenders to Mr. G. K. Mills, secretary, Paddington Station, London, by Aug. 2.

Hull.—The Electric Lighting Committee invite tenders for the supply and laying of electric mains etc., required in connection with extensions during the period ending March 31, 1910. Forms of tender and specification obtainable on depositing £1. 1s. (returnable) with the city treasurer, Mr. T. G. Milner, Town Hall, Hull. Tenders to the Chairman of the Electric Lighting Committee, Town Hall, Hull, by July 29.

Dublin.—The Directors of the Midland Great Western Railway of Ireland Co. invite tenders for the supply of from 50,000 to 60,000 tons of best quality South Wales steam coal for locomotives, subject to specification. Form of tender and specification obtainable from Mr. R. L. Badham, secretary, Broadstone Terminus, Dublin. Tenders, addressed to the Chairman, Broadstone Terminus, Dublin, must be sent in by Aug. 3.

Eastbourne.—The Highways and Drainage Committee invite tenders for the supply of about 465 tons in all of cast-iron pipes, 4 ft. to 5 ft. internal diameter. Drawings and specification can be seen and forms of tender and copies of the specification obtained at the Borough Engineer's Office on payment of £3. 2s. (returnable). Tenders to Mr. A. Ernest Prescott, borough engineer, Town Hall, Eastbourne, by July 31.

London, E.—The Guardians of Mile End Old Town invite tenders for the supply of six Aron type wattmeters of the following description—viz.: watt-hour, shunted-pattern, switchboard meters, mounted in threes on two polished slate slabs, 3 ft. 4 in. by 3 ft. 8 in. by 1¾ in., with shunts fixed on back of slabs ready for connections and with cyclometer dials, and to be of 100-ampere capacity at 105 volts. Further particulars obtainable from the Master of the Workhouse.

Treforest.—The Pontypridd Urban District Council invite tenders for the formation of ponds and erection of retaining walls and pump-room at the Treforest generating station. Plans and specification can be seen and quantities and forms of tender obtained on application at the office of Mr. W. E. Lowe, engineer and surveyor to the Council, upon a deposit of £1. 1s. (returnable). Tenders to Mr. J. Colenso Jones, clerk, Municipal Buildings, Pontypridd, by July 26.

Leyton.—The Education Committee invite tenders for the electric wiring and fittings for an installation of electric light required at Sybourn-street School. Specification, conditions, and form of tender obtainable from Mr. William Jacques, A.R.I.B.A., of 2, Fen-court, Fenchurch-street, E.C., after July 20, which application must be accompanied by a deposit of £1 (returnable) Tenders must be delivered at the meeting of the Council to be held on July 27 at 7 p.m.

Coventry.—The General Works Committee invite tenders for the supply and erection complete of the constructional steelwork required for the bridge over the River Sherbourne Drawing and general conditions can be inspected and specification and bill of quantities obtained on deposit of £1. 1s. with the City Treasurer (returnable) on application to Mr. J. E. Swindlehurst, city engineer and surveyor, St. Mary's Hall. Tenders to the office of the Town Clerk, 10, Hay-lane, by July 26.

Gretna and Carluke.—The Directors of the Caledonian Railway Co. invite tenders for the work to be executed in the renewal of the superstructures of 10 underbridges on the main line between Gretna and Carluke. Drawing can be seen at the offices of the Company's District Engineer, Princes-street Station, Edinburgh, where copies of the specification and schedule can be obtained on payment of £2. 2s. (returnable). Tenders to Mr. J. Blackburn, secretary, 302, Buchanan-street, Glasgow, by Aug. 2.

Southport.—The Southport, Birkdale, and West Lancashire Water Board invite tenders for the supply and erection of two beam pumping engines, three Lancashire boilers, and other machinery required at the Bickerstaffe pumping station. Drawings can be seen and a copy of the specification with form of tender obtained at the office of Messrs. H. Rofe and Son, civil engineers, 8, Victoria-street, Westminster, S.W., upon a deposit of £5. 5s. (returnable). Tenders to Mr. Alleyne Brown, clerk to the Board, 11, St. George's-place, Lord-street, Southport, by Aug. 9.

Edmonton —The Guardians invite tenders for the supply and installation of a private telephone equipment at the infirmary, consisting of a 100 line switchboard with direct lines to different parts of the buildings, and operated by magneto generator, calling and clearing. Specification can be obtained of the Architect on payment of £1. 1s. (returnable). Plans can be seen during business hours at the offices of the architect, Mr. Stuart Hill, 106, Cannon-street, London, E.C. Tenders to Mr. F. Shelton, clerk, Lower Tottenham, London, N., by July 28.

Sheffield.—The Tramway Committee invite tenders for the installation of heating and hot-water supply apparatus at the proposed new car depôt, Shoreham-street. Specifications, forms of tender, and

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copies of the plans obtainable from the City Architect, Town Hall, Sheffield, on deposit of £1. 1s. (returnable). Tenders to Mr. R. M. Prescott, town clerk, Town Hall, Sheffield, by Aug. 5. The City Council's form of clauses respecting wages, hours, and conditions of labour and prohibition against assigning or sub-letting to be complied with, which can be seen on application at the Town Clerk's Office.

London, W.C.—Tenders are invited by the Postal Authorities for the supply of telegraph poles of (*a*) home-grown larch or fir; (*b*) Swedish, Norwegian, Finland, or Russian red fir. The poles are to be delivered at any one or more of the following ports as may be directed: London, Tilbury, Grimsby, Hull, West Hartlepool, North and South Shields, Ellesmere Port, Swansea, Cardiff, Newport, Southampton, Leven (Fifeshire), Ardrossan, Belfast. The poles to be felled during the winter of 1909-10, and to be delivered during the following summer. Butt sections, 2 in. thick, stamped with the shipper's or tenderer's mark from not fewer than three poles, to show the quality of the timber offered, must precede or accompany the tender of any person who has not already supplied the Postmaster-General with poles. Forms of tender, containing all particulars, obtainable from Mr. G. Morgan, controller of stores, Stores Department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders by Aug. 9.

COLONIAL AND FOREIGN.

Russia.—The Kharkoff Municipality invite tenders for the construction of electric tramways.

Cuba.—The Colon Municipality invite tenders for the erection and equipment of an electricity generating station.

Cadiz—The Harbour Board invite tenders for the supply of two automobile steam cranes. Tenders by Aug. 10.

Crete.—The Canea and Candia Municipalities invite tenders for the establishment of electric light and power supplies.

Victoria.—The Postmaster-General invites tenders for the supply of 5,000 telephones complete. Tenders by Aug. 10.

Holland.—The Directors of the State Railway invite tenders for the construction of a railway from Metslawier to Anjuin.

Cologne.—The Municipality invite tenders for the erection of four harbour cranes, electrically driven. Tenders by Aug. 25.

Rome.—The Minister of the Interior invites tenders for the construction of an electric tramway from Ponte Nossa to Clusone.

Vernon.—The Municipality invite tenders for the provision of two gas motors. Particulars from the Maire. Tenders by July 27.

Charlottenburg.—Tenders are invited for pumping machinery, boilers, crane, etc., by Aug. 4. Particulars from the Municipality.

Madrid.—The Public Works Department invite tenders for the construction of a line from Noguera to Pallarese. Tenders by Aug. 12.

New South Wales.—The Postmaster General invites tenders for the supply of 10 switchboards for 100 metallic circuits. Tenders by Sept. 10.

Russia.—Tenders are invited by the Governor of Jekaterinoslaw for the lighting of the streets of Bachmut by electricity. Tenders by Sept. 13.

Saarbrucken.—The Prussian State Railways invite tenders for pumps and compressors by Aug. 3. Particulars from K. Eisenbahn Direction.

Bukarest.—Tenders are invited for the supply of copper tubes for locomotives and tenders for the Roumanian State Railways. Tenders by Aug. 9.

Prahran.—The Prahran and Malvern Tramways Trust invite tenders for the supply complete of 12 electric tram-car bodies. Tenders by Aug. 27.

Brussels.—The Belgian State Railways Department invite tenders for the construction of a section of the Schaerbeck-Hal line. Tenders by Aug. 14.

Brussels.—Tenders are invited for the construction of a section of the Soire sur-Sambre to Bersillies for the Vicinal Railways. Tenders by Aug. 17.

Madrid—The Public Works Department invite tenders for the construction of a narrow-gauge line from Petro Abad to Martos. Tenders by Aug. 28.

India.—The South Indian Railway Co. invite tenders for the construction of a railway from the Ferry Station at Danish Koti to Rameswaram.

Liege.—Tenders are invited for an electric supply installation at Hollagm-aux-Pierres. Particulars from the Communal Secretary. Tenders by July 27.

Wilhelmshaven.—Tenders are invited for the supply of broad-gauge ammunition railway wagons to the Marine Artillery Depôt. Tenders by July 31.

Madrid.—Tenders are invited by the Public Works Department for the construction and working of a railway from Villajoyoso to Denis. Tenders by July 31.

Madrid.—The Public Works Department invite tenders for the construction of a narrow-gauge line from Fortuna to Caravaca. Tenders by Sept. 4.

Rome.—Tenders are invited for 600 mounted axles for goods wagons for the Italian Government Railways. Tenders by Aug. 8 to Ferrovie dello Stato.

Dresden.—The Municipal Council invite tenders for the supply of two 700-kw. single-phase alternating-current dynamos, switchgear, etc. Tenders by Aug. 4.

Bukarest.—The Roumanian State Railways Department invite tenders for the supply of copper tubes for locomotive and tender funnels. Tenders by Aug. 19.

Rome.—Tenders are invited by the Italian Government Railways for 50,000 kilos mild-steel plates for boilers. Particulars from Ferrovie dello Stato. Tenders by Aug. 1.

Paris—Tenders are invited by the Under Secretary for Posts and Telegraphs, 103, Rue de Grenelle, for 75 stamping machines worked by electric motors. Tenders by Aug. 18.

Brussels.—Tenders are invited for the annual supply of accessories of Vignoles rails for the Belgian State Railways. Specification from 11, Rue de Louvain. Tenders by July 31.

Russia.—The Department of Ways and Communications of St. Petersburg invite tenders for the construction of the western section of the Amur Railway from Ourume to Kerok.

Paris.—Tenders are invited for 10 lots of telegraph and telephone subscribers' material. Tenders by July 25 to the Under Secretary for Posts and Telegraphs, 103, Rue de Grenelle, Paris.

Brussels.—The Directors of the Belgian State Railways invite tenders for the supply of steel washers and other materials. Specifications from 11, Rue de Louvain. Tenders by Aug. 18.

Narvik.—Tenders are invited by the Commissioners of the Norwegian State Railways for the supply of 15 tons of firebars. Particulars from Ofotenbahn, A. Tenders by July 30.

Alicante.—The Harbour Commissioners invite tenders for the supply of three centrifugal pumps and three gas-motors. Particulars from Junta de Obras del Puerto. Tenders by Aug. 12.

Brussels.—Tenders are invited by the Société des Chemins de Fer Vicinaux for extensions of lines, etc., at Bressaux-Trou-Loette. Particulars from 14, Rue de la Science. Tenders by Aug. 3.

Paris.—Tenders are invited by the Direction de la Manufacture d'Aimes, at Châtellerault (Vienne), for cables, copper wire, and dynamo construction material (11 lots). Tenders by Aug. 11.

Hanover.—The Prussian State Railways invite tenders for copper sheets, copper plates, copper bars, copper tubes, and copper wire. Particulars from K. Eisenbahn-Inspection. Tenders by July 30.

Winnipeg.—Tenders are invited for the hydraulic and electric equipment of the generating station now under construction on the Winnipeg River at Thirty foot Falls. Tenders by Aug. 2 and 16.

Brussels.—Tenders are invited for the supply of tirefonds, bolts, and nuts to the Belgian State Railways Department. Specification No. 237 can be obtained from 11, Rue de Louvain. Tenders by Aug. 4.

Robida.—The Public Works Department, Madrid, invite tenders for the construction of a railway to Robida. Particulars from the Direccion de Obras Publicas, Ministerio de Fomento. Tenders by Aug. 20.

Rome.—Tenders are invited for the supply of electric cable to the Italian Government Railways Department. Particulars from Ferrovie dello Stato Segretariato Generale, Sezione Contratti. Tenders by Aug. 10.

Victoria.—The Postmaster-General invites tenders for the supply and delivery at the post office, Hawthorn, of eight sections of a common-battery switchboard and subscribers' apparatus. Tenders by Sept. 14.

Brussels.—Tenders are invited by the Commissioners of the Belgian State Railways for spare parts in connection with carriage and wagon construction. Specifications from 11, Rue de Louvain. Tenders by July 28.

Brussels.—Tenders are invited for the supply of insulators, phosphor-bronze wire, and other electric lighting material for Tournia lighting. Specification from 15, Rue des Augustins. Tenders by July 28.

Alexandria.—Tenders are invited for the supply and erection of cast-iron grooves for the regulator under construction on the Rayah Behera. Particulars from the Inspector of Irrigation. Tenders by July 26.

Santa Croce.—The Municipality of Santa Croce, Tenerifa, invite tenders for the provision of suction dredger and pontoon with steam-engine. Particulars from the Junta de Obras del Puerto. Tenders by Aug. 27

Santiago.—Tenders are invited by the Chilian Railways Department for the supply of rails, fishplates, dog-spikes, and bolts. Particulars from the Direccion-General de Obras Publicas. Tenders by Sept. 1.

Belgium.—Tenders are invited by the Direction Générale des Ponts et Chaussées for the equipment of a transformer sub-station at the harbour at Ostend. Tenders by Aug. 4 to the above-named at 38, Rue de Louvain.

Wevelghem.—Tenders are invited by the Vicinal Railways Department, Brussels, for the construction of a line to Wevelghem. Specification, price 10d., can be obtained from 14, Rue de la Science. Tenders by Aug. 4.

Brussels.—Tenders are invited for the construction of a section of the Vicinal Railways from Anderlues to Lobbes. Particulars from Direction Générale des chemins de fer Vicinaux, 14, Rue de la Science. Tenders by Aug. 24.

Madrid.—The Public Works Department invite tenders for the construction and exploitation of electric tramways in Barcelona. Tenders by Aug. 27. Particulars from Ministerio de Fomento, Direccion de Obras Publicas.

Paris.—The Directors of the Railways de l'Etat invite tenders for doubling the section of the French State Railways from Argentan to Flers of the Paris de Granville line. Papers from 42, Rue de Châteaudun. Tenders by July 29.

Spain.—The Direccion General de Obras Publicas, Madrid, invites tenders for an electric tramway concession for 60 years (between

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Monachil and the suburbs of Gabia Grande, Granada Province). Tenders, with £130 deposit, by Aug. 26.

Bukarest.—Tenders are invited for steel bars for bolts, etc., mild hammered steel for machinery parts, also steel for tools, for the Roumanian State Railways. Particulars from the General Director of Roumanian Railways. Tenders by Aug. 3.

New South Wales.—The Postmaster-General invites tenders for the supply, delivery, and erection of a branching multiple-magneto switchboard at the Edgecliffe telephone exchange in accordance with Specification No. 247. Tenders by Sept. 29.

Barcelona.—The Public Works Department, Madrid, invite tenders for the construction and exploitation of electric tramways in Barcelona. Particulars from the Direccion-General de Obras Publicas, Ministerio de Fomento. Tenders by Aug. 27.

Madrid.—The Public Works Department invite tenders for the construction and exploitation of an electric tramway between Monarhil and the suburbs of Gabia Grande, Granada. Particulars can be obtained from the Commercial Intelligence Department of the Board of Trade. Tenders by Aug. 26.

Santiago.—The Chilian State Railways invite tenders for the supply of five locomotive tenders, in accordance with the specifications, which can be obtained at the Servicio de Materiales, Santiago. A deposit of 500 pesos (£37. 10s.) for each locomotive tender will be required to qualify any tender. Tenders to the office of the Dirección Jeneral de los Ferrocarriles del Estado, Santiago, by July 31.

Buenos Ayres (Argentine).—The Ministry of Public Works invite tenders for the supply of seven locomotives for the Patagonian Railways, in accordance with plans and specifications (in Spanish), copies of which can be seen on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C. Tenders to the Direccion General de Ferrocarriles, Buenos Ayres, by Aug. 21.

Adelaide.—The Municipal Tramways Trust invite tenders for the erection of buildings for power station on the site of Ocean Steamers' Wharf, Port Adelaide. The sum of 10 guineas will be charged per copy of specification, which will only be refunded on receipt of *bona fide* tender and return of specification. Particulars from Mr. H. C. Mais, 31, Queen-street, Melbourne. Tenders to Mr. W. G. T. Goodman, chief engineer and general manager, 8, King William-street, Adelaide, by July 27.

Honefoss (Norway).—The Commercial Intelligence Branch of the Board of Trade are notified that tenders are invited by the Norwegian State Railways for the supply of pumps with motors. Tenders, marked "Anbud paa pumpeverk," must be delivered at Overingeniorens Kontor, Honefoss, Norway, by July 25. Copies of the specification and conditions of tender, together with drawings, can be inspected by British makers on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

Melbourne (Australia).—The Corporation invite tenders for the supply of one overhead travelling crane. Tender form, conditions of tendering, specification, and plans, etc., can be obtained on application to Messrs. McIlwraith, McEacharn, and Co., Billiter-square-buildings, London, E.C., agents for Melbourne City Council, by depositing the sum of £1. 1s., which amount will be returned on receipt of a *bona fide* tender. Tenders to the Chairman, Electrical Supply Committee, Town Hall, Melbourne, by 2 p.m. on Aug. 4.

Brisbane (Australia).—The Board of Waterworks invite tenders for the supply of 42-in. and 48 in. steel pipes, or alternatively 42 in. and 48-in. wrought-iron pipes or 42 in. and 48-in. cast-iron pipes. The whole of the material to be used in the manufacture of the pipes must be the product of the United Kingdom or of the Commonwealth of Australia. Specifications and drawings can be obtained on application at the office of the Engineer to the Agent General for Queensland, 409 and 410, Strand, London, W.C., on payment of a fee of £3. 3s. Tenders must be sent to the Secretary, Brisbane Board of Waterworks, Brisbane, Queensland, by Sept. 1.

Rome (Italy).—The Rome *Gazzetta Ufficiale* of June 17 announces that tenders are invited for the construction of the Ostiglia Nogara section of the Bologna-Verona Railway, nine miles long, and of various junctions. The upset price is placed at 3,650,000 lire (£146,000), and the competition will turn on the percentage of reduction offered thereon. To qualify any tender a deposit of 182,000 lire (£7,280) will be required, to be increased by the successful tenderer to 365,000 lire (£14,600). Tenders must be enclosed in sealed envelopes, marked on the outside "Offerta per Asta: tronco Ostiglia-Nogara," and addressed to Direzzione-Generale delle Ferrovie dello Stato (servizio 1, ufficio contratti), *via* Ludovisi 4, Rome, where they will be opened on July 31. Tenderers will be required to furnish certificates of competency. The award in respect of this competition will no doubt involve the purchase of a substantial quantity of permanent-way material, which may have to be obtained wholly or in part out of Italy. The *Gazzetta*, containing further particulars, can be seen by British firms interested on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall street, London, E.C.

RESULTS OF TENDERS.

Swinton.—The tender of Callender's Cable and Construction Co. has been accepted, at £181, for cables.

Dundee.—The Town Council have accepted the tender of the Union Cable Co., London, N., for supply of cables.

Colwyn Bay.—The tender of Chamberlain and Hookham has been accepted for ordinary and prepayment meters.

King's Lynn.—The Town Council have accepted the tender of Myers, Rose, and Co. for coal for the electricity works.

Tralee (Ireland).—The Urban District Council have accepted the tender of W. Steele, Athlone, at £125, for renewals to retorts.

Droxford.—The Rural District Council have accepted the tender of Wheatley, Wickham, at £52. 18s., for the supply of cast-iron pipes.

Rotherham.—For an electrical installation at the High School, for the Town Council: Felgate and Storey, Reading, £225 (accepted).

Rotherham.—The Borough Council have accepted the tender of Halley's Engineering Co., at £685, for the supply of a motor tower wagon.

Mansfield.—The tender of Messrs. Green for the extension of the economiser has been accepted at the sum of £159 by the Town Council.

Erith.—For the installation of new improved heating apparatus at the Central School, for the Education Committee: J. Grundy, £120 (accepted).

London.—The Metropolitan Water Board have accepted the tender of Glenfield and Kennedy, at £450, for an electric water-level indicator.

Maidenhead.—The Town Council have accepted the tender of the Diesel Engine Co. for the supply of a 150 kw. Diesel-E.C.C., generating set.

Southport.—The Education Committee have accepted the tender of R. A. Ault and Sons to supply and fix electric bells at the infants' and mixed school blocks for the sum of £35.

Battersea.—The London County Council have accepted the tender of W. Cannon and Sons, at £334. 10s., for providing and fixing two new boilers at the Lavender Hill Schools.

Birkenhead.—The Corporation have accepted the tender of W. B. Dobell and Co., Birkenhead, for the supply of small coal, delivered at the electricity generating stations.

Coupar Angus.—The School Board have accepted the offer of James Keith, Blackman, and Co., Arbroath, at £224, for the installation of a heating apparatus throughout the school.

Adelaide (Australia).—The tender of J. P. G. Brill Co., Philadelphia, U.S.A., £36,673, has been accepted for the supply of 50 car bodies in connection with the tramway system.

Fareham.—The Urban District Council have accepted the tender of the British Insulated and Helsby Cables for the supply of cables, and that of the Union Electric Co. for the supply of lamps.

Salford.—The Town Council have accepted the tender of E. Wood and Sons, at £36, for the supply and erection of a steel gallery at the works in connection with the switchboard extension work.

Norwich.—For improving the heating at Nelson-street Junior School and Surrey-road Boys' School, for the Education Committee: Barnards, Limited, £12. 10s. and £33. 5s. respectively (accepted).

London.—The London County Council have accepted the tender of Hurst, Nelson, and Co., S.W., for the supply of 260 top landing-boards for use in the tramways department of the County Council, at 3s. 6d. a board.

London, N.—The Stoke Newington Borough Council have accepted the tender of the Reason Manufacturing Co. for demand indicators, and that of Crompton and Co., at £150, for the provision and erection of a balancing machine.

Carlisle.—The Town Council have accepted the following tenders: Willans and Robinson, turbo-generator and condensing plant, £3,035; Underfeed Stoker Co., automatic stoker gear, £1,076; Gordon and Co., superheaters, £395.

Bermondsey.—The Electricity and Street-Lighting Committee of the Bermondsey Borough Council have accepted the tender of Davidson and Co., Egypt House, New Broad-street, for the supply of a high-pressure steel-plate forced-draught fan, also a steel-plate exhaust fan.

Worksop.—The Urban District Council have accepted the following tenders: W. T. Glover and Co., cables, as per specification, £354; J. P. Hall and Sons, Peterborough, repairs to condenser pump valve chests, £9. 15s.; Everett, Edgcumbe, and Co., two illuminated dial voltmeters, £7. 8s. 6d.

Devonport.—The Town Council have accepted the tender of Callender's Cable and Construction Co. for lead-covered and paper-insulated cables; Siemens Bros. and Co. for rubber-covered wires, flexibles; the Reason Manufacturing Co. for house main fuse boxes; Kenneth Ling for lubricating oils; and that of Ferranti Limited for direct-current meters.

Bedford.—The Town Council have accepted the tender of Edwin Danks and Co., Oldbury, for the supply and erection of one 30 ft. by 8 ft. Lancashire boiler, with superheater and pipework, at the price of £659. 10s.; and that of W. H. Allen, Son, and Co. for the supply and erection of the condensing plant and pipework now required to be installed at the works for the sum of £1,169. 5s.

London, S.E.—The Southwark Borough Council have accepted the following tenders: John Marsland and Son, erection of a battery-room, £1,120; Electrical Power Storage Co., erection and maintenance of a battery for 15 years, £247; Heenan and Froude, supply and fixing of four superheaters, £420; Western Electric Co., 110 yards of paper-insulated and lead covered cables, £56.

London.—The following tenders have been accepted: Western Electric Co., supplying and laying feeder cables in connection with the new power station at Blackfriars; General Electric Co., supplying and installing telephone exchange equipment at Willesden; British Insulated and Helsby Cables and London Electric Wire Co., and Smith's, Limited, J. Wilkes, Sons, and Mappleback, hard-drawn copper wire; T. Bolton and Sons, copper wire annealed; Jones and Attwood, bends, split, and couplings; Gell Telegraphic Appliance Syndicate, keyboard perforators.

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Aberdeen.—The Harbour Board have accepted the tender of Vickers, Sons, and Maxim, Barrow-in-Furness, at £49,250, for the construction of the new sectional pontoon floating dock.

Swansea.—The Harbour Trust have accepted the following tenders for the plant required for lighting and power purposes at the new King's Dock: Willans and Robinson, turbo-generators, alternators, and condensers; Crompton and Co., switchboards and sub station equipment; H. and T. Danks (Netherton), boilers.

London.—The London County Council have received the following tenders for the supply and fixing from time to time as required of not less than 1,000 and not more than 3,000 hydrant indicator tablets: Griffiths and Browett, 46, Gray's-inn-road, W.C., square single tablets 11d. each, oval single tablets 1s. 1d., and double or corner tablets 1s. 4d. (recommended for acceptance); S. Pontifex and Co., Regnart-buildings, Euston-street, N.W., 1s. 6d., 1s. 6d., and 2s.

London, S.E.—The London County Council have received the following tenders for the necessary wiring and fittings required for an electric lighting installation at the New Cross fire station:

Tilley Bros., 53, Kingsland-road, Shoreditch*	£191
W. Leonard and Co., 4, Soho-street, Oxford-street	197
G. E. Taylor and Co., 8, Bush-lane, E.C.	257
J. Bryden and Sons, 90, Gloucester-road, Queen's-gate	282

Chief engineer's estimate, £295. * Recommended for acceptance.

Stoke-under-Ham.—The following tenders have been received for heating apparatus at the new Wesleyan Chapel and School:

W. H. Chant	£74 10 0
Green	74 0 0
Haden and Sons	70 0 0
W. Sparrow, Limited	67 10 0
Crispin and Sons	64 10 0
Yandle and Sons	60 0 0
Saunders	59 17 0
Skinner, Board, and Co.	59 17 0
Weech and Sons	55 10 0
A. H. Skinner and Co., Bristol (accepted)	54 0 0

London, S.E.—For the supply of about 130,000 tons of coal required for the Greenwich generating station for the 12 months ending July 31, 1910, for the London County Council: W. Cory and Son, Mark-lane, E.C., 130,000 tons at 11s. per ton*; J. Hudson and Co. (London), Fenchurch-street, E.C., 130,000 tons at 11s. 2d.; Rickett, Cockerell, and Co., Trinity-square, E.C., 60,000 tons at 11s. 5d., 70,000 tons at 12s. 7d.; Myers, Rose, and Co., Eastcheap, E.C., 15-20,000 tons at 11s. 1d., 20-25,000 tons at 12s.; Dinham, Fawcus, and Co., Coal Exchange, E.C., 25,000 tons at 11s. 5d.; Harrison, Hardman, and Co., Great St. Helens, E.C., 20,000 tons at 11s. 6d., 30,000 tons at 12s. 9d.; P. Speakman and Sons, East India-avenue, E.C., 20,000 tons at 12s. 3d., 10,000 tons at 11s. 10d.; Phillips and Co., Coal Exchange, E.C., 20-30,000 tons at 12s. 3d.; A. Blackmore and Co., Cornhill, E.C., 30,000 tons at 12s. 9d., 20,000 tons at 11s. 9d.; Cleeves and Co., Lime-street, E.C., 130,000 tons at 12s. 10d.; Harrison, Tidswell, and Co., Mark-lane, E.C., 20,000 tons at 13s. 6d.; Charrington, Sells, Dale, and Co., Ratcliff, E., 20-25,000 tons at 14s. 3d. * Recommended for acceptance.

PROVISIONAL PATENTS, 1909.

JULY 9.

16029. Improved unidirection current dynamo-electric machine. Roughsedge Wallwork, Charles Henry Wallwork, and Bernard Joseph Shillito, 64, Barton-arcade, Manchester.

16039. Improved means for electrically igniting miners' safety lamps. Joseph Prestwich, 4, St. Ann's-square, Manchester. (Complete specification.)

16076. Process for the production of a metallic connection between incandescent filaments and their leading-in wires. Pope's Electric Lamp Company, Limited, 322, High Holborn, London. (Dr. Carl Trenzen, Germany.)

JULY 10.

16095. Improvements in electromagnetic clutches. Claude William Hill, 9, Queen Anne's-gate, Westminster.

16112. Antiseptic telephone mouthpiece. Bertram Archer and John de Coster, 89, Abbey-road, St. John's Wood, London.

16114. Improvements in the controlling mechanism of automatic electric lifts. Electromotor Equipment Company, Limited, and Alfred James Barlow, 6, St. Bride-street, Ludgate-circus, London.

16117. Improvements in and relating to electric impulse or step-by-step clockwork mechanism. Isaac Hardy Parsons and Alfred Ernest Joseph Ball, 38, St. Saviour's-road East, Leicester.

16119. Improved electric cable union coupling. Walter Harry Mansell, George Craggs Craggs, and James Alfred Hunton, 6, Finkle-street, Stockton-on-Tees.

16134. Improvements in electric arc lamps of the enclosed type, whereby they are made suitable for use in photography when a non-fluctuating light is required in one direction and a limited space only is available. Westminster Engineering Company, Limited, and Arthur George Way, Victoria-road, Willesden Junction, London.

16143. Automatic switch for use with auto-transformers, auto-balancers, or transformers for the prevention of no-load losses. William Bonnella, 9, Great Percy-street, King's Cross, London.

16146. Preparation of material for the construction of fold-up boxes for holding incandescent electric lamps. Mary Isabel Cooper, 4, Mitre-court, Temple, London.

16155. Improved device for automatically stopping electrically-driven rotary printing presses when the folding cylinder is choked. Francis Norman Pickett and Adams Manufacturing Company, 11, Southampton-buildings, London.

16167. Improvements in or relating to the control of induction motors. Maurice Milch, 83, Cannon-street, London. (Application for patent of addition to No. 1457/07.)

16170. Improvements in alternating-current dynamo-electric machines. Louis John Hunt and Sandycroft Foundry Company, Limited, 6, Lord-street, Liverpool.

16174. Improvements relating to enclosed electrical machines. Henry Alexander Mavor and Mavor and Coulson, Limited, 45, Lincoln's-inn-fields, London.

16177. Improvements in and connected with telegraphic recorders and relays. Axel Orling, 22, Southampton-buildings, London.

JULY 12.

16205. Improvements in direct-current and alternating-current balancers, boosters, and auto-transformers. Alfred Mills Taylor, Avondale, Ashfield-road, King's Heath, Birmingham.

16222. Arc lights with permanent metallic electrodes. Henry Andrew Kent, The Poplars, Maidstone-road, Bounds Green, London.

16224. Improvements in the production of compounds of oxygen and nitrogen by electrical means. Paul Bunet and Adrien Badin, 60, Queen Victoria-street, London. (Date applied for under Section 91 of the Act, Aug. 17, 1908, being date of application in France.) (Complete specification.)

16225. Improvements in apparatus for the production of electric arcs, intended for the formation of compounds of oxygen and nitrogen. Paul Bunet and Adrien Badin, 60, Queen Victoria-street, London. (Date applied for under Section 91 of the Act, Nov. 30, 1908, being date of application in France.) (Complete specification.)

JULY 13.

16273. Improvements in automatic electric switches. Thomas Ferguson, 1, The Mount, Altrincham.

16292. Electric arc lamps. Paul Albert Messenie and William Edwin Slaughter, 154, St. Vincent-street, Glasgow. (Complete specification.)

16304. Improvements in reflectors for lamps. Sherard Osborn Cowper-Coles, 82, Victoria-street, Westminster.

16309. Production of lighting effects on the stage by means of high-tension currents of high frequency. Ferdinand Zhaniel, née Camille Feher, 20, High Holborn, London. (Date applied for under Section 91 of the Act, July 16, 1908, being date of application in Germany.) (Complete specification.)

16328. Improvements in or relating to the manufacture of incandescence lamp filaments. C. Heinrich Weber, 37, Furnival-street, Holborn, London. (Complete specification.)

16331. Electric transmission for motor vehicles. William Morrison, Chancery-lane Station-chambers, London. (Complete specification.)

16332. Improvements in electricity meters. William Harry Johnson and Arthur Marston Billington, 46, Lincoln's-inn-fields, London.

16341. Improvements relating to the lighting of gas burners electrically. Marcel Delage and Paul Woog, 24, Southampton-buildings, London. (Date applied for under Section 91 of the Act, July 13, 1908, being date of application in France.) (Complete specification.)

JULY 14.

16405. Combined massaging and magneto-electric machine. Fred Burks, 55, Market-street, Manchester.

16415. Improvements in valves or rectifiers for high alternating potential differences. Ernest Wilson and William Hamilton Wilson, 64, St. John's-park, Blackheath, London.

16447. Improvements in dynamo-electric machinery. Albert Henry Midgley and Charles Anthony Vandervell, 1, Queen Victoria-street, London.

16457. Improvements in or relating to apparatus for winding frames, coils, and similar parts of electric machinery with insulating material, and for manufacturing structures from the same material. Emil Hafely, 111, Hatton-garden, London. (Complete specification.)

JULY 15.

16475. Multiplex accumulator. Henry George Carter, 45, Rectory-road, Salisbury.

16476. Improvements in electrically-driven centrifugal fans. Alldays and Onions Pneumatic Engineering Company, Limited, and Edward Livingstone Jocelin, 35, Temple-row, Birmingham.

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16502. Electrical indicator movements for signalling and the like and methods of actuating or operating the same and their application. William Cranswick Laidler and Thomas Edward Ritchie, Nutsford-vale, Pink Bank-lane, Longsight, Manchester.

16520. Improvements in connection with telephone and other similar mouthpieces. William Boothman Tattersall, 55, Chancery-lane, London.

16522. Improvements in methods of charging and discharging electric accumulators or secondary batteries. Alfred Mills Taylor, Avondale, Ashfield-road, King's Heath, Birmingham.

16537. Improvements in and relating to electric motor-starting switches. Siemens Bros. Dynamo Works, Limited, and Ernest Schupp, Caxton House, Tothill-street, Westminster. (Complete specification.)

16538. Improvements in and relating to the bearings of electricity meters. Siemens Bros. Dynamo Works, Limited, Caxton House, Tothill-street, Westminster. (Siemens-Schuckertwerke G. m. b. H., Germany. (Complete specification.)

16547. Improvements in electric heaters. F. W. Forbes Ross, Birkbeck Bank-chambers, Southampton-buildings, London.

16552. Improvements in and relating to electrical generating plant. J. Stone and Co., Limited, and Charles Henry Vidal, 77, Chancery-lane, London.

16558. Improvements relating to devices for producing electrical oscillations. William Edward Lake, 7, Southampton-buildings, London. (Polyfrequenz Elektricitats, G. m. b. H., Germany.) (Complete specification.)

16559. Improvements in or relating to the control of induction motors. Maurice Mirch, 83, Cannon-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on July 29.)

1908.

14483. Soldering of the metallic filaments of electric lamps to their electrodes. Marietti. (Date applied for under International Convention, July 8 1907.)

14513. Starting switch for electric motors. Timar and Von Dreger. (Date applied for under International Convention, Aug. 19, 1907.)

14530. Magnetic clutches. Ravenshaw, Middleton, and Townsend.

14700. Regulation of electric motors. British Thomson-Houston Company and Garton.

15100. Process for rendering artificial stone, mortar, plaster, and the like waterproof, heat and electricity non-conducting, and sound-proof. Kathe.

16298. Electromagnetically-operated switches. British Thomson-Houston Company. (General Electric Company.)

16529. Storage batteries. Bimeler.

18812. Spark distributors for use in electrical ignition apparatus for internal-combustion engines. Deniéport.

20877. Holders, sockets, or like attachment fittings for electric lamps. Bayliss.

21586. Measuring instruments for alternating currents according to Paalzow-Rubens bolometric principle. Lux. (Rights under Section 91, Patents, etc., Act, 1907, not granted.)

22345. Portable switch or key for electric flash signalling purposes. Davey.

25279. Universal joints or couplings for electric light fitting and other purpose. Thursfield.

27436. Electric signalling system. Blackall and Jacobs.

1909.

1270. Telephone exchanges. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

2642. Machines for electrically welding chains. Akt.-Ges. Stahlwerke Weissenfels vorm. Goppinger und Co. (Date applied for under International Convention, Feb. 3, 1908.)

3280. Life-guards for electric tramcars and the like vehicles. Johnson and Steele Brown.

3567. Means for safe locking power-driven railway signals, points, and the like. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

5018. Trolleys or rotary collectors for electric cables. Bennett, Estes, and Evans.

5413. Apparatus for measuring alternating electric currents. Guggenheimer and Gosser.

6106. Electrical resistances applicable for electric heating, cooking, and other purposes. Cooper and Sharp.

6878. Telephone installations. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

7630. Transformers for operating vapour-electric apparatus. Conrad. (Date applied for under International Convention, April 10, 1908.)

8108. Heating coil protecting devices for weak current electrical circuits. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

9592. Switch plugs for telephone exchanges. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos 1-70,000	1	–	⅛-⅜
—— Ord., 1,125,000	1	–	⅛-⅜
Anon Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	⅜-½
—— Ordinary, Nos. 1-125,000	1	–	⅜-½
British Aluminium Co., Ordinary, 2,001-40,000	5	–	⅛-⅜
—— 7 per cent. Cum. Pref., 1-40,000	5	–	1¼-1⅜
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	–	3-3¼
—— 4 per cent. Funding Certificates, 1-20,000	5	–	2½ 3/32
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	82-87
—— 5½ per cent. Loch Leven Deb. (Reg.), Red., 1-3,000	100	–	94 99
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	7⅜-7⅞
—— 6 per cent. Cum. Pref., 1-100,000	5	–	6⅛-6⅜
—— 4½ per cent. Mortgage Debentures	100	–	103 106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	91-96
British Westinghouse Elec. and Manuf. 10 per cent. Pref. 275,001-475,000	3	–	3/16-7/16
—— 4 per cent. Mortgage Debenture Stock	100	–	38-42
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	–	0-⅛
—— Non. Cum., 6 per cent., Pref.	2	–	0-⅛
—— 4½ per cent. 1st Debenture Stock	100	–	43-48
—— 4½ per cent. 2nd Debenture Stock	100	–	27-31
Callender's Cable, Debentures	100	–	105-107
—— Ordinary	5	–	9½-10½ xd
—— 5 per cent. Pref.	5	–	5⅛-5½
Consolidated Electrical Co., Ordinary, 1-110,000	1	–	7/16-9/16
Crompton and Co., Nos. 1-85,500	3	..	½-1
—— 5 per cent. 1st Mort. Reg. Debs., Nos. 1-900 of £100, and 901-1,100 of £50, Red.	—	..	91-94
Dick, Kerr, and Co., Ordinary, 1,250,000	1	–	1 1/16-1⅛
—— 6 per cent. Cum. Pref., 1-305,000	1	–	1 3/32-1 7/32
—— 4½ per cent. Debenture Stock, Red.	100	–	99-102 xd
Edison and Swan United, 'A" Shares, 1-99,261	5	–	⅜-⅝
—— "A" Shares, 01-017,139	5	–	1½-2½
—— 5 per cent. Debentures	100	..	68-73
—— 4 per cent. Deb. Stock, Red.	100	..	93-96
Electric Construction, Nos. 1 to 112,100	2	..	7/16-½
—— 7 per cent. Cumulative Pref.	2	..	1 7/16-1 11/16
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	63-67
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	71-77
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	7⅛-7½ xd
—— 4 per cent. 1st Mort. Deb. Stock	100	..	85-88
W. T. Henley's Telegraph Works, Ordinary	5	..	11¾-12½
—— 4½ per cent. Preference	5	..	5-5⅜
—— 4½ per cent. Debentures	100	..	105-107
India Rubber, Gutta Percha, and Telegraph Works	10	..	14½-15½
—— 4 per cent. Debentures	100	..	99-101
National Electric Construction Co., 1-170,000	1	–	⅛-⅜
Telegraph Construction and Maintenance	12	–	33-35
—— 4 per cent. Bonds	100	–	99-101
White, J. G., and Co., 5 per cent. Cum. Pref., 1-15,000	10	–	9-10

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	–	5⅛-5⅜
Bournemouth and Poole, Ordinary	10	–	9⅝-10⅛
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9⅜-10⅜
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	10¼-10⅝
—— 4½ per cent. Debenture Stock, Red.	100	–	99-103 xd
Bromley (Kent) Electric Light and Power Co.	5	–	4½-5
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	93-96
Brompton and Kensington, Ordinary	5	–	8 8½
—— 7 per cent. Preference	5	–	8-8½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-100,000	5	–	5⅞ 6¼
Cambridge Electric Supply Company, £10 Ord.	8	–	12⅝-13¼
Canadian General Electric Co., Common Shares	$100	–	120 122
—— 7 per cent. Cum. Pref. Stock	$100	–	117-119
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	–	97-100
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	3¾-4⅛
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	4⅛-4½
—— 4 per cent. Debenture Stock, Red.	100	..	96 99 xd
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000	5	..	3⅝-4⅛ xd
Chelsea Electricity Supply	5	–	3⅝-4
—— 4½ per cent. Debentures	100	–	100-103 xd
City of London, Ordinary	10	–	10½-11
—— 6 per cent. Cumulative Pref.	10	–	12-12⅜
—— 5 per cent. Debenture Stock	100	..	121-124
—— 4½ per cent. 2nd Deb. Stk., Red.	100	–	99-102 xd
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	–	90-98
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	–	2⅜-3¼
—— 5 per cent. Preference, 1-50,000	5	–	3¼-3⅜
County of London Elec. Supply, Ordinary	10	..	8¼-8⅝
—— 6 per cent. Cum. Pref.	10	..	10⅛-11⅛
—— 4½ per cent. Debentures Prov. Certs. All pd., Rd.	100	..	105-106
—— 4½ per cent. 2nd Debentures Prov. Certs	100	..	100-103
Edmundson's Electricity Corporation, Ordinary, 1-80,000	5	..	3/16-5/16
—— 6 per cent. Cum. Pref.	5	..	⅜-⅝
—— 4½ per cent. First Mort. Deb.	100	..	59-62
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	—	..	85-87 p c.
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	..	85½-88½ xd
Folkestone Electric Supply, Ord., Nos. 1-10,000	5	–	4½-5
—— 5 per cent. Cum. Pref., Nos. 1-10,000	5	–	5-5½
—— 4½ per cent. First Deb. Stock, Red.	100	–	98-101
Hove Electric Lighting, Ord., 1-13,000	5	–	7⅛-7
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	5	–	1½-2
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100	–	74-79
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	–	25/32-⅞
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5	–	6⅛-7
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	–	98-101

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Name.	Amount paid. £		Last price. £
London Electric Ordinary	5	–	1⅛-2⅛
—— 6 per cent. Pref.	5	–	5⅛-5⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red	100	–	93-97
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	–	76-80
Metropolitan Ordinary, 100,001-300,000	5	–	4¼-4⅜
—— 4½ per cent. First Mortgage Debenture Stock	100	..	105-108 xd
—— 4½ per cent. Cum. Pref.	5	..	4⅜-5⅛
—— 3½ per cent. Mortgage Debenture Red.	100	..	83½-86½
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,000 ($500) M 1-4,400 ($1,000) ($500), 4,001-14,000 ($1,000)	—	..	82-84 p.c.
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	87½-89½
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-87,500	5	..	93-97
—— do. 87,501-137,500 (issued at £1 prem.). All paid (Prov. Certs.)	5	..	4⅜-5¼
—— do., 5 per cent. Pref., 1-87,500 (Prov Certs.)	3	..	4⅜-5¼
—— 5 per cent. Pref., 87,501-137,500 (Prov. Certs.)	4	..	4⅜-5¼
Notting Hill Electric Lighting	10	..	11½-12¾
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	..	6-6¼
—— 4 per cent. Debenture Stock	100	..	92-95
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	..	1⅛-1 7/16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	1 1/32-1 5/32
—— 5 per cent. Debenture Stock, Red	100	..	102-105 xd
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20,000	5	..	5 5/16-5 9/16
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5	..	5⅛ 6
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	102-104
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	..	104-106 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	..	9/16-13/16
South London, Ordinary	4	..	2⅛-3⅛
South Metropolitan Electric Light and Power, Ord.	1	..	5/16-9/16
—— 7 per cent. Cum Pref.	1	..	1 5/16-1 5/16
—— 4½ per cent. 1st. Mort Deb.	100	..	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	8⅜-9½
—— 7 per cent. Pref.	5	..	7-7½
—— 3½ per cent. Deb.	100	..	84-88
Urban Electric Supply Co., Ordinary, 8-30,007	5	..	¼-1
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	1⅛-2⅛
—— 4½ per cent. First Mort. Debenture Stock, Red.	100	..	80-84
Westminster, Ordinary	5	..	8⅛-9⅛
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	–	4⅛-5⅛

Electric Tramways.—

Name.	Amount paid. £		Last price. £
Anglo-Argentine 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007	5	..	9 3 16-9 7/16
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	91-92
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	101-103
Bath Elec. Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	..	¼-⅜
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1	..	9/16-11/16
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	..	87-91
Blackpool and Fleetwood Tramroad	10	..	13⅜-13⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	10	..	9½-10
—— 4½ per cent. Deb. Stock, Red.	100	..	93½-95½
Brisbane Tramway Invest., Ord., 1-75,000	5	..	6⅛-6⅜
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	5-5⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	100½-104½
British Columbia Electric Railway Co., Ord. Def.	100	..	143-147
—— Ord. Pref.	100	..	122-126
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	107-110
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	102-104
—— 4½ per cent. Vancouver Power Deb.	100	..	101-101
British Electric Traction, Ord. 1-30,000 & 60,001-90,000	10	..	½ ⅝
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	2⅜ 2⅝
—— 5 per cent. Perpetual Debenture Stock	100	..	86-90
—— 4½ per cent. 2nd Deb. Stock	100	..	66-70
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	..	81-86
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	..	102-107
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	..	103-106
Buenos Ayres Lacrose Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	93-101
Calcutta Tramways Ord., Nos. 1-137,610	5	..	4⅜-4⅝
—— 5 per cent. Cum. Pref., Nos. 1-30,000	5	..	4⅜-5
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	97-100
Cape Electric Tramways, Nos. 1-480,000	1	..	⅜-½
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	4⅜-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	..	97-101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	6	..	5⅜-5⅝
—— 4 per cent. Deb. Stock, Red. (1985)	100	..	98-101 xd
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	98-101
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13-14
—— 6 per cent. Cum. Pref.	10	..	12⅜-13⅜
—— 4 per cent. Debentures	100	..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	12½-13½
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	..	90-95
Hastings and Dist. Elec Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	75-80
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000	..	91-94
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14½
—— 4½ per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	..	⅜-1⅜ xd
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1	..	1/32-3/32
—— 5 per cent. "A" Deb. Stock	100	..	90-93
—— 6 per cent. "B" Deb. Stock	100	..	64-68
Kidderminster and District Lighting and Traction, Pref.	5	9	15/16-10 3/16
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	..	88½ 90½
—— £296,500 2nd Mort. Deb. Stock	–	..	–
—— £83,330 Deferred Deb. Stock (all fully paid)	–	..	–
bon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	–	15/16-1 1/16
—— 6 per cent. Cum. Pref., Nos. 1-425,653	1	–	15/16-1 3/16
—— 5 per cent. Mort. Deb., 1-5,000, Red.	100	–	94-98
London United Trys. (1901) 5 per cent. Cum. Pref.	10	–	2-2½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	65 68
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	..	93-96
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	..	94-96
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5	..	4½-5
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	86-91
Metropolitan Elec. Trams., Defd., 1,000,001-1 314,016	1	..	1/32-5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	23/32-27/32
—— 4½ per cent. Deb. Stock, Red.	100	..	95-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	–	..	92½-94½
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort. Bonds (1926) 1-5,500 and 7,001-8,000	$1,000	–	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922)	100	–	102-104
New General Traction, 5 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	–	⅛-⅜
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mort. Deb. Stk.	100	..	100½-103½
Potteries Electric Traction, Ordinary, 1-245,000	1	..	3/16-7/16
—— 5 per cent. Cum. Pref., 300,001-545,000	1	..	¼-⅜
—— 4½ per cent. Debenture Stock	100	..	86-89
Provincial Tramways Co., Ordinary, 1-24,912	10	..	4-4¼
—— 6 per cent. Cum. Pref., 1-10,000	10	..	9½-10¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	..	5⅜-5⅝
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	99-101
Sao Paulo Tramway, Light, and Power Co.	$100	–	149-152
—— 5 per cent. 1st Mort. Deb., Red. (1929) 1-12,000	$500	..	97½-99½ p.c
South Metropolitan Electric Tramways and Lighting Co. 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	⅜-⅝
—— 4 per cent. Deb. Stock, Red. (1940)	100	..	70-74
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red, 1-1,600	100	..	82-86
Yorkshire (West Riding) Elect. Tram. Co., Ord., 70,001-110,000	5	..	⅛-⅜
—— 6 per cent. Cum. Pref., 1-46,261	5	..	1⅜ 2⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	84 88

Electric Railways.—

Name.	Amount paid. £		Last price £
Central London, Ordinary	100	..	61-63
—— 4 per cent. Pref.	100	..	83-85
—— " " deferred	100	..	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	100-102
City and South London, Consolidated Ordinary	100	..	31½-32½
—— 4 per cent. Debenture Stock	100	..	99-101
—— 5 per cent. Pref. Stock '91	100	..	110-113
—— " " " '96	100	..	106-109
—— " " " '01	100	..	102-105
—— " " " '03	100	..	93-95
Liverpool Overhead, 5 per cent. Pref.	10	–	10-10⅛
—— Ordinary, 1-50,000	10	–	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	–	–	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	–	–	102½-103½

Telegraphs and Telephones.—

Name.	Amount paid. £		Last price £
Amazon Telegraph Co., 1-25,000	10	–	2⅜-3⅛
—— 5 per cent. Debs., Red., within 1-1,069	100	–	92-96
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	–	97-99
Anglo-American Telegraph Co., Ordinary	100	–	58-60
—— 6 per cent. Preferred Ordinary	100	–	101½-102½
—— Deferred Ordinary	100	..	16½-17
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	102-104
Chili Telephone Co., 1-44,000	5	–	8-8⅜
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	..	89-91
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	–	8⅛-8⅜
—— 10 per cent. Preference, 1-6,000	10	–	17-18
Direct Spanish Telegraph Co., Ordinary	5	..	2⅛-3⅛
—— 10 per cent. Cum. Preference	5	..	8⅛-8⅜
—— 4½ per cent. Debs., 1-600	50	..	91-101
Direct United States Cable Co.	20	..	12⅜-13⅛
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	–	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000 (1909)	100	–	100-102
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	25	..	103½-105½
Eastern Extension, Australasia and China, 1-300,000	10	..	11¼-11⅜
—— 4 per cent. Mort. Deb. Stock, Perp.	100	..	103½-105½
Eastern Telegraph Co., Ordinary Stock	100	..	125-128
—— 3½ per cent. Preference Stock	100	..	—
—— 4 per cent. Mortgage Debenture Stock	100	..	104½-106½
Great Northern Telegraph Co. (of Copenhagen)	10	..	25½-26½
Halifax and Bermudas Cable Co., 4½ per cent. 1st. Mort. Debs., within 1-1,200, Red	100	..	99-101
Indo-European Telegraph Co.	25	..	51½-53½
Marconi's Wireless Telegraph Co., Nos. 256,128-384,190	1	..	11/16-13/16
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	⅛-1
—— 5 per cent. Preference, 1-26,492	1	–	13/16-15/16
National Telephone, Preferred	100	..	108½-110
—— Deferred Stock	100	..	125½-127½
—— 6 per cent. Cum. First Pref.	10	..	10¼-11
—— 6 per cent. Cum. Second Pref.	10	..	10¼-11
—— 5 per cent. Non. Cum. Third Pref.	5	..	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100	..	97-99
—— 4 per cent. Deb. Stock, Red.	100	..	99-101
Oriental Telephone and Electric Company	1	..	1 5/16-1 7/16
—— 6 per cent. Cum. Pref.	1	..	1-1⅛
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	..	99-101
United River Plate Tele. Co., Ordinary, 1-100,000		..	6⅛-7⅛
—— 5 per cent. Cum. Pref., 1-40,000	5	..	5-5⅜
—— 4½ per cent. Debenture Stock, Red.	100	..	102-103½
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	..	98½-100½
West African Telegraph Co.	10	..	12⅜ 13⅜
West Coast of America, 1-30,000 and 53,001-53,008	2½	..	1⅛-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	..	99-101
West India and Panama Telegraph Co., Ordinary	10	..	⅛-⅜
—— 6 per cent. Cum. 1st Preference	10	–	8⅛-8⅜
—— 6 per cent. Cum. 2nd Preference	10	–	–
—— 5 per cent. Debs., Red., 1-800	100	..	100½-102½
Western Telegraph Co., 1-207,930	10	–	13⅛-13⅝
—— 4 per cent. Debenture Stock, Red.	00	–	93-96

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns week. Ending	1909.	1908.	Increase or decrease. Week.	Current year.	Miles of track open. 1909.	1908.	Accounts for past year. Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	Cost per car mile.
		£	£	£	£				£						
Aberdeen Corporation	July 14	1,452	1,378	+ 114	- 112	27¼	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5·93
Ayr Corporation	,, 17	467	456	+ 10	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	,, 17	3,105	3,150	- 45	+ 230	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 18	1,115	1,144	- 29	- 442	23·53	23·53	—	—	—	—	—	—	—	
Birmingham Corporation	,, 10	9,098	6,501	+2,597	—	56·792	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 7	1,130	1,153	- 23	- 637	28 8	28 3	—	—	—	—	—	—	—	—
Blackpool Corporation	,, 8	1,694	1,692	+ 2	+ 778	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Aug. 8	2,304	2,328	- 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	July 11	2,346	2,180	+ 166	- 534	42	42	March 31	117,799	25,492,902	2,492,147	1·1	11 34	2,804	6·50
Bournemouth Corporation	,, 14	1,651	1,704	- 53	+ 19	29¼	29½	,, 31	86,225	13,991,324	1,766,068	1 47	11 71	2,912	7·22
Bradford Corporation	,, 10	4,965	4,693	+ 272	+ 1,203	98½	98½	,, 31	235,258	47,839,569	5,331,007	1 17	10·59	2,378	—
Brighton Corporation	,, 18	1,037	966	+ 71	+ 805	—	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	,, 16	5,739	5,579	+ 220	—	57	51½	Dec. 31	265,362	46 652 389	5,756 842	—	—	—	—
Burnley Corporation	,, 17	1,256	1,451	- 195	—	19½	19½	March 31	64,261	12,355,958	1,2.2,330	1·23	12 83	5,971	7 92
Burton Corporation	,, 18	275	311	- 36	- 132	10	10	,, 31	14,9 8	3,221,595	430,913	1·04	8 30	1,460	5 85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	,, 31	109 979	25,058,146	2,497,169	—	10 57	—	—
Carlisle Tramways Company	June 19	170	175	- 5	- 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	July 10	5,608	7,225	-1,617	—	6·32	5·77	Dec. 31	350,150	41,838,373	1,456,781	2 01	5 769	55,404	30 27s
Charing X, Euston, & Hamp. Ry	,, 17	3 850	3,280	+ 570	+ 1,255	—	—	—	—	—	—	—	—	—	—
City and South London Railway	,, 18	3,085	2,704	+ 381	+ 365	—	—	—	—	—	—	—	—	—	—
Colchester Corporation	,, 14	200	219	- 19	—	8	—	March 31	10,983	2 308,721	349,539	1·09	7 74	1,477	6 56
Cork E. T. and L. Company	,, 15	537	570	+ 7	- 930	—	—	Dec. 31	24,044	5,737,478	896,945	—	6 43	—	4 43
Croydon Corporation	,, 9	1,561	1,473	+ 88	+ 24	11½	—	March 31	74,132	16,277,318	1,883,137	1 06	9 56	3,703	7 10
Darwen Corporation	,, 9	269	270	- 1	- 147	7·23	7·23	,, 31	13,193	2 557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	,, 10	221	370	- 149	- 355	7	—	,, 31	11,593	2,697,672	316,754	·98	8 78	—	—
Dublin and Lucan Electric Ry.	,, 16	347	338	+ 9	—	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	,, 16	5,691	5,434	+ 247	- 86	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 14	1,112	1,143	- 31	- 419	—	26½	May 15	60,573	16 367 911	1,281,.52	·875	1·9	2,371	·46
East Ham Corporation	,, 17	1,026	840	+ 186	+ 2,305	15	15	March 31	47,430	15,355,703	1,091,586	·73	10 26	—	6 96
Glasgow Corporation	,, 10	15,719	16,561	+ 158	- 1,878	185½	179	May 31	907,494	226,948,290	20,756,722	·96	10 49	5,08	5·89
Gloucester Corporation	,, 14	301	299	+ 2	+ 181	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton.	,, 17	5,410	5,405	+ 25	+ 280	—	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	March 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	,, 17	1,626	1,550	+ 76	+ 564	28½	28½	,, 31	84 704	6 260,020	1,960,.29	1·29	10 37	2,421	5 10
Hull Corporation	,, 17	2,481	2,576	- 95	+ 329	26	26	,, 31	128,722	30,964,254	3,022,844	1	10·22	—	6 04
Ilford Corporation	,, 10	544	521	+ 23	+ 608	10	10½	,, 31	25 328	385,466	634,446	·87	9 58	2 066	6·42
Ilkeston Corporation	,, 15	135	153	- 18	- 167	4	4	,, 31	7,214	1,968,850	198,415	9 1	7·9	1 803	7·04
Kirkcaldy Corporation	,, 14	269	265	+ 4	—	7½	7½	May 15	14,993	4,874 199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	,, 14	1,347	1,346	+ 1	+ 218	39	39	Dec. 31	68,904	12,551,593	2,244,344	—	—	—	—
Leeds Corporation	,, 10	7,230	9,775	- 2,485	+ 138	96½	96½	March 31	340,368	75,734,083	7,694,989	1·06	10 62	3,527	5·51
Leicester Corporation	,, 10	2,245	2,313	- 67	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 10	11,766	11,148	+ 618	- 2,997	104	104	Dec. 31	572,822	124,043,239	12,211,799	1·108	11 24	5.503	7·94
Liverpool Overhead Railway	,, 18	1,434	1,478	- 44	+ 34	6 65	2 40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	,, 3	36,273	37,188	- 915	+18,395	121	115½	March 31	1274,660	279,166 461	25,591,028	1·08	11·74	—	6 79
Lowestoft Corporation	,, 4	190	222	- 32	- 666	3½	—	Sept. 30	11,399	2,645,2.6	370,32	1·03	7·36	2,279	6·12
Maidstone Corporation	,, 10	184	219	- 35	—	5¼	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 10	17,335	15,521	+1,674	- 465	181	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	,, 17	10,136	9,530	+ 606	+ 1,532	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 11	15,699	15,390	+ 309	—	24½	24½	June 30	680,357	99 846,735	—	1·46	—	—	—
Nelson Corporation	,, 17	143	143	—	- 84	2¾	2¾	March 31	7,362	2,060,712	204,7..	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	,, 17	3,743	3,706	+ 37	- 1,330	60½	59⅛	,, 31	211,085	46,243,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	,, 10	676	685	- 9	- 261	14½	14½	,, 31	35,531	8,174,003	798,029	1·04	9 89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	- 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	March 31	97,741	21,247,048	2,309,479	1·10	10·15	—	
Reading Corporation	July 8	645	680	- 35	+ 75	13½	13½	,, 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	,, 31	56,558	10,196 148	1,252,925	1·32	10 83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	- 32	—	—	—	—	—	—	—	—	—	—	
Salford Corporation	July 12	5,075	4,6 2	+ 393	- 1,861	78	74¾	March 31	244,065	45,771,511	5,486,150	1 25	10 67	3,185	
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	*
Sheffield Corporation	,, 11	5,499	5,563	- 64	- 1,301	68½	66½	March 25	289,745	17,568,686	7,065 380	·896	9 842	4,225	5·04
Southampton Corporation	,, 7	1,137	1,132	+ 5	- 465	18	18	,, 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	,, 14	586	514	+ 72	+ 1,045	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	March 31	52,004	9,155,172	1,335,911	1 34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	- 26	- 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	July 7	127	162	- 35	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	,, 15	354	329	+ 25	—	5·16	—	Dec. 31	15,065	2,880.420	353,297	1·40	1 023	—	-
Wallasey U.D.C.	,, 10	1,063	935	+ 127	+ 481	12 68	12·45	March 31	43,823	8,331,038	891,540	1 2	11·79	3,353	·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	,, 8	2,463	2,240	+ 223	+ 1,955	14·7	14·7	March 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	,, 15	884	921	- 37	- 817	20½		,, 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

* Train miles. † Half-year's figures.

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THE

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WATER POWER—A SET-BACK AND POSSIBILITIES.

As we know, the schemes of mice and men aft gang agley, but it is seldom that a large concern such as the Victoria Falls and Transvaal Power Company, Limited, with its enormous capital of £4,400,000, so completely reverses its policy in the initial stage, yet prospers. Originally formed with the intention of utilising the immense power of the mighty Victoria Falls for local industries to be fostered on the spot, but more especially for transmission to the Rand, this most interesting of tasks had to be abandoned, not for any inherent difficulties in the engineering problems, but solely on account of local politics and economic considerations. Probably for many years to come the superb head of water at the Victoria Falls will be untapped, and the great electric supply will be generated by means of coal. The powerful coal-mining and railway interests were dead against the tapping of the falls, not through any sentimental reason, but because they foresaw the loss that such a scheme would entail on the coal industry. Luckily, South African coal is fairly cheap and good. Sir Charles Metcalfe, speaking at the annual general meeting of the company, was able to announce that the company's electrical plant, probably the most up-to-date in the world, was being worked extremely economically, the expenditure on coal being a minimum compared with the kilowatts raised. This result, no doubt, is as much due to the economical planning of the plant as to the price and quality of the fuel. Still, we cannot help regretting the postponed, we trust not the lost, opportunity of testing the cost of generating electricity in such bulk would come to with the far cheaper water power. At present some 12,000 kw. are in active work, and this is to be more than doubled by next year. There can be no doubt that the company has done exceedingly well, and has a bright future before it. The surplus of revenue over expenditure has increased from £36,685 to £48,177, and there is in immediate sight, so soon as the necessary machinery is in working order, a revenue of £500,000. This is, to a large extent, due to the elimination of competition. While the mine owners and others saw the possibility of taking supplies either from the Victoria Company or from Mr. Harper's company, they held back, awaiting events, to see which group would offer better facilities and lower terms. But when Mr. Harper's interests were taken over, the demand for power flowed in so fast that the difficulty for some time will be to cope with such demand. This is easily to be understood when we find Mr. Ryersbach giving evidence before a Royal Commission to the effect that the use of electricity in the mines means a saving of something like a shilling per ton of mineral raised. Under the circumstances it is not astonishing to find the Rand Mines, Limited, contracting to take electricity, estimated to amount to 270,000,000 units per annum, for a term of twenty years, while the Eckstein group, the Consolidated Gold Fields of South Africa, Limited, the Johannesburg Consolidated Investment Company, and other important mining groups are also entering into contracts for lengthy periods. In passing, it is interesting to note that the newly registered Transvaal company, the Rand Mines Power Supply Company, Limited, will operate the Eckstein contract and supply the Victoria Falls and Transvaal Power Company with electricity in bulk. This new company has a capital of £1,500,000 in half a million one-pound shares and a million debentures, the whole of which capital is provided by the parent company. The whole device seems to have been called up as a step in the measures adopted to overcome local opposition and competition. It will, however, probably have the effect of

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fostering Transvaal activity and putting off the day of industrial development of Rhodesia round about the Victoria Falls. We can quite imagine that the present arrangements will bring quicker returns to the company, though the original plan offers greater possibilities for the future. It is, no doubt, only a matter of postponement. Ultimately the Victoria Falls will contribute their full quota of power to the industrial life of South Africa. The temporary shelving of the original proposal is to be regretted, if only for the fact that the scheme would have presented several important problems for technical men, and would also have given an impetus to the utilisation of natural forces for the generation of electricity. Water power will, at some future date, be used in other parts of the African Continent, and give scope for British capital and enterprise. In our own islands we have not the opportunities for emulating the great water-power electricity supply schemes of Switzerland, the Scandinavian countries, France, and Italy, but Canada offers an enormous field or both large and small schemes. This especially holds good of British Columbia, where mining is rapidly being developed, the coal being mostly absorbed for shipping and railway purposes. British Columbia possesses splendid rivers and falls, often in close proximity to mining districts and the growing cities where industries of one kind or another are being developed. This, therefore, is a country deserving of careful study on the part of electrical engineers. Even the Continent of Europe may offer some scope for us. This is notably the case in Spain, a country possessing very considerable mining and industrial potentialities, with its natural mineral wealth and its sufficiency of fairly competent cheap labour. At present only some 80,000 h.p. of electricity is being generated by water power, in small works erected mostly on the banks of the Tagus, Guadalquiva, and the Ebro. But this is a mere nothing compared to the 5,000,000 h.p. and more that Spanish engineers estimate are still running to waste in their numerous rivers. This is a conservative figure of the power actually available for such purposes. According to the Madrid authorities, it would cost some £400,000 per working day to generate such a volume of horse-power by means of coal. Our French friends seem to be alive to the possibilities for their enterprise on the other side of the Pyrenees, and appear inclined to see what they can do to repeat in Spain the successes they have achieved in their own country on the banks of the Rhone and in other districts. It is a field that should not be overlooked by ourselves.

THE RITTEN ELECTRIC RAILWAY.

To the north-east of the town of Bozen, between the Eisack and the Talfer valleys, is a long chain of mountains, the highest peaks of which are about 7,500 ft. above the sea-level. In the southern part these are known as the Rittenberg Mountains, and at an average height of about 4,250 ft. they form an undulating plateau penetrating into the very heart of the Alps. From very ancient times until the Middle Ages this was an important pass between Germany and Italy; the commercial and military roads made by the Romans traversed this pass, and did not descend to the level of the valley until the village of Waidbruck was reached—now a railway station. In the latter period of the Middle Ages the route had shifted towards the north, and the Rittenberg plateau was neglected. Lately the success of the Mendel Railway and the rapidly increasing tourist traffic in South Tyrol has led a company to construct an electric railway, which will give the pass some of its ancient importance.

The gauge of the Ritten Railway is 1 m.—part of the road is on the ordinary system and the other part has a toothed rack in the centre. Starting from the Place Walter at Bozen, the rail follows the road to the station of the same name on the railway, and then turns towards the foot of the mountain, where the toothed rack section commences which terminates at Ober-Bozen. The maximum rise in the sections without racks is 4½ per 100; where the toothed racks are laid it reaches 25½ per 100. The total length of the line is about 7¼ miles; the difference of level reaches 3,200 ft.

The racks are on the Strub system, and are about 13 ft. long. They are mounted on curved bases. The Strub system is the only one in use on the Swiss mountain railways of recent construction. The local engineers have to satisfy very severe conditions as regards the safety of passengers, and have the most experience in this special branch of engineering. The only line that has not adopted the Strub system is the Montreux-Tylon Railway, and this is simply because a different system allows it to be joined more easily to the old Glyon-Naye rail.

The toothed rack is very simply constructed, and, although it is relatively light, it is extremely resistant, both horizontally and vertically, and adapts itself easily to the most variable contours of the ground. There is a great advantage in being able to use a single form of toothed racks throughout the railroad, and to be able to fix this on the sleepers in the same manner as the rails are fixed. The rack wants the minimum amount of inspection, and allows the service to be continued even when the railroad is encumbered with ice and snow. Security against derailment is increased by lateral disc guides, fixed at the side of the pinions. If the teeth of the pinions leave the cogs in the rack, they are quickly brought back into position by these guides.

The electric current is brought from works in Bozen and Meran. It is a tri-phase current at 10,000 volts and 46 periods per second, and is led to a sub-station in the middle of the section of the rail which has the toothed rack. Here the high-tension current is reduced by a 300-kw. transformer to 3,000 volts. At this tension it supplies a 325-h.p. motor, which is asynchronous, and is provided with a short-circuit induction. The converter is started on the direct-current side and brought to its desired speed under regulation by a special resistance inserted in the battery circuit. On account of the high speed of rotation (960 per minute) and of the high tension of the current employed, the direct-current dynamo is provided with four auxiliary poles.

The battery consists of 364 elements, and its capacity is from 266 to 352 ampere-hours, according to whether it has to be discharged in one or two hours. It is charged by means of a high-voltage continuous-current motor driven with a flexible shaft from a continuous-current dynamo. The tension in the contact wire is 750 volts. The rails carry the return current. The rolling stock is composed of three toothed gear locomotives, four automobiles, two passenger coaches, and four goods wagons. As the locomotives and the vehicles which they draw travel over ordinary railway and over rack railways equally well, there is no need to make passengers change each time the type of railway alters during the journey.

Each locomotive weighs 16·2 tons, with a tractive force of 12·5 tons, and has two toothed driving wheels and a shunt motor of 150 h.p., with four principal poles and auxiliary poles also. Each driving axle acts upon the rack wheel nearest to it by means of guides and a connecting rod.

As regards safety appliances, each carriage is provided with two independent hand brakes, an automatic brake for the two axles worked by the induced current, and also with an automatic spur gear to compensate for the action of the short-circuit. These, together with Strub's safety clutches, prevent all chance of derailment.

Each passenger automobile is equipped with two usual railway motors of 45 h.p., and weighs (empty) 21 tons. Although there are only 58 seats in it, it can hold about 90 persons.

Each train is composed either of a locomotive and an automobile with four axles, such as we have just described, or of a locomotive and two two-axled vehicles, whereof one is automobile and the other has to be drawn. The maximum weight of the train is about 46 tons, and the journey takes about 80 minutes.

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INSULATING MATERIALS.*

BY THOMAS GERMANN AND STANLEY M. HILLS.

There are many insulating substances, but so few are of practical value that only a very small percentage can be used, and "mixtures," therefore, have to be employed. The following insulating materials may be mentioned: amber, ashes, cambric, camphor, chalk, dry metal oxides, dry paper, glass, leather, lime, linen, marble, mica, oils (fatty and ethereal), parchment, phosphorus, porcelain, resin, rubber, silk, slate, shellac, varnishes, wax, and wool. The properties of some of the principal materials are indicated below:

Material.	Properties — Electrical.	Thermal.	Mechanical.	Nature.
Asbestos	Good	Good	Very poor	Non-hygroscopic
Marble	Good	Good	Good	Slightly hygroscopic
Mica	Excellent	Excellent	Very poor	Non-hygroscopic
Oiled linen	Excellent	Very fair	Fair	Hygroscopic
Shellacked linen ..	Good	Fair	Poor	Hygroscopic
Slate	Poor	Poor	Good	Hygroscopic
Vulcanised fibre ...	Good	Good	Fair	Hygroscopic

A substance insulates by virtue of three distinct properties: first, the ability to stand mechanical and electrical stresses due to the voltage used; secondly, conductivity such that but a negligibly small current can flow through it and leak away; and, thirdly, the power to resist any chemical action that may be caused by the application of the voltage. The first property is called by Maxwell the "dielectric strength" of the insulator, the second property being termed the ohmic resistance There is no direct relation between the breakdown E.M.F. and the ohmic resistance of an insulator. A low ohmic resistance usually means a low breakdown test, but a low breakdown test does not necessarily mean a low ohmic resistance. The principal value of ohmic resistance measurements is the proof they afford of damp-proof properties.

There is hardly a piece of electrical machinery in which some insulation is not to be found, and yet but little special consideration seems to have been given to the subject of dielectrics. The scanty amount of information upon it which is available is bound up in the proceedings of the various scientific societies, and in the one book by Messrs. Hobart and Turner. Doubtless, many of the large firms have acquired considerable knowledge on the subject, but it is so jealously guarded that the average electrical engineer stands but little chance of receiving any benefit from it. The authors, who have had some practical experience in connection with insulation, have prepared the present paper in the hope that it may be found of interest and use to their fellow-members.

A good insulator should possess: (1) high disruptive strength; (2) good insulation resistance; (3) physical properties permanent over a wide variation of temperature, be non-volatile. It should also be: (4) non-hygroscopic; (5) able to resist the action of water, acids, alkalies, and oils; and (6) fireproof.

In addition to answering the above description, insulators for switchboards should be of good mechanical rigidity with low surface leakage. The additional qualities of insulators for dynamos are: pliability, freedom from fracture, toughness and ability to stand mechanical strain, and a high softening point. For cables, flexibility and elasticity and low specific inductive capacity are essential.

As no single substance fulfils all these requirements, in order to obtain a satisfactory insulator "mixtures" are resorted to. An insulator will thus consist of pure rubber, vulcanised rubber, impregnated paper and cotton, varnish, oil, and air. Since the molecular composition of all these substances is different, they all have different densities. The particles or cells can move more freely in some than in others. The electric displacement of some of them is greater than that of others. It may here be stated that the electric displacement varies directly with the density.

Dr. Baur made several experiments to determine the relation between the breakdown voltage and the dielectric strength of an insulator, and he found that this relation could be expressed by the equation:

$$V = c\, d^{0.666}$$

where d = thickness of insulation in millimetres;
V = potential difference in R.M.S. volts A.C.;
c = a constant representing the potential difference necessary to break down a sample of the dielectric 1 mm. thick. This constant is termed "the electrical breaking strength."

The values for the electrical breaking strength are given in the following table:

Dielectric.	c.
Empire cloth	12,500 volts.
Fuller board	19,000 ,,
Mica	58,000 ,,
Dry air	3,300 ,,

In high-tension distribution, insulation of the lines must be specially considered. The insulators are usually made of glass or porcelain. As leakage occurs through moisture which collects on its surface, the insulator must be non-hygroscopic. The dielectric strength between the conductor and the insulation support must be high. To avoid leakage the insulator should be so designed that the extent of surface is as long and narrow as is practicable; and this surface also must be initially and continually highly insulating. To minimise leakage, insulators are constructed as a series of petticoats. Glass or porcelain gives excellent results up to about 5,000 volts, but most of those of glass permit of surface leakage, even when new, and they weather very considerably. In time the surface becomes somewhat roughened, and then dirt and moisture begin to collect until a conductor is formed which is fairly good. Again, glass is slightly soluble in water, and this is in itself a reason for its hygroscopic nature. It should never be used in damp climates. Variations of insulating efficiency occur; a drizzling rain or a fog will be found to result in effects more detrimental than those due to a heavy rain. The latter tends to wash off any dirt from the outer surfaces, and has practically no effect upon the undersides of the petticoats.

In regard to porcelain it is found that cheap material is often extremely hygroscopic; especially is this the case with some of the American porcelain, which will absorb 1 to 2 per cent. of its weight in water, this showing poor insulating properties. The best porcelain should absorb no moisture and should show a brilliant vitreous fracture which will give no flowing stain on the application of ink. The glaze on the porcelain affects the properties. Glass is homogeneous throughout its thickness, but with porcelain it is a common experience to find that as soon as the glaze is damaged a porous and practically uninsulating porcelain is revealed. Thoroughly vitrified porcelain, in which the ordinary glaze is replaced by an actual fusing of the material itself, is much preferable to ordinary glass. It is strong and tough, non-hygroscopic, has very high insulating properties, the surface does not weather, and the insulation is practically permanent. If the vitrification extends considerably below the surface, the resistance will not only withstand leakage but puncture better than any glass.

Varnishes play a very important part in the insulation of armature coils, field coils, etc., and, therefore, call for some special attention in the present paper. They are chiefly manufactured from linseed oil, and this fact is often plainly stated in manufacturers' price lists. Up to quite recently linseed oil was a very undesirable ingredient in an insulating varnish, as it rapidly absorbed oxygen and formed a tough elastic oxide; this oxidation continued until a viscid substance, partially soluble in water, was formed.

Mr. R. C. Wamer made a series of experiments to illustrate this point, and the figures in the accompanying table show the results of his experiments upon three varnishes.

Specimen A was composed almost entirely of linseed oil;

Specimen B of 15 per cent. linseed oil; and in

Specimen C there was no linseed oil.

Specimen of varnish.	Time of exposure and percentage absorption of moisture. 1 day.	4 days.	7 days.	15 days.	1 mon.	5 weeks.
(A)	0·228	0·38	0·45	0·53	0·98	1·34
(B)	0·15	0·21	0·23	0·28	0·36	0·49
(C)	0 05	0·05	0·1	0·2	0·25	0·35

* From a paper read before the Junior Institution of Engineers.

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The experiments were carried out as follows: Pieces of tin plate were cleaned and accurately weighed, then covered with two coats of the respective varnishes and air-dried for one week. They were then baked for 10 hours at 100 deg. F. and six hours at 212 deg. F. to harden the films, after which they were removed to a desiccator and weighed again. The samples were then exposed to the air and weighed at the intervals shown in the above table. After five weeks the samples were stoved at a temperature of 70 deg. F. to 80 deg. F. for a few hours, cooled in a desiccator, and weighed, when it was found that they had returned to their original weight, thus proving that their increase in weight was due to absorption of moisture.

Similar samples were prepared and immersed in water at a temperature of 60 deg. F. for 24 hours, with the following result:

Specimen C, 0 15 per cent. absorption of moisture.
Specimen B, 0·85 per cent. absorption of moisture.
Specimen A, 2 15 per cent. absorption of moisture.

That the effect of this absorption on the dielectric strength is very great is shown by the following figures:

Average breakdown voltage of linseed-oil varnish, 517 volts;

Varnish free from linseed oil not punctured at 933 volts.

It is common practice to impregnate cotton and cambric with insulating varnishes. Cotton contains acid bodies derived from pectin, which are soluble in water, and although water is only feebly ionised on the application of an electric current it helps other substances to ionise, and in so doing sets up electrolysis and chemical action. The production of green on the insulation of copper conductors is commonly termed verdigris, but this is a mistake, for the green formation is a compound resulting from the chemical action produced by acids in the cotton acting upon the linseed oil.

Linen and cambric play important parts in insulating, it being usual to impregnate these with varnish. The texture should be fairly fine, but not so fine that varnish cannot percolate and soak into the pores of the material. Dressing is a disadvantage, and should be avoided as much as possible, as it is liable to contain chlorine from the bleaching operation, and the chlorine will react on the varnish and cause rotting. The softness of the material increases inversely with the dressing.

If the linen or cambric is to be used for the production of oiled linen, such as Empire cloth, it should be closely woven, as oil will not satisfactorily fill large pores or openings in the cloth. These oiled cloths possess a high dielectric strength, are very flexible when new, but rapidly deteriorate with age, and it is imperative that "ageing tests" be made on this class of insulator.

Mica is a very good insulator, as it not only possesses a high dielectric strength, but is also unaffected by heat. One great objection to its use is that it is not flexible, but this has been overcome to a large extent by preparations of mica, such as micanite, mica cloth, etc. Mica is practically the only insulator used for commutators. It is an anhydrous silicate of aluminium and potassium or sodium, the most transparent varieties being composed of aluminium and potassium silicates, whilst the less transparent qualities contain magnesia and iron, together with earthy matter. Mica crystallises in a laminated mass easily split along the axis. A high percentage of magnesia gives a darker colour to the mica, while high percentages of iron colour it grey and black. Most mica used in electrical work comes from India. The green shades are the softest, the variety known as "white amber," which comes from Canada, being the most flexible.

Marbles, etc.—Marbles and artificial stones are largely used for switchboards, etc. The greatly increased use of marble for switchboards demands that a note should be made as to its behaviour as an insulator. Though marble is preferable to slate on account of its greater freedom from metallic veins and more pleasing appearance, it is by no means an ideal switchboard material. It is one of that class of substances which are always cold, consequently it rapidly condenses moisture, and this on a switchboard causes surface leakage.

Marble used in electrical machinery is usually of a soft variety, and will crack with a knock or jar, and if a panel of a switchboard cracks great inconvenience may be caused. Hard marbles can be used, but a great sacrifice in dielectric strength has to be made. The authors have found by experiment that: (1) mechanical properties of marble are good in the inverse proportion to the electrical properties; (2) the greater the specific gravity the lower the absorption of moisture; (3) the greater the specific gravity the lower the breakdown voltage; (4) the greater the specific gravity the greater the crushing stress.

It will thus be seen that the specific gravity exerts considerable influence on the electrical properties.

Turning now to insulating materials used in connection with dynamo-electric machinery, these vary greatly according to the conditions to be withstood. Rubber should never be employed, as it deteriorates so rapidly. A number of composite insulations are used consisting of mica strip pasted on to sheets of another insulating material, among which the following may be mentioned:

1. Two sheets of red rope paper with one thickness of mica between them, the whole being shellacked together. The average B.D.V. (breakdown voltage) is about 230 volts per mil.
2. Mica and bond paper made in a similar way. Average B.D.V. 250 volts per mil.
3. Mica and canvas. B.D.V. 65 volts per mil.

The B.D.V. above are R.M.S. values, and the main insulation is due to the mica, the outside covering being determined by the allowable space factor and the mechanical strains which have to be met.

It is common practice to insulate armature coils and field coils by taping them with cotton tape wound on the half lap. The coil is then dipped in an insulating varnish, and afterwards baked in an oven. The object of the dipping is to thoroughly impregnate the tape with a good insulating material, at the same time excluding any moisture. Permanently good results cannot be obtained if there is any moisture in the coils, not only because moisture is occupying the space which should be occupied by the varnish, but also because when continually undergoing temperature changes, which occur in the case of a dynamo, disintegration is set up in the mineral and vegetable fibres of the cotton; this in the course of time may utterly break down the insulation. From this it will be seen that the very first procedure is to exclude any moisture, and this may be done by heating the coils *in vacuo*, and while the coils are still hot forcing the varnish into them under pressure, the apparatus for effecting which is necessarily very elaborate.

Where this process cannot be carried out it is usual to heat the coils in a well-ventilated oven immediately after taping at a temperature of about 90 deg. C. for about three or four hours untill all moisture is excluded. All products of combustion should be excluded from the oven, as water vapour is always in suspension in the products of combustion of gas, wood, or coal. When the coils are thoroughly hot they are ready for the dipping process. The varnish is poured into tanks, and the coils are immersed and allowed to remain until air bubbles cease rising to the surface; the varnish thus fills every space, and in so doing forces the air out. The coils are then removed from the tank and held over it, so that all surplus varnish may drain off. It is advisable while draining to occasionally turn the coils end for end, so that a fairly uniform coating is obtained. The coils are then ready for baking, which should continue until the varnish is plastic at a temperature of 90 deg. C.

After baking, it is the usual practice to bind the coils with some suitably strong tape, after which the whole is dipped again in the varnish. The coil now need not be hot; as a matter of fact a cold dip gives a thicker coating and a better finish than a hot dip. The coil is now drained as before. If, however, the desired coating is not obtained, then after about half an hour's draining the coil is given a quick dip in and out again, and redrained. It is now ready for the final baking.

The temperature, as before, should be about 90 deg. C., cotton, silk, or other fibrous insulation not being injured even up to 105 deg. C. Baking at a lower temperature incurs loss of time in the operation, and is liable to introduce the risk of moisture, while if a high temperature be used the permanent elasticity of the varnish is injured,

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and it is liable to break or chip. After baking, the coils are ready for use.

In order to obtain an efficient dynamo it is highly essential that the space factor of the armature be high, and to obtain a high space factor the space occupied by the armature insulation must be reduced to a minimum. It is usual to line the armature slot with some fibrous material, suitably treated to render it waterproof, and then to place the former-wound coil in the lined slot. Among other materials the following, arranged in order of toughness, are used: leatheroid, presspahn, B.P., black paper, red rope paper, and manila paper. All slot-lining material should be thoroughly dried and waterproofed, the best method being to submit the material to prolonged soaking in hot linseed oil. It should be noted that most papers have a grain, and where used for slot linings or for purposes where the paper has to be bent, that the paper should be bent along the grain.

STORAGE BATTERIES.

For a long time past there has been an agitation going on in the electrical world in favour of the adoption of large storage batteries with the object of assisting in getting over the "peak" on both tramways and lighting loads, and the decision of the Manchester Corporation to put down in one of their electric generating stations an electric battery consisting of some 200 cells, each 6 ft. long by 2 ft. wide, has aroused fresh interest in this question. In any attempt to persuade engineers of the desirability of introducing accumulator plant into a central station for dealing with the peak, three main objections present themselves: unreliability, short life, and inefficiency. With regard to the alleged unreliability of accumulators, a storage plant by a responsible maker is usually claimed to be more reliable than either a boiler or a steam engine, or a generator considered as separate units. A battery, practically speaking, cannot fail under load as a steam unit may, neither can a battery suddenly develop serious faults. As to its durability, this point must be considered in connection with its maintenance. On a 10 years' basis, maintenance of accumulators can be obtained up to 100 per cent. of their specified capacity at a rate of about 7 per cent. on their capital cost. As this rate covers all items for repairs and renewals, no further charges for these items need be allowed for. The absolute efficiency of an accumulator is 75 per cent. reckoned in units, or, say, 70 per cent. to include auxiliaries.

The D.P. Battery Company, Limited, Bakewell, Derbyshire, have furnished us with some information which is an apt example of the savings resulting from the installation of one of their batteries after the station had been erected and running some years. A Diesel oil-engine was the motive power, having a guaranteed consumption of ·468 lb. per brake horse-power hour at three-quarter load. The following figures show the actual working results: Without battery, 10·2 units were generated per gallon; with battery, 12·3 units were generated per gallon. Thus the installation of the battery enabled an increase of 20 per cent. in the output on the same consumption of fuel. Without battery, 24,628 total units were generated and 22,718 lb. of oil consumed; with battery, 24,516 total units were generated and 18,198 lb. of oil consumed. Thus the consumption of fuel was reduced by 24·8 per cent. on practically the same load. The figures on another test were: Without battery, ·580 lb. per brake horse-power hour; with battery, ·474 lb. per brake horse-power hour. Thus the reduction in the average consumption on a four months' working is 22·15 per cent.

These figures are striking, but are by no means the actual measure of economy effected, for the installing of a battery is followed by a reduction also in the wages sheet, stores supply, etc. It is further evident that in designing a generating plant to meet the circumstances of a fluctuating load such as has to be provided for in power stations, factories, mines, ironworks, and similar undertakings the initial outlay can be considerably minimised in equalising the load by means of a battery.

THE ELECTRICAL OPERATION OF TEXTILE FACTORIES.*

BY HERBERT W. WILSON.

In submitting some notes concerning this subject, the author is faced by the difficulty that so much has been written during the past few years upon the various aspects of the question that it is extremely difficult to set forth anything fresh, and the present paper does not profess to be much beyond a review of the arguments for and against the use of electrical transmission as the method of conveying power to the various departments of a textile factory. Many, if not all, of the arguments employed can be found in some part or other of the voluminous literature on the subject contained either in the transactions of various engineering societies or the columns of the technical Press, but in many cases these arguments are somewhat distorted to suit the views of the person writing the article.

It is necessary to recognise first that a number of conditions affect the relative importance of the favourable considerations, and it will be well to make these clear at once. As regards the factory itself it may be (1) a spinning mill; (2) a weaving shed; (3) a bleaching, finishing, or dyeing works; (4) a combination of any two of the whole of these different sections. Also the particular case may (1) a totally new factory; (2) an existing works requiring additions; (3) an old mill requiring partial or entire re-equipment. Again, in an electrically-driven factory the energy may either be produced by the mill's own plant or purchased from some outside source of supply, provided sufficiently favourable terms can be obtained. It is obvious that there are such wide variations in the essential primary conditions presented, that it is impossible to lay down a list of advantages which will apply with equal force to all cases. Stated briefly, however, the main advantage claimed by the advocates of the electric drive and generally admitted by the owners of electrically-driven textile factories is that electrical driving permits of an improvement in the quantity and quality of the output of practically all textile machines. The importance of this point can hardly be exaggerated. If it is at once admitted that the claim of the electric drive's advocates in this respect is substantially true, the question of capital cost of equipment and running cost sink into relative insignificance.

To amplify the claims put forward by those in favour of electrical driving, they may in tabular form be stated as follows: (1) The mill and engine house can be placed each in its most convenient position without regard to their relative situations. (2) The internal arrangements of the mill as regards shafting, gearing, belt and rope drives, etc., are much simplified and the cost reduced. The flexibility as to extensions is, of course, obvious. (3) The grouping of the machines is much less arbitrary than in an ordinary mill, as the motors and light shafting required can be placed where most convenient. (4) The reduction of the chance of a breakdown which would stop the whole mill. (5) The ease with which sections of the machinery can be either stopped or run overtime (where conditions permit) without waste of power. (6) The reduction in the maintenance and depreciation charges. (7) The reduction in the capital cost per loom or per spindle of the whole factory when once a given size is exceeded; this is partly due to reduction in the weight and cost of the buildings. (8) The possibility of obtaining records of the work done in the different sections of the factory, otherwise impossible, and the keeping of a constant check upon them. (9) The greater steadiness of drive which can be obtained, with a consequent permissible higher average speed and increased output.

As before stated, this last claim is by far the most important one. It has been proved to all reasonable satisfaction in many cases that electrically-driven spindles in a mill can be run at a higher average speed, on the same counts, than mechanically-driven ones, with a corresponding higher production, and this can only be accounted for by the fact that the electrically-driven spindles run more steadily. Except in cases where a varying speed is

* Paper read before the Institution of Mechanical Engineers, July, 1909.

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arranged for to suit special conditions, an absolutely constant speed is most desirable. The tension on the yarn being spun is mainly dependent upon the spindle speed. Slight variations in speed above that corresponding to the maximum safe tension breaks the threads, and unless absolutely constant speed can be relied upon it is necessary to allow a margin of safety and to run at a speed materially below the breaking point.

In an electrically-driven factory properly laid out the speed of every machine should correspond directly with the speed of the prime mover, and, given satisfactory regulation on the engine, every producing machine can be speeded up to its safe maximum and kept there. With even the best rope transmissions it has been found in a number of cases in Lancashire mills that the speed of the machines closest to the driving point is steadier and higher than that of the machines furthest away. In other words, the one machine will give a larger output than the other. This has been tested by several persons in different factories quite independently, and the general order of the results have been the same. In one fairly well-known case in Lancashire, with two mills under the same management and of about the same size and working under the same general conditions, the results obtained from the electrically-driven factory have been distinctly superior to those from the mechanically-driven one. To such a marked extent was the improvement in quality of yarn noticeable that the output of the electrically-driven mill fetched a distinctly better price than that from the other factory, the increase being stated at about 2½ per cent.

It is exceedingly difficult to get absolutely reliable statistics concerning the improvement in output and quality obtained by mills in this country which have adopted electrical driving, but it may be taken as a conservative estimate that the increase in production is on the average at least 5 per cent. The improvement in value, as stated above, per pound of output has been given as anything up to 2½ per cent., but in the subsequent calculation this is left out of account.

Considering Lancashire practice, it may be advisable to point out that the cotton spinners and weavers state their costs at so much per pound of yarn or cloth produced. In the case of a spinning mill on most classes of counts, it may be taken that the margin over the price of raw cotton, out of which the manufacturer has to pay all his costs and make his profit, is something like 3d. to 3¾d. per pound. Assuming a price of 4d. per pound, therefore, the selling price of the yarn would be, say, 7½d. A considerable portion of this 3½d. is made up of the piece-work price per pound paid to the operatives, and it would not be easy to get any modification of this price. What may be taken as the standing charges of the mill—that is, the amount required to cover rent, rates, taxes, insurance, salaries, day labour, and cost of power—is but a comparatively small percentage of the cost of the finished article, and it would, therefore, take a considerable increase in output to make any considerable difference in the total costs per pound. Assuming, however, that these fixed charges amount to 12 per cent. of the total costs, which is a fairly average figure, then an increase in output of 5 per cent. would mean a reduction in cost per pound on the whole output of 0·6 per cent. In a modern spinning mill the total power costs do not amount to more than 2½ to 3 per cent. of the total expenses, and an increase of 10 per cent. in the cost of power would only mean an addition of 0 25 per cent. to the cost per pound of production. It will be seen, therefore, that even allowing for a considerable increase in the cost of power, which, personally, the author does not admit, there is a margin of 0 35 per cent. extra profit on the whole turnover, which means a considerable amount in a year.

Admitting for the sake of argument the approximate correctness of these figures, the opponent of the electric drive would immediately advance the objection of increased capital cost caused by the installation of an electrical transmission system. This has been argued almost to death, but it may be said that taking a new spinning factory as a basis, and assuming that if electrically operated the structure would be brightened and modified to suit the altered conditions, then below 80,000 mill spindles the mechanical transmission system is the cheaper, between 80,000 and 100,000 the costs are about equal, and above 100,000 the electrical system is the cheaper. This implies the taking of the total cost of the finished factory, and would involve the use of a steam turbine or quick-revolution engine as the prime mover for the electrical transmission system. The steam consumption per indicated horse-power hour would probably be slightly higher than if a slow-revolution mill engine had been used. The efficiency of the electrical transmission system would be about 82 to 83 per cent, or about the same as a well-laid-out modern mechanical transmission system.

In the case of an old factory requiring re-equipment it frequently happens that, owing to the inconvenient arrangement of the existing buildings, the electric drive offers distinct advantages both as regards initial capital outlay and efficiency. Cases have come before the author where the conversion has resulted in a reduction of 20 per cent. of the power consumption. Cases such as this can hardly be argued about, and anyone having experience of bleaching, finishing, and dyeing machinery, with its variable power requirements and intermittent use, will admit the advantages which electrical driving offers for this class of factory. The intermediate case, however, of a fairly modern factory with a good mechanical transmission system requiring extensions above the capacity of the engine is a very interesting and promising one. Under such circumstances as these the use of the exhaust steam turbine has many advantages, and, as will be shown, this almost of necessity involves either wholly or partially the electrical driving of the factory.

To take a concrete case now under consideration. A spinning mill mechanically driven but electrically lighted has a main engine of the compound vertical type developing 1,000 i.h.p., with a steam consumption of about 13 lb. per indicated horse-power hour. The lighting dynamos are driven by the main engine, and in the winter when fully loaded require a trifle over 100 h.p. It is required to make some extensions in the factory involving an additional load of about 200 h.p. It was first suggested that a generating set of 150 kw. (225 i.h.p.) should be installed at once, and later on a second set of the same capacity when other extensions became necessary. The first set would supply the lighting and also about 100 h.p. of motors in the preparation section, and thus relieve the main engine. A small set such as this with a standard quick-revolution engine, however, would use at least 16 lb. of steam per indicated horse-power hour, and it has since been suggested that an exhaust steam turbine might be a better solution of the difficulty. As plenty of condensing water is available the question was investigated, and it has been found possible to alter slightly the valve-setting of the main engine, obtain about 850 i.h.p. from it non-condensing and 500 i.h.p. from an exhaust steam turbine utilising the steam from the engine. In this manner it would be possible to obtain some 1,350 i.h.p. for a steam consumption of about 10·5 lb. per indicated horse-power hour. The saving in fuel over the other arrangement suggested is very considerable, being approximately 30 per cent, and this with the comparatively high price of coal in the district under consideration makes the total saving a large one. There are, however, several features in this case which require to be specially met, and the most important and obvious of these is the fact that the load on the turbine generator is to be a variable one, at all events as far as regards the lighting. This is a feature of difficulty, inasmuch as the load on the main engine is fairly constant and the amount of steam passed by it fairly regular. In order to meet the conditions, it is necessary either to use a portion of the steam from the main engine for other purposes at times of light load on the turbine, or else to make such an arrangement as will permit of the variation in load affecting both engine and turbine in the same proportions, and thus automatically regulating the supply of steam to the combined machines. The simplest method of doing this is to rope drive a small generator of, say, 100 kw. capacity from the engine, and to run this generator in parallel with the turbo-generator. This involves, again, the driving of a larger portion of the mill electrically than was originally intended, but the large fuel economy justifies this, apart

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altogether from every other consideration. This brief statement of a comparatively common case shows how in existing factories the introduction of the electric drive may reduce working costs apart altogether from every other advantage.

A question which is frequently argued with great vigour is the advisability or otherwise of a textile factory taking its supply of power from an outside source. This means, of course, the price at which it pays a manufacturing concern to buy energy rather than to produce it itself. The result of the author's observations is that a Lancashire factory of, say, 1,500 i.h.p. capacity can produce energy at, say, 0·2d. per indicated horse-power hour, or 0·3d. per kilowatt-hour, allowing for interest and depreciation. This is on a basis of being able to purchase good slack with a calorific value of 11,000 B.Th.U. at 8s. per ton delivered. It has been found generally practicable to induce fairly large factories to purchase power at about 0·4d. per unit net, the power being metered on the low-tension side of the mill switchboard before reaching the motors.

The main differences of opinion among engineers designing the lay-out of electrically-equipped mills arise over the questions of group or individual driving. The larger and the fewer the motors in a mill the smaller is the capital outlay, but at the same time the less the special advantages of electrical driving are felt. The more nearly the ideal of a motor to every machine can be approached the better the actual results, but the higher the capital outlay and generally the running cost. The author's personal feeling is in favour of the individual driving of ring spinning frames and the group driving of all other machines, but keeping the groups fairly small. The mere substitution as in some factories of a large motor for the rope pulley on a line shaft can hardly be regarded as the final step in the adaptation of an electrical installation to suit textile manufacturing needs. It is absolutely essential that the arrangement of the motors shall have very careful consideration.

A point needing attention is the heating effect of the motors. In a ring spinning room, for example, with a large number of small motors directly coupled to single machines, the total amount of heat given off from the motors may be sufficient to raise the room temperature considerably. It is now the best practice to build these motors with hollow frames and to bring cooling air from some external source round the frames, thus preventing the discharge of heat to the room.

Horse-Power Required.—Electrical manufacturers generally do not appear to realise that the actual powers required need very careful investigation before the machines are actually installed, and it is by no means a safe rule to assume that the horse-power is so much per 100 spindles of the mill, as this may lead to considerable error. If a large mill engine is being put down to drive the whole of the plant, it may be perfectly safe to use such general assumptions; but when what is practically equivalent to a subdivision of the prime mover is made, the most careful consideration of the power taken by each section of the installation is necessary.

Considering this question of horse-power required, some figures from mills actually working near Manchester may be of interest.

In Table I. is given a list of the machines installed in a small mule spinning mill, with statement of the horse-power required by the various machines, calculated on the usual basis. In Table II. is given a more accurate statement of the power required per machine, or the *average* number of spindles per horse-power, the speed of running of the machine, and the nature of the load provided by the machine, including also an estimate of the time the machine is standing idle for doffing, shown as a percentage of the total running time. In Tables III. and IV. are given the sizes of motors actually installed in two mills in Lancashire where group driving is employed, and it may be said that in nearly all cases these motors are direct-coupled to high-speed line shafts. It must be remembered that in all these cases the *average* number of spindles per horse power is stated, and this may vary considerably with the speed of the spindles and class of counts spun. In the case of ring frames, the number of spindles per horse-power may vary between 140 at 6,000 r.p.m. and 80 at 9,000 r.p.m., so that great care has to be exercised in considering the question of the size of motors required.

The object of this paper has been to give an idea of the recent developments in a very interesting application of electricity, and to show some of the main points requiring attention in considering any particular case.

TABLE I.

Machines.	Horse-power
1 bale breaker and lattice mixing arrangement	3
3 horizontal exhaust openers	18
10 single scutchers	35
84 carding engines	84
11 draw frames	20
9 slubbers, total spindles 882	17
16 intermediates, total spindles 2,212	36
40 rovers, total spindles 6,880	100
28 mules, 1⅛-in. gauge, total spindles 36063	314
40 mules, 1⅜-in. gauge, total spindles 42,320	242
Total	869

TABLE II.

Machines.	H.P.—Approx.	R.P.M.	Load.
Hopper bale breaker	3	300	Steady, if feed is regular.
Hopper feeder	1½	600 850-1,000	,,
Exhaust opener	6-8	950-1,400	,,
Single scutcher	3½-5½	950-1,400	Steady.
Carding engine	1	140-190	,,
Drawing frame	0·15 per delivery	180-300	8-27·5 per cent loss of time due to stoppages; load steady during run.
Slubbing frame	45 sps. per h.p.	200-450	39·22% ,,
Intermediate frame.	55 sps. per h.p.	360-490	18·8% ,,
Roving frame	65 sps. per h.p.	360-480	17·5% ,,
Ring frame	70 sps. per h.p.	600-1,000	5·10% ,,
Mules	100 sps. per h.p.	—	4·7½ per cent. loss; load very variable.
Doubling frame	40-70 sps per h.p.	600-1,000	5·10 per cent. loss; steady during run.
Winding	300 sps.	140-180	Steady.
Beaming	6 per h.p.	40	,,
Sizing machine	1½-3	210-300	,,

TABLE III.

Machines.	Size of motors.
Bale breakers, exhaust openers, lattice mixers, scutchers	45 h.p., 575 r.p.m., directly connected to line shaft.
20 carding engines, 3 draw frames, 3 slubbers, and 6 intermediate.	55 h.p., 575 r.p.m., driving counter-shaft with ropes.
3 pairs of mules and 14 rovers	100 h.p., 580 r.p.m.
6 pairs of mules	130 h.p., 530 r.p.m.
4 pairs of mules and several ring frames	100 h.p., 580 r.p.m.
120 looms	50 h.p., 580 r.p.m.
152 looms	65 h.p., 580 r.p.m.

TABLE IV.

Machines.	Driven by
2 waste pickers 1 roving waste opener 2 hopper bale breakers with lattice mixers	1 motor, 12 h.p.
4 hopper feeders 4 horizontal openers with double scutchers 12 single scutchers	2 motors, 40 h.p. each.
84 cards, 45-in. cylinder 3 drawing frames, each 6 heads of 7 deliveries each	2 motors, 65 h.p. and 50 h.p.
8 slubbing frames, 100 spindles 19 intermediates, each 146 spindles 45 rovers, each 184 spindles	2 motors, 90 h.p. and 75 h.p.
63 ring frames, 2¼-in. gauge 6-in. lift. Total spindles, 74,864 32 mules, 1¼-in. gauge. Total spindles, 41,216	Several motors, aggregating 850 h.p., in 200 h.p. and 150 h.p. units.
3 winders, 2,000 spindles 10 beaming engines	15 h.p. Approx. total = 1,250 h.p.

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ELECTRIC LIGHTING FOR MOTORCARS.

It is rarely that motorcar owners give that consideration to the question of car lighting which it deserves. Even motorcar engineers do not give to it more than passing attention, which is a great mistake, for the importance of ample, efficient, and economical illumination cannot be too exaggerated. The most essential requirements in connection with car lighting are powerful headlights, capable of

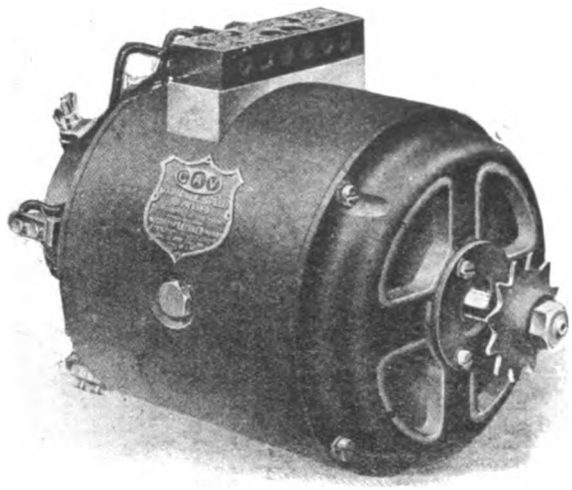

FIG. 1.—Leitner-C A.V. Variable-Speed Auto-Generator.

projecting a non-dazzling, non-flickering, penetrating light. Now, very few acetylene lamps comply with these requirements. It is true that the actual flame produced by them is of very high candle-power, but on account of the intense heat generated and the space required for combustion and its products it is possible to bring but a part of the flame into correct focus. Most of the light is therefore dissipated in a useless and trouble-provoking direction. The reflecting surfaces are only efficient if kept scrupulously clean, and the vibration of the car tends to keep the flame the reverse of steady. Can electricity provide a better solution? Theory, added to the weight of practical experience, answers yes. Leaving the source of supply for a moment out of the question, a well-designed electric headlight possesses all the features which have already been referred to as being essential. The whole of the light given by the high-power bulb is in focus, and, therefore, efficiently used. The side lights, tail light, dash light, and, in the case of cars with limousine bodies, interior lights, have next to be considered. Oil lamps are, of course, capable of providing a more or less satisfactory illumination for these lights, but assuming there exists no difficulty as to the source of supply, it can be confidently stated that electricity would be universally preferred.

Now, the question that remains to be considered is that of the method of supplying electrical energy. The best known is, perhaps, the storage system. It would undoubtedly be more advantageous to automatically provide a permanent source of electricity on the car. This would involve the conversion of some of the mechanical power of the motor into electricity through a small dynamo. Provision must, in addition, be made for continuing the supply of current when the car is at rest, and this would necessitate the use of a small battery together with an automatic switch for connecting or disconnecting the former to or from the dynamo. A simple system embodying these features has been evolved by Messrs. C. A. Vandervell, Acton-vale, London, W. This, which is known as the C.A.V. system, is in effect the well-known "Leitner" system of train-lighting in miniature. Although we do not believe that it has been heretofore prominently placed before the motoring public, the system has during the last three years been subjected to practical working under careful observation, during which time any mechanical weaknesses would have become apparent in the many equipments fitted.

The essential components forming the C.A.V. automatic electric generating and storage equipment are as follows: one Leitner variable-speed dynamo and automatic switch, one battery of small accumulator cells. The primary energy is derived from the motor of the car or boat (for the system is equally applicable to motor boats), and is transmitted to the dynamo either by direct drive, gear, chain, or belt from one of the motor shafts, or one of the moving parts of the vehicle, as, *e.g*, the clutch shaft or cardan, according to the most suitable means. A continuous supply of current is thus furnished to the battery, through the automatic switch, whenever the engine or vehicle is running; and ample storage is provided by the battery for such times as the motor or vehicle is at rest. The generation, storage, and regulation of current is

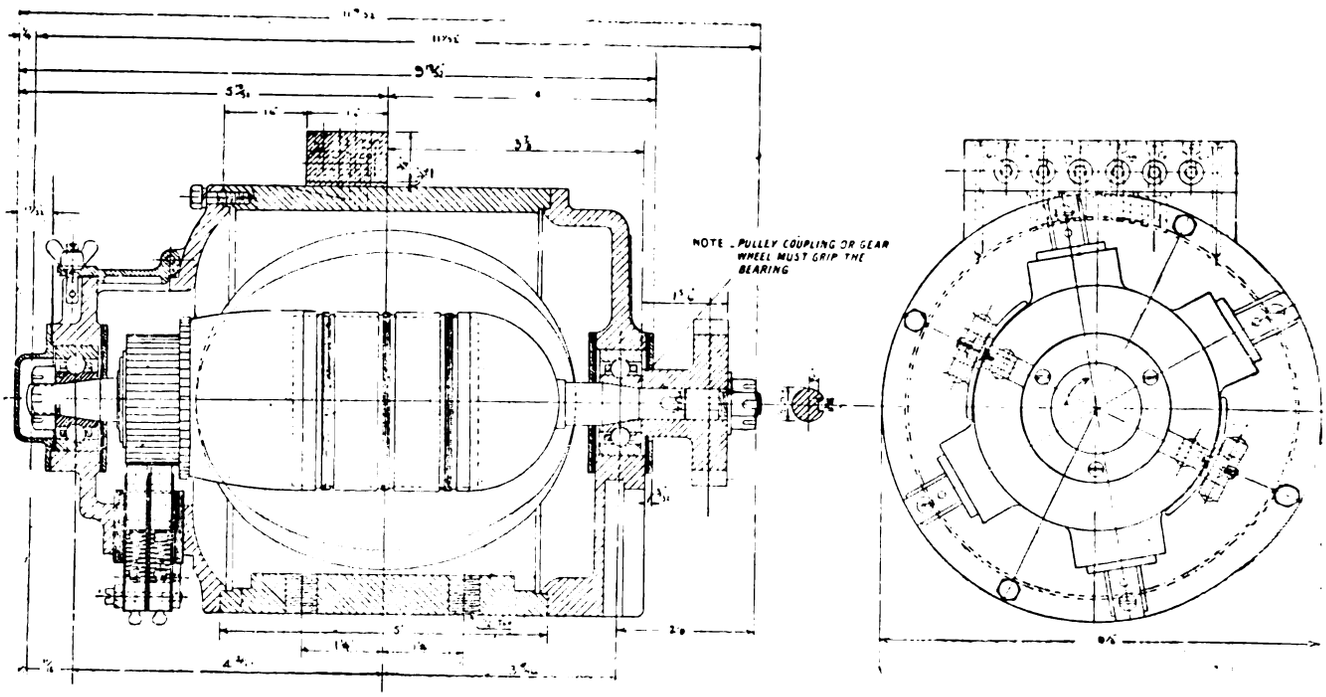

FIG. 2.—Sectional Side Elevation and End View of Variable-Speed Dynamo (Leitner's Patents), showing complete dimensions.

entirely automatic, and thus, from a theoretical point of view, the upkeep is represented by the exceedingly small amount of energy taken from the motor in revolving the armature of the dynamo, which is about $\frac{1}{8}$ h p In practice, it may be found necessary to add distilled water to the cells from time to time and, say once a year, to examine the lubrication of the ball bearings of the dynamo, otherwise the system, once properly installed, requires no adjustment or attention. Steadiness of voltage on the lamps is achieved by

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the introduction of a resistance of positive temperature coefficient, which is automatically placed in series with the lamp circuit whenever the battery is being charged. Protection against electrical defects in wiring is obtained by the introduction of small fuses in the principal circuits. Another facility afforded by the C.A.V. system is adjustment of the dynamo output according to prevailing conditions. This is accomplished by so arranging the wiring that resistance is either inserted into or withdrawn from the "field" of the dynamo by a small switch, which may be referred to as the "output adjuster." The objects are two-fold—that for daylight running, instead of wastefully pumping the maximum current into a battery already charged, or nearly so, the dynamo delivers but a small part of its normal output with proportionate economy of energy, and to permit of a partially discharged battery

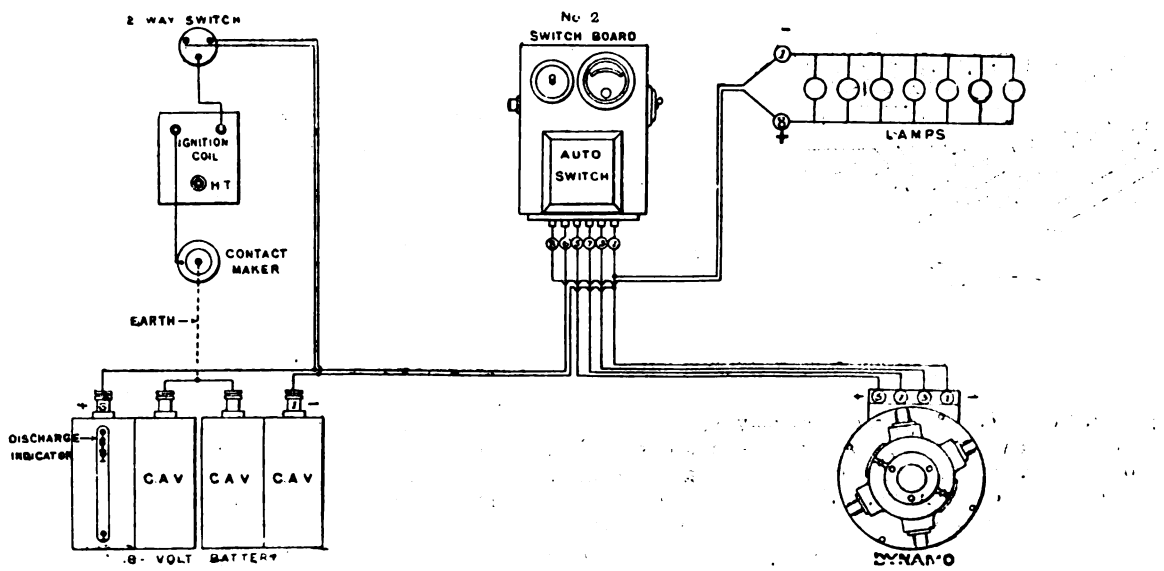


FIG. 3.—Wiring Diagram of System, with Switchboard, including Connections for Four-Volt Ignition.

(due to running conditions) receiving the maximum output of the dynamo if required. The output-adjuster switch has two positions, "half" or "full" output. The normal position for running is at "half output," but by a simple wiring connection the mere fact of turning on the lights automatically causes the dynamo to give its full output, irrespective of the position of the adjuster switch.

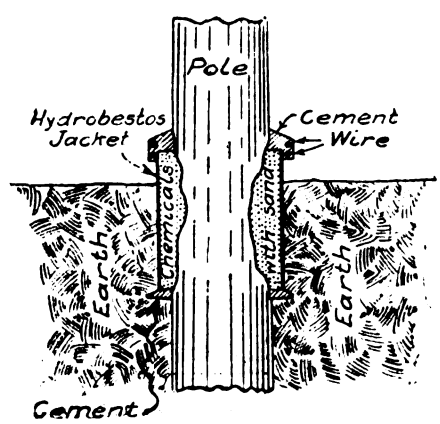
Where possible, all the wiring should be contained in enamelled steel tube, or otherwise suitably protected. While this is not an inherent requirement of the system, experience has proved the ultimate value of taking all possible precautions to avoid leakages and broken wires. A diagram showing the wiring connections for one of the schemes to which this system is applicable is given in Fig. 2. It will be seen that in this scheme the automatic switch is combined with the switchboard. The connections for coil ignition are shown in order to indicate that the battery may be used for this purpose. By this method, not only is there a fully-charged accumulator always available for the coil ignition, but also a spare; thus no more accumulators are required than would ordinarily be provided for dual ignition, using a 14-volt system with a spare accumulator. It will also be noticed that when wired in this way, the act of switching over from one accumulator to the other reverses the direction of the current through the coil, thus preventing pitting of the contacts.

A NEW METHOD OF PRESERVING WOODEN POLES.

In a paper read before the Association of Railway Telegraph Superintendents in Detroit, U.S.A., and reported in the *Electric Railway Journal*, H. P. Folsom described a new method of preserving wooden poles and posts from decay at the ground line. The unique feature of this method is in surrounding the base of the poles with a fibre cylinder which encloses a mixture of powerful germicides packed around the pole above and below the ground line.

In applying this method of preservation to poles which have begun to decay, a hole is dug around the pole to a depth of 14 in. below the ground line. All decayed wood is removed from the surface of the pole, and the bottom of the hole is then covered with a thin layer of Portland cement mixed with sand. A cylindrical jacket of "hydrobestos" about 4 in. larger in diameter than the butt of the pole is then put in place in the hole and the lower edge of the jacket is embedded in the cement. The two edges of the jacket are lapped over about 2 in. and fastened with a specially prepared cement. The hydrobestos jacket is made in the form of a sheet composed of a special mixture of asbestos and "asphaltum." This mixture is subjected to a pressure of about 27,000 lb. per square inch during manufacture, and it is claimed that it is practically indestructible, being impervious to water, acids, or alkali.

When the jacket is put in place around the pole the intervening space is filled with a germicide mixture, packed dry. In selecting the germicide the aim was to use a mixture which was powerful and effective in destroying animal organisms, and which would not injure the fibre of the wood, or be too costly to be practicable. The mixture ordinarily used consists of hydrated lime, rock salt (chloride of sodium), and a small quantity of sulphate of copper, mixed with coarse sand. After the germicide is in place in the shell or jacket, a reinforced cap or collar made of Portland cement and sand is formed around the pole on top of the jacket. For the reinforcement, one or more turns of the old telegraph or telephone wire are used.



Method of Applying Preservative to Wooden Poles.

The reinforced cap protects the chemicals, and the jacket and cap prevent the lodging of other germs in the wood near the ground line. The reinforced cement cap gives a finished appearance to the pole, and experience has proved that there is little or no tendency for the concrete to crack or disintegrate, as there is no expansion or contraction in the pole which it surrounds. When applying this method of preservation to a small number of poles the men work in gangs of three. One man precedes the other two and digs around and cleans the poles. The other two men follow with a wagon containing the chemicals, and finish

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the treatment. If the poles are located along a railroad, the material can be distributed in small sacks at each pole from a hand-car. Three men can treat from 20 to 30 25-ft. poles per day. The cost per pole for labour and material is from 3s. to 4s. Some very large poles cost from 6s. to 10s. A few poles were treated by this method nine years ago, and it is stated that the protecting sleeve is still in good condition.

ELECTRICAL INVENTIONS AT THE WHITE CITY.

At the invitation of the Cowper-Coles Engineering Company, Limited, a number of representatives of the technical

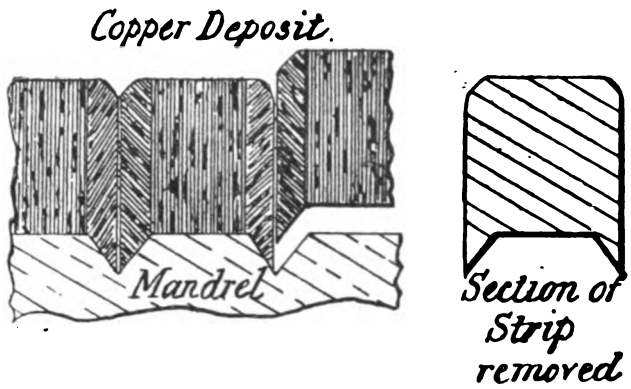

FIG 1.—Diagram showing Method of Forming Weak Line of Cleavage due to Crystalline Structure.

Press visited the Imperial International Exhibition, Shepherd's Bush, on Friday to view the many inventions exploited by the company. The display is an interesting one, covering a very wide field of industry, though only a section of Mr. Sherard Cowper-Coles's ingenious contrivances directly concern us. Several of the processes exhibited are already well known, but the inventor is constantly introducing modifications and improvements, so the collection is well worth inspection.

Excellent specimens of copper sheets and tubes of various dimensions are shown produced by the "C.C." centrifugal electrolytic process, together with working drawings of the plant required and parts of the apparatus. Heavy tubes of small dimensions and cylinders 4 ft. in diameter, produced by deposit on revolving mandrels in the electrolyte, present a beautiful, smooth inner and outer surface. They are of wonderful strength. An extension of this process concerns the production of metal strips, either for forming light ribbons or for wire manufacture. Early in his experiments Mr. Cowper-Coles discovered the weak lines of cleavage formed in metals cast in right-angled moulds could be obtained with electro-deposited copper. This discovery was put to practical use by scoring mandrels with V-shaped spiral scratches. These mandrels are revolved in the electrolyte until the desired thickness of copper deposit is obtained. The metal can then be unwound in strips, which may attain very considerable lengths—up to four miles, the inventor assures us. Of course, by varying the depth of the V-shaped spirals, by making it close or open, the dimensions of the strips may be regulated so as to secure bands or metal strips square in section, which can be readily finished off into wire of perfectly equal and great tensile strength. The whole process is delightfully simple and economical.

A varied assortment of metallic parabolic reflectors, electro-deposited, are shown. These have already been largely adopted by the Admiralty and War Office for searchlight purposes, but Mr. Cowper-Coles is now adapting them for use in connection with motorcar headlights. Originally these strong, light parabolic mirrors were silvered, giving an intensely dazzling effect. Then Mr. Cowper-Coles coated the reflectors with gold, thus obtaining a very penetrating light, carrying far even through fog, and without the dazzling effect. This form is used for motorcar headlight and kindred purposes, but by an ingenious contrivance both the penetrating power and dazzling effect may be secured on one reflector. This object is attained by depositing the white and yellow metal alternately in sections, circles, or spirals. These combinations give a beam which, while penetrating, yet retains the valuable property for searchlight purposes of dazzling. This will undoubtedly add enormously to the already great advantages possessed by the electro-deposited reflectors. Several other inventions are now in the course of being perfected. Among these we think highly of the future of a new method of taking electrotypes for printing purposes. To complete the exhibit, plans and drawings of the different appliances used in the processes of manufacture are shown, and also an important collection of metals treated electrolytically. These include chromium, cobalt, platinum, palladium (largely used in silvering the parabolic reflectors), and iridium, as well as electro-deposited alloys, such as cadmium and silver and copper and zinc.

Apart from the display of the Cowper-Coles Engineering Company, there is very little to interest the electrical engineer in the machinery hall of the White City. The A/S De Norske Salpeterverker and Norsk Hydro-Elektriak Kvælstof - Aktieselskab, Christiania, combine to show samples of nitrate of lime fertilisers, containing 25 per cent. of lime and 13 per cent. of nitrogen, the nitrogen being extracted from the air electrically. The power for generating the electricity at the Norske Salpeterverker is obtained from the Bjukan Fall, from which 227,000 h.p. can be obtained.

Another interesting exhibit is the "float" electric

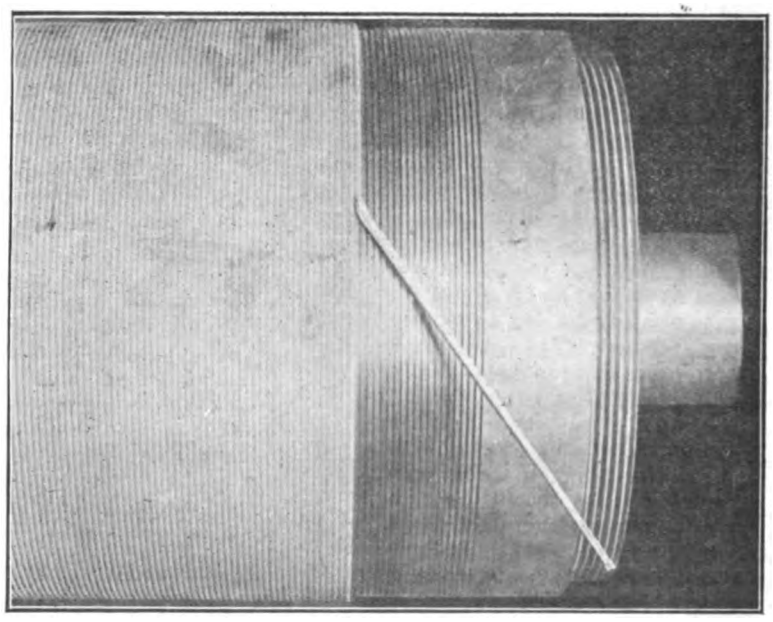

FIG. 2.—Mandrel, showing Method of Unwinding Copper Strip.

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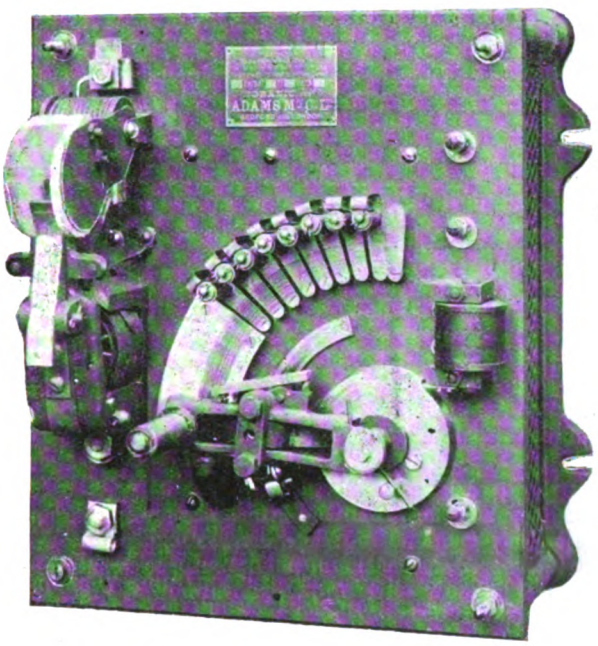
inspection lamp, manufactured by the New Ignition Syndicate, Limited. It is for use with "float electrolyte," the batteries being hermetically sealed and charged from any main or generating battery to give 12 hours' service.

NEW MOTOR-STARTING SWITCH FOR PRINTING MACHINES.

Particulars of a new type of motor-starting switch for use with printing machines have been sent to us by the Adams Manufacturing Company, Limited, of Bedford and of 106, New Bond-street, London, and some of the features



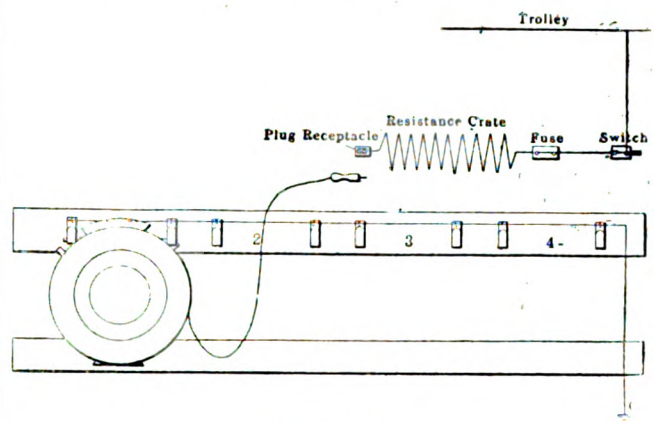
"Igranic" Motor-Starting Switch for Printing Machines, with outside cover removed.

are not only quite novel, but decidedly ingenious. Every printer's engineer knows that the starting of printing presses is very hard on the switchgear on account of the constant "inching" which is necessary when preparing the press. This constant "inching" causes most injurious arcing on the contacts of the starting switch, with the result that ordinary starting switches are soon destroyed, and even though renewable contacts may be used, the renewals are so frequently required as to become a nuisance as well as a very serious expense. To prevent this injurious arcing, all sorts of devices have been employed. The most successful is to use self-acting motor-starting rheostats, in which the motor circuit is always made and broken by means of a solenoid-controlled switch which has carbon contacts for circuit breaking as well as magnetic blow-outs. For small flat-bed presses, however, the initial cost of self-acting motor starters is often too great.

With the object of rendering ordinary hand-operated starters suitable, such devices have been employed as carbon auxiliary contacts, magnetic blow-outs, and interlocked solenoid switches, etc. These devices have failed because they have protected only the first step, whereas the minder, whose eyes must be on the machine and not on the starter, pulls the handle when inching over to the third or fourth contact, or, perhaps, further, and in moving it back draws a destructive arc across the starter steps. As will be seen by the illustration, the new "Igranic" switch employs an interlocking magnetic circuit maker and breaker, but the essential merit of the arrangement consists in the fact that no matter how far the operator pulls the handle over in a forward direction the slightest backward movement instantly open the circuit breaker. Consequently no arcing can occur on the starter steps because they are "dead." The circuit breaker has carbon contacts and magnetic blow-out, and will open circuit an infinite number of times without receiving injury. With this starter, therefore, "inching" may be practised to an unlimited extent—in fact, a recent extended trial in a large printing works under ordinary working conditions left the contacts as good as new. In addition, the interlocking of the circuit breaker with the starter makes it impossible to close the motor circuit except with all the starting resistance in circuit, so that the motor receives proper protection and the starting switch may be said to be practically "fool-proof."

HEADLIGHT TESTING RACK.

Mr. Wayne P. Hendricks, superintendent of the Sterling Dixon, and Eastern Electric Railway, Dixon, Illinois, has supplied the New York *Electric Railway Journal* with a sketch and some particulars of a headlight rack used on his line, which we reproduce. It is a tell-tale rack, enabling the lamps to be tested before they are used. The rack is provided with hooks for supporting four headlights. These hooks are connected to ground, and above the rack is a plug receptacle connected with the trolley circuit through a resistance grid, fuse, and switch. During the day the headlights for the four cars operated are hung on this rack, and at night, before placing one on a car, it is only necessary to put the lamp plug in the near-by



Headlight Rack.

receptacle to ascertain whether the lamp is in good operating condition.

TANTALUM AND ITS INDUSTRIAL APPLICATIONS.*

BY ALEXANDER SIEMENS, ESQ., M.INST.C.E., M.R.I.

When the announcement was made in the year 1878 that "the division of the electric light had been successfully accomplished," many people believed that the days of lighting by gas had come to an end, and acted accordingly, much to their own disadvantage: for the competition of the glow lamp served only to stimulate its rival to new life. Burners of improved construction, regenerative burners, and, finally, gas mantles helped to restore to gas the ground it had lost, and until a short time ago even threatened to check the spreading of electric lighting. Not only this growing competition of gas, but the universal necessity of cheapening the production of commodities that are for general use, forced electrical engineers to study in all its aspects the question of improving the efficiency of electric lighting. As a guide in their researches they had the well-known principle that the illuminating power of a solid body increases at a much greater ratio than its temperature, or, in other words, that with the increase of temperature a greater percentage of the energy expended for heating the body is converted into light. There is plenty of room for improvement, for even the most economical source of light, the electric arc lamp, converts only about 1 per cent. of the energy of the electric current flowing through it into light, the rest appearing as heat, so that in reality all methods of lighting devised by men are, to a much greater extent, methods of heating. The first successful incandescent lamp consisted of a carbon filament; and for a long time carbon appeared to be the only suitable

* Paper read before the Royal Institution of Great Britain.

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substance, although the temperature to which such a filament can be raised is limited to about 1,600 deg. C., as above this point the carbon begins to disintegrate rapidly. At this temperature the lamp consumes from 3 to 3½ watts per candle-power, while any attempt to produce light more economically by raising the temperature of the filament results only in shortening its life, and destroying thereby its power of competing with gas lighting. An improvement on this result was introduced by Prof. Nernst, of Göttingen, who suggested as a source of light refractory earths, similar in character to those used for gas mantles, which, however, conduct electricity only when they are hot. Lamps constructed on Prof. Nernst's principle have, therefore, to be fitted with contrivances for heating their filaments when starting, which complicate the construction of the lamp.

Another step forward was made by the invention of the osmium lamp, which is produced in a somewhat similar manner to the carbon lamp, by squirting a plastic mixture of metallic oxide and a reducing agent into the shape of a filament, which is gradually heated in a glass bulb by the passage of an electric current, while the bulb is being exhausted by an air-pump, or an equivalent device. As far as utilisation of energy goes, these lamps are a great improvement on carbon lamps, but their filaments are very brittle, and the total production of osmium per year is only about 8 kg. for the whole world, of which 5 kg. are wanted for medical purposes.

In January, 1905, Dr. W. von Bolton, the head of the chemical laboratory of the firm of Siemens and Halske, announced in a lecture to the Elektrotechnische Verein of Berlin that he had succeeded in producing pure tantalum, and his discourse was followed by Dr. O. Feuerlein, describing how tantalum had been utilised for filaments in the lamp works of the firm. These discourses presented the result of long years of research work, based on the general principle already alluded to, that that filament would give the best economical results which could be maintained for the longest time at the highest temperature. The number of substances capable of conducting electricity and of sustaining such high temperatures is very limited, and platinum—the most refractory of the well-known metals—had been tried and found wanting. It became, therefore, necessary to start the research by devising methods for producing the rare metals in a commercially possible manner, and then try one after the other as filaments of incandescent lamps. While working on these lines, Dr. von Bolton succeeded, in the first instance, in producing a vanadium filament by heating a mixture of vanadium pentoxide and paraffin to 1,700 deg. C., and thereby producing sticks of vanadium trioxide, which in their turn were heated by electric currents in a glass bulb exhausted by an air-pump, and so converted into metallic filaments. As it was found that vanadium melts at about 1,680 deg. C., such filaments were no improvement on carbon filaments; and the next substance to be investigated was niobium, which belongs to the same group of elements, but has nearly double the atomic weight. Treated in a similar manner, the niobium filament gave somewhat better results, but still its melting point, estimated at 1,950 deg. C., was too low for practical purposes. In this connection it should not be forgotten that at a temperature considerably below their melting point all these metals begin either to soften or to disintegrate, so that their "working" temperature is not identical with their melting temperature.

Turning his attention to tantalum, which has an atomic weight of 181, Dr. von Bolton experimented with the black metallic powder produced by the method of Berzelius and Rose, and found that it could be rolled into a fairly coherent mass in the form of ribbons. Alternative experiments, conducted on the lines by which vanadium and niobium had been obtained, resulted in the production of pure tantalum in the form of a metallic button, which was found to be tough and malleable like steel. These and other qualities convinced Dr. von Bolton that nobody before him had handled pure tantalum, although Berzelius had first obtained the metal by a chemical process in 1824, and later Moissan succeeded, in 1902, in producing it in his electric furnace. The latter describes tantalum as a hard, brittle metal of the specific gravity of 12·8, and a non-conductor of electricity, but he adds that the substance obtained by him contained about ½ per cent. of carbon. Considering the high atomic weight of tantalum, this admixture of carbon evidently exercises a great influence on the physical qualities of tantalum, and explains the differences between the observations of Dr. von Bolton and those of his predecessors.

In Nature, ores containing tantalum are found in many places, principally in Scandinavia, North America, South-West Africa, and Western Australia. A specimen of columbite from South Dakota and another of tantalite from Western Australia are exhibited. The columbite contains from 10 to 40 per cent. of tantalum pentoxide (Ta_2O_5), and a good deal of niobium combined with iron and manganese in various proportions. As the separation of tantalum and niobium is somewhat troublesome it is preferable to utilise the tantalite, which consists almost entirely of iron and manganese combined with tantalum pentoxide. From these ores tantalum is separated in the form of a fluoride in combination with potassium (K_2TaF_7), and subsequently reduced by metallic potassium to the black powder already mentioned, which, however, still contains some oxide and some hydrogen. In order further to purify the product the powder is pressed into the form of small cylinders (one of which is on the table), which are melted in a vacuum by an electric current under certain precautions into small buttons of pure tantalum such as are exhibited.

Since the production of tantalum has been carried out on a commercial scale, it has been possible to improve many details of the process, so that the tantalum produced by it at the present time is even purer than that shown in 1905 at the discourse of Dr. von Bolton and Dr. Feuerlein. Some specimens of this latest tantalum have been submitted to Sir James Dewar, who has very kindly made experiments with reference to its specific heat and to its thermal conductivity. He ascertained the specific heat by plunging small spheres of tantalum, which had been heated to the temperature of boiling water, into water of 14 deg. C., then transferring them to melting carbonic acid (−78 deg. C.), and finally to liquid air (−183 deg. C.), and as an average of several experiments the specific heat was found to be between

100 deg. C. and	14 deg. C.	= 0·033
14 deg. C. „	−78 deg. C.	= 0·032
−78 deg. C. „	−183 deg. C	= 0·028

while Dr. von Bolton in 1905 gave the specific heat as 0·0363. Multiplying these results by the atomic weight (181), it will be seen that Dr. von Bolton's value (6·57) is slightly higher and Sir James Dewar's value (5·97) lower than 6·4, which, according to Dulong and Pettit, is the atomic specific heat. By the kindness of Sir James, his experiment for showing the relative thermal conductivity of iron, copper, and tantalum can be repeated here by dropping three short rods made of these metals in liquid air, while their tops above the cardboard cover are exposed to the air of the room. In a short time the moisture of the air condenses on the rods and freezes to a distance, which depends on the conductivity of each metal. The results of Sir James Dewar's experiments prove tantalum to have about three quarters the conductivity of iron and about one-eighth the conductivity of copper. At ordinary temperatures, say below 300 deg. C., pure tantalum resists the action of all acids, except fluoric acid, of all alkalies, and of moisture, so that it is an ideal material for chemical apparatus which do not require high temperatures and for any implements which, when made of steel, are liable to rust.

It has already been stated that pure tantalum is rough and malleable, so that it can be hammered out into thin sheets or drawn into fine wire, the diameter of the filament wire being 0·03 mm., or about $\frac{1}{800}$ in.; all the same, it is elastic and as hard as soft steel, and has a tensile strength of 93 kg. per square millimetre, which is equal to 57 tons per square inch. This means that the filament wire is capable of supporting about 80 grm., or 2·8 oz., as can be shown by actual experiment. Tantalum sheet can be stamped into various shapes, and out of bars of tantalum springs can be bent, as the specimens on the table show.

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Another use made of tantalum is as material for writing pens, manufactured in the usual way. When it was first offered for this purpose, it was found that the material could not pass the test prescribed for pens made of steel. These are pressed by a weight of 180 grm. on writing paper, which is moving at the same speed as ordinary writing, and while 10 km. (6¼ miles) of paper are passing, the loss by abrasion must not exceed 0·7 mg. (0·01 grains). At first the tantalum pens lost more than double the permitted weight, but it was found that slightly oxidising the surface of the pens hardens them so much that they only lose 0·8 mg. by the 10-km. test. By weight this is still more than permitted for steel pens, but having regard to the specific weights of the two substances, the actual volumetric abrasion of the tantalum pen is the lesser of the two.

Although only the surface of the pens had been oxidised it was found that the rate of abrasion remained the same for the whole length of 10 km., when it was expected that this rate would increase materially after the skin of oxide had been ground off. Advantage was taken of this circumstance when an inquiry was received from India whether it would be possible to manufacture cataract knives for oculists out of tantalum. The qualities demanded of such a knife are that its blades should be: (1) intensely hard, so as to be able to acquire a very sharp edge of great smoothness, and to retain this fine edge for a long time; (2) very tough without any tendency to bend; (3) chemically and mechanically stable, so that it can be easily sterilised and that it is not liable to rust; (4) capable of acquiring a high polish. Manufacturing such a blade out of pure tantalum and slightly oxidising it before polishing it appears to fulfil these stringent conditions, but as the knife which is on the table has not yet been actually tried for an operation, it can only serve to demonstrate the similarity of tantalum to steel for such purposes. Another field for the application of tantalum may be found in the supply of dental instruments, owing to its immunity from chemical changes, but beyond showing two cases of such appliances, there is no necessity to go further into details.

While possessing all these qualities of a true metal, tantalum has some others which rather limit its usefulness. When heated to a dull red it absorbs gases greedily, especially hydrogen and nitrogen, and by combining with them it loses its tensile strength and becomes brittle. Here are three pieces of tantalum wire taken from the same coil; one of them has been heated in an atmosphere of nitrogen, the other in hydrogen, and the third has not been interfered with. The consequence is that the latter has retained its strength, while the former have become brittle and useless. On heating tantalum in air, it shows first a yellow and then a blue tint like steel, but when the heating is continued it burns to pentoxide. The black powder and thin wires can even be lighted by applying a match to them, as the experiment shows. Its melting point, *in vacuo*, lies between 2,250 deg. C. and 2,300 deg. Celsius, which makes it particularly suitable for electrodes in vacuum tubes, especially as it does not disintegrate—for example, Ta electrodes are extensively used in Röntgen tubes—and its specific weight is 16 6.

Turning now to the electrical qualities of tantalum, its specific resistance was stated by Dr. von Bolton, in 1905, to be on the average 0·165, with a temperature coefficient of 3 per cent. between 0 deg. and 100 deg. Celsius. Further experiments conducted by Dr. Pirani in the laboratory of Siemens and Halske revealed the fact that wires of various thicknesses varied in their specific resistance from 0 173 to 0·188; but after they had been heated to 1,900 deg. Celsius in a high vacuum for from 100 to 200 hours, they all possessed the same specific resistance—viz., 0 146—and their temperature coefficient between 0 deg. and 100 deg. Celsius had risen to 0 33 per cent. As a temperature of the tantalum filament, when consuming 1·5 watts per candle-power, is about 1,850 deg. C., and its resistance about six times its resistance at 100 deg. C, the temperature coefficient between 100 deg. and 1,850 deg. C. may be taken, on the average, as 0 29 per cent. No doubt the difference between these results is caused by alterations in the structure of the wires during their manufacture, and the heating *in vacuo* served a similar purpose to the annealing of steel, so that Dr. Pirani's results published in 1907 may be taken as standards.

At present the most important industrial application of tantalum is its use for the filaments of incandescent lamps, which may be said to date from July, 1903, when Dr. Feuerlein had succeeded in producing a tantalum wire $\frac{1}{20}$ mm. in diameter. Of this wire he made a glow lamp with a filament 54 mm. long, using a current of 9 volts 0·58 amperes, and giving a light of 3·5 candles (Hefner), at the rate of 1·5 watts per candle-power. A simple calculation shows that for a current of 110 volts 660 mm. of the same wire would be required, giving at the same rate of consumption of energy a light of 43 candles. In carbon lamps for 220 volts the length of filament is only 400 mm., and the filaments remain hard until they disintegrate. Tantalum filaments, like other metallic filaments, soften, however, to such a degree that they cannot be used in the same shape as carbon filaments. After trying various methods of housing the long Ta filament in a glass bulb of approximately the same dimensions as the carbon glow lamps, the present form was arrived at during the year 1904. In this lamp, which was adopted as standard, the length of the filament was 650 mm., its diameter 0·05 mm., and its weight 0·022 grm., so that about 45,000 of these lamps contain 1 kg. of Ta. Since then these dimensions have been modified to a certain extent; for instance, the diameter of the filament is now only 0·03 mm., but the external shape has not been altered. It was soon found that after burning a short time the filament underwent certain structural changes and lost its great tensile strength. Examination under a microscope revealed the fact that in about 1,000 hours the smooth cylindrical filament shows signs of capillary contraction, as if the cylinder was going to break up into a series of drops, and the surface, from being dull, commences to glitter. This contraction of the filament after being heated is readily recognised by comparing a new lamp with an old one. On the stars of the new lamp the filament hangs loosely, while in the old lamp the filament is evidently in tension.

The characteristic difference between carbon filaments and tantalum filaments is shown by a diagram representing the influence of temperature on the electric resistance of the two filaments in proportion to each other. In order to have the differences at once shown in per cents., the normal pressure and the normal resistance of both filaments, when giving the light of one candle for 1 5 watts, is marked as 100, and it is immediately seen that the resistance of Ta alters directly and that of carbon inversely as the temperature. Owing to this quality, a Ta filament is better able to resist overheating than a carbon filament, as the following experiment shows, where two lamps, one Ta and one C, burning normally at 110 volts with 1·5 watts per candle-power, are gradually exposed to higher voltages. The C lamp breaks while the Ta lamp stands up to 200 volts, the highest voltage available to-night. Of course, its useful life will be shorter than at its normal voltage.

As stated at the beginning of the discourse, the primary object of all the research was to find a filament more economical in the consumption of electrical energy than the C filament, and the following experiments will show that the Ta filament is, in this respect, a great improvement on the C filament. To begin with, a comparison can be made by burning a Ta and a C lamp under water, each being immersed in a vessel containing the same quantity of water. Owing to the C lamp requiring more energy to give the same light as the Ta lamp, the temperature of the water in the C vessel rises quicker than in the other vessel. Another way of showing the difference is by measuring the current taken by each of the two lamps when giving approximately the same light, or by sending the same current through both lamps in series and noting the difference in candle-power.

In conclusion, two interesting qualities of Ta should be noted. The first is that when a Ta filament is heated in a high vacuum it will expel any oxygen that has combined with it. It is possible to detect whether a filament contains any oxide by very gradually heating it up, when the parts containing oxide will appear brighter than those consisting

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of pure Ta, owing to the greater electrical resistance of the oxide. These lamps have been purposely exposed to the air while they were being exhausted, and have become "spotty" in consequence, but if they are raised a little above their proper voltage and left burning for a few minutes, their filaments become quite uniform by the expulsion of the oxygen. The second is that Ta will act as a rectifier when used in an electrolyte—that is to say, it will allow of the passage of the positive current only in one direction. In the apparatus shown the positive current passes through the lamp to a Ta anode, thence to a Pt cathode, but in a very short time the Ta anode covers itself with a film of oxide which stops the current When the current is reversed the lamp lights again and continues to burn. When an alternate current is connected to the lamp it will also continue to burn, but with reduced light. All these experiments are intended to show the remarkable qualities of this material, and when they are fully appreciated and its limitations are properly understood, there appears to be a great field open to tantalum and its industrial applications.

ELECTRICITY IN NEW SOUTH WALES COAL MINES.

Mr. A. A. Atkinson, chief inspector of coal and shale oil mines, and Mr. W. Humble, chief inspector of collieries, read a most interesting paper on the above subject before the Northern Engineering Institute, Newcastle, New South Wales.

The authors are able to say that in New South Wales electrical plants have not so far been responsible for any death in connection with the local coal and shale mines, nor yet has any fire been traced to this source. Whilst giving whatever credit is due for this result to the firms which have installed the plants, and also to the colliery managers, it may be pointed out that there are several reasons quite apart from that phase of the question which have operated in the direction of reducing the possibilities of accident in our mines as compared with those in Great Britain, and amongst others the following may be given: (*a*) thicker seams, and usually wider and more roomy working places; (*b*) better roofs over the seams; (*c*) usually dry conditions. Something must also be attributed to the excellent local regulation whereby it is enacted that: "All electrical apparatus and conductors shall be sufficient in size and power for the work they may be called upon to do, and efficiently covered or safeguarded, and so installed, worked, and maintained as to reduce the danger of accidental shock or fire or overheating to the minimum, and shall be of such construction and so worked that the rise in temperature caused by ordinary working will not injure the insulating materials."

It will be remembered that Mr. W. C. Mountain, giving evidence before our own Home Office Departmental Committee on the use of electricity in coal mines, declared: "Nearly all the trouble that has arisen in the past has been due to the plants being too small for their work." This point has been noted in New South Wales, with the excellent results above reported. This is all the more remarkable when we study the table given by the authors, showing the amount of coal cut by electrical coal-cutters since the year 1904, together with the number of machines used in its production year by year:

Year.	Quantity produced. Tons.	Number of machines used.
1904	163,800	10
1905	720,151	29
1906	757,495	36
1907	1,205,812	70
1908	1,428,160	82
Total	4,275,418	

The authors are perfectly justified in adding: "It is very satisfactory that with a total quantity of 4,275,418 tons, so far no person has been fatally injured. Although it is very difficult to obtain statistics with reference to the relative dangers of holing coal by human agency and by machines, we venture to say that the production of so large a quantity as that named above has seldom, if ever, been effected where hand holing has been in operation without involving a loss of some lives. This is important testimony from a safety point of view in favour of coal-cutting machines, and it should appeal to the miners at least as one reason for their retaining the machine and advocating their further use."

RAILWAY GOODS CLEARING HOUSE.

Railway and parliamentary circles are just now very busy with a gigantic proposal to establish in London a railway clearing house for goods. The building will be some 1,000 ft. wide by 400 ft. long, to accommodate about 2,000 trucks coming from all railways having connection in the Metropolis. The scheme will, it is estimated, cost £1,000,000. Plans for the building have been prepared by Mr. R. Stephen Ayling, F.R.I.B.A, and the engineers will be Mr. A. W. Gattie, C.E, of Notting Hill, Mr Guy Lloyd, A.M.Inst.C.E, and Mr. A. G. Seaman, M.I.E.E. The mechanism for handling the goods, which will include moving platforms, will be operated by electricity. If the project is carried through considerable economies would be effected, as it would render unnecessary about 75 per cent. of the railway delivery vans which now help to congest the street traffic.

Mr. Gattie, a patentee of several of the new appliances, in discussing details, laid stress on the fact that his inventions were for dealing with goods of every description, from a letter or postcard to the heaviest bale of merchandise normally dealt with in trade. Correspondence, it appears, is already passing between himself and the Post Office authorities in regard to a proposal to install his apparatus in the parcels sorting offices at Mount Pleasant, London. The present staff at these offices, he said, was 700 men, who were engaged eight hours a day, and had 120,000 parcels to deal with in that time. By the use of machinery the work could be done in two hours—provided, of course, there was no enforced idleness through delays in delivery—with 100 men feeding the machine, and a like number to relieve it.

AMERICAN NOTES.

A committee of investigation has been appointed by the American Railway Association to report upon the railways having adopted electrification. This committee is composed of officers of roads which have electrified portions of their lines or contemplate doing so. Mr. George Gibbs, chief engineer of electric traction of the Long Island Railroad, is chairman of the committee. The railroads represented on the committee are the Illinois Central, Union Pacific, Southern Pacific, Erie, Delaware and Hudson, and New York, New Haven, and Hartford.

A proposal is now before the New York Central Lines to lay out considerably over £4,000,000 during the current year, largely for the continuation of the electrification work at the New York terminal. Another section of the West Shore road between Syracuse and Utica will be converted to electric power, and some double tracking, elimination of level crossings, and grade revision will be carried out around Rochester and Buffalo. A considerable amount of new equipment will be purchased.

PERSONAL.

Mr. A. L. Weekes, the general manager of the British Electric Calibrated Fuse Co., has been presented with a pedestal writing desk by the staff and employés of the company on the occasion of his marriage.

Mr. A. W. Banister, late manager of the Norwich Electric Tramways Co., has accepted the managership of the New British Motor Cab Co.

Dr. T. C. Baillie, M.A., at present head of the physics and electrical engineering department at the Sunderland Technical College, has been appointed principal of the Croydon Polytechnic, in succession to Dr. Becket Burnie, at a salary of £300 per annum, rising to £350. Dr. Burnie has been appointed to the Brighton Municipal Technical College.

The Woolwich Borough Council have appointed Mr. C. P. H. Bowmaker, engineer in charge of the Torquay electricity works, and Mr. G. Bartholomew, engineer-in-charge, Messrs. Dorman and Long, Middlesbrough, to the positions of charge engineers in the electricity department at a salary of £90, rising by annual increments of £10 to £140 per annum.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

ANSWERS.

Question No. 1,190.—It is intended to make a series of tests upon telegraph poles to determine the "deflection" at various strains. What precautions should be taken regarding wind pressures, variation of temperature, and area affected due to wind pressure? Also give formulæ for these.

Answer to No. 1,190 (awarded 5s.).—The calculation of the bending moment at the base of a pole due to a wind pressure of given intensity acting uniformly along the pole may be carried out as follows. Three distinct cases are assumed: (1) parallel poles; (2) poles tapering to $\frac{1}{2}$ D at the top, where D = diameter at ground plane; (3) poles tapering to an extreme point. Cases 1 and 2 represent practical conditions, but 3 is, of course, an extreme case, which is nevertheless useful in as far as it permits of interpolation for cases lying between examples 2 and 3, as will be seen later. (For the actual tapers common in practice reference may be made to Fig. 1.) The above three classes are again divided, each into two cases. Poles when strained to breaking point naturally fail near the ground, providing there be no flaw higher in the wood, and usually the failure is about 3 ft. to 5 ft. above the ground level. This result would not be expected from theoretical considerations, since it clearly involves that the stress in the pole is greater at a short distance above the ground than at the latter level. For this reason the bending moment is calculated below at: (*a*) ground level; (*b*) a section 5 ft. above the ground level in each case. Under these assumptions, and referring to Fig. 2 and denoting the wind pressure by p pound per square foot (l and D then being expressed in feet).

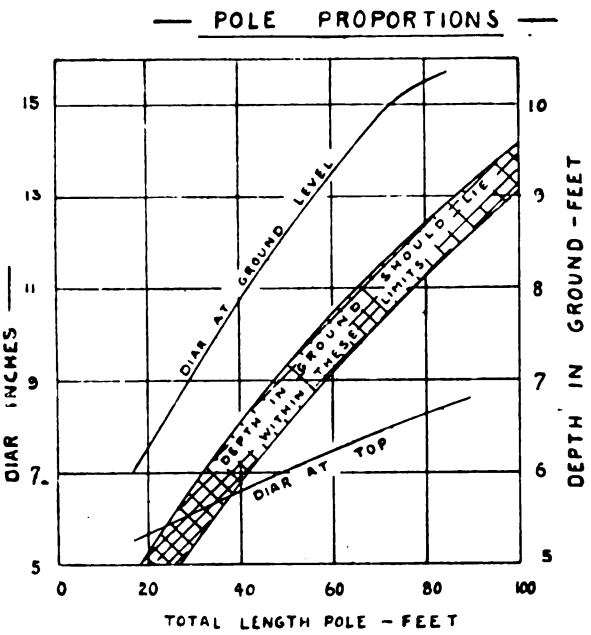

FIG. 1.

Case I.—(*a*) The wind pressure on the small element $y\,z = p\,\mathrm{D}\,dx$, and the bending moment at A A due to this load $= (p\,\mathrm{D}\,dx)\,.\,x$, so that the bending moment at A A due to the load on the whole pole

$$= \int_0^l p\,\mathrm{D}\,x\,dx = \frac{p\,\mathrm{D}\,l^2}{2}.$$

(*b*) The elemental bending moment at B B $= (p\,\mathrm{D}\,dx)\,(x-5)$, and hence the total bending moment at B B

$$= \int_0^l p\,\mathrm{D}\,(x-5)\,dx = p\,\mathrm{D}\left[\frac{x^2}{2} - 5x\right]_5^l$$

$$= \frac{p\,\mathrm{D}}{2}(l^2 - 10\,l + 25).$$

Case II.—The diameter of the pole at the section $y\,z$, assuming a uniform taper, is $\left(\frac{2\,l-x}{2\,l}\right)\mathrm{D}$, whence as above:

(*a*) The elemental bending moment, A A

$$= \left(p\,.\,\frac{2\,l-x}{2\,l}\,.\,\mathrm{D}\,dx\right)x$$

and the total bending moment at A A

$$= \frac{p\,\mathrm{D}}{2\,l}\int_0^l (2\,l-x)\,x\,dx = \frac{p\,\mathrm{D}}{3}\,l^2.$$

(*b*) The total bending moment, B B

$$= \frac{p\,\mathrm{D}}{2\,l}\int_5^l (2\,l-x)\,(x-5)\,dx$$

$$= \frac{p\,\mathrm{D}}{12\,l}\left[3\,(2\,l+5)\,x^2 - 2\,x^3 - 60\,lx\right]_5^l$$

$$= \frac{p\,\mathrm{D}}{12\,l}(4\,l^3 - 45\,l^2 + 150\,l - 125).$$

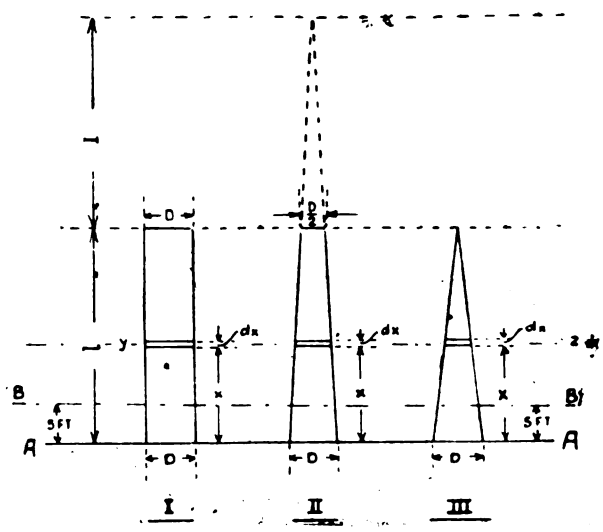

FIG. 2.

Case III.—The diameter of the elemental slice here $= \frac{l-x}{l}\,\mathrm{D}$. Hence (*a*) the bending moment, A A

$$= \frac{p\,\mathrm{D}}{l}\int_0^l x\,(l-x)\,dx = \frac{p\,\mathrm{D}}{6}\,l^2.$$

(*b*) The total bending moment, B B

$$= \frac{p\,\mathrm{D}}{l}\int_5^l (x-5)\,(l-x)\,dx$$

$$= \frac{p\,\mathrm{D}}{6\,l}\left[3\,(l+5)\,x^2 - 30\,l\,x - 2\,x^3\right]_5^l$$

$$= \frac{p\,\mathrm{D}}{6\,l}(l^3 - 15\,l^2 + 75\,l - 125).$$

As an example of the use of these formulæ: assume $p = 30$ lb. per square foot, D = 20 in. at ground, pole 60 ft. high (from the ground level) and 10 in. diameter at top; then from II. (*b*) the bending moment 5 ft. up the pole is

$$\mathrm{M} = \frac{30 \times 20/12}{12 \times 60}(4\,(60)^3 - 45\,(60)^2 + 150\,(60) - 125)$$

$$= 49{,}300 \text{ foot-pounds.}$$

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But this result assumes that the pole offers a wind resistance equal to that of a flat surface of area = the projection (mean $D \times l$) of the pole. The curved surface of the pole actually results in the wind resistance being about half this value, hence the bending moment should be $\frac{1}{2}$ 49,300 = 24,650 foot-pounds. Values of M for other values of D and L have been calculated for the above formulæ in similar manner, and the results obtained are graphically expressed in Fig. 3, which also shows the maximum bending moment that may be applied to the poles to retain the factor of safety of 8 usually worked in this connection. In the particular example taken above, the bending moment, M, will produce a stress, S, given by

$$S = \frac{M}{Z} \text{ — } i.e., \; S = \frac{24{,}650 \times 12 \times 32}{\pi\,(20)^3} = 377 \text{ lb. per square inch,}$$

and assuming a maximum permissible stress of, say, 550 lb. per square inch (though by using special woods—*e.g.*, teak—this figure may be about doubled) the pole has a margin of skin stress of about 173 lb. per square inch to cover the wind pressure on the wire and insulators. This corresponds to a bending moment of 11,300 foot-pounds—*i.e.*, 198 lb. at 58-ft. arm (the radius of application of the cross-arm strains)—which is insufficient to allow for wind pressure on wires, insulators, and cross-arms. It will be seen that many of the cases considered in the curves (Fig. 3) would be similarly placed in this respect, some, indeed, being overstrained by the wind pressure on themselves alone. Moreover, on large poles a factor of safety of 10 should be required, so that in such cases an A pole built up of two equal poles of considerably less diameter than that of the equivalent single pole would be employed. The strength of A poles agaainst bending *across* the line of the wires is found to be from four to five times that of a single pole of the same diameter as the members of the A type—*i.e.*, by using twice the material in the poles a gain of from 200 to 250 per cent. is attained in the effective strength per pound. This is a point well demonstrated by the data of Table I.

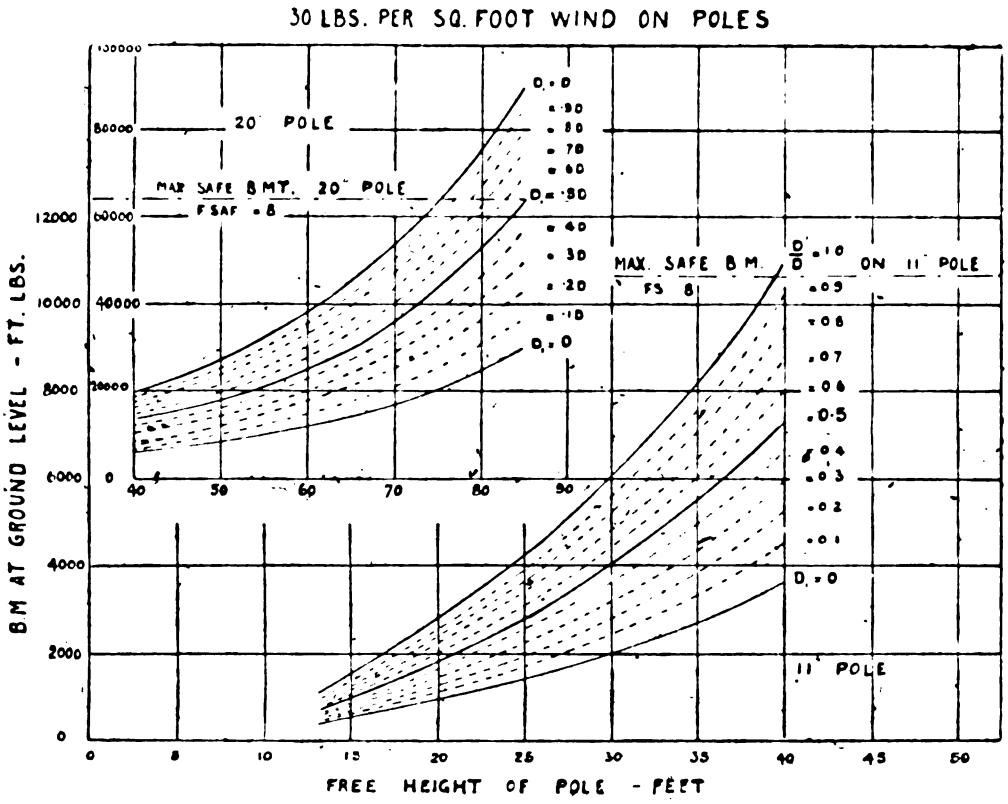
30 LBS. PER SQ. FOOT WIND ON POLES
BM AT GROUND LEVEL - FT. LBS.
FREE HEIGHT OF POLE - FEET
20' POLE
MAX SAFE B MT. 20' POLE
FSAF = 8
MAX. SAFE B M.
FS 8
ON 11' POLE
11' POLE
D = D
D = 0

Fig. 3

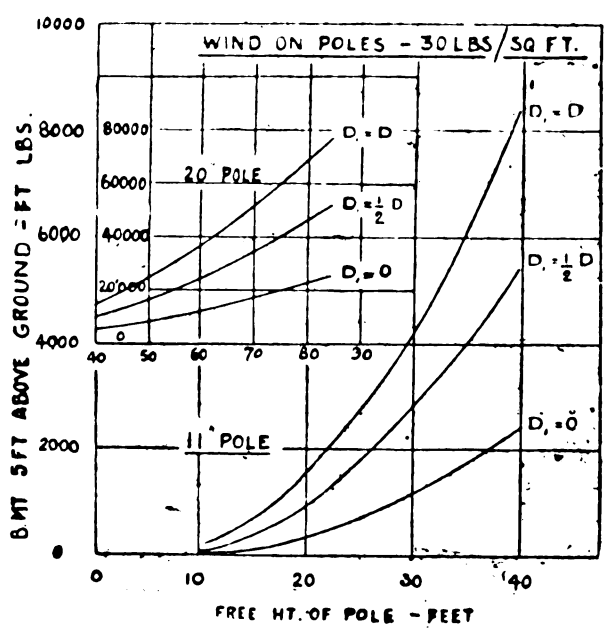

Fig. 4.

Table I.—Wade's Data for Deflection of Poles (summarised).

—	—	Single poles. Dia. inches 5 ft. from butt.				A poles. Dia. inches 5 ft. from butt.			
		6 in.	8 in.	10 in.	12 in.	6 in.	8 in.	10 in.	12 in.
20	13	1·4	0·5	0·2	0·1	0·03	0·01	—	—
26	19	4·4	1·4	0·6	0·3	0·09	0·03	0·01	—
32	25	10·1	3·2	1·3	0 6	0 20	0·06	0·03	0·01
38	31	19·3	6·1	2·5	1·2	0·39	0·12	0·05	0·02
45	38	—	11·2	4·6	2·2	0 71	0·22	0·09	0·04
60	53	—	—	12 5	6 0	1·93	0 61	0·25	0·12

The strains on the poles and wires *across* the line route should always be considered, since it is in this direction that the maximum forces tending to bend the pole are applied. The data of Table I. will probably supply the information requested in the query (which is not worded very explicitly). For instance, all tests regarding strength of poles, etc., should be made on a convenient plot of ground before the poles are erected, they being gripped horizontally during the test. The load is then much more conveniently applied, and all readings are more readily and accurately taken. Wind resistance errors are then avoided. The results obtained will be based on conditions very closely resembling those of practice, except that the actual results under working conditions will be slightly more favourable where multiple—*i e*, A or H—poles are used, since the compression legs will not then be subject to an initial sag due to their own weight, which considerably favours

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buckling. With regard to the point raised as to temperature effects, if the temperature effect on the strength of the poles is referred to, this is negligible for all ordinary ranges of temperature. Measuring instruments, etc, must be corrected for temperature, where necessary, in accordance with instructions supplied with them. If the temperature effect on the sag of the line is referred to, it may be mentioned that Trotter has expressed the opinion that the weight of the wires need not be considered in all ordinary pole designs; the wind pressure on the poles and lines is the real governing factor. The method of calculating the wind pressure on poles and the bending moment due to it has been explained. The pressure on the wires is more easily calculated, and $= \frac{2}{3} p d l$, where p = wind pressure in pounds per square inch, d'' = diameter, and l = span in inches, the coefficient of wind resistance being two-thirds that of a flat surface. This force, whose magnitude has been calculated by various authorities for all standard cases and tabulated in convenient form, is taken to act, say, 2 ft. from the top of the pole; this the average location of the cross-arms. The bending moment produced at the foot of the pole and the skin stress due to it are then calculated as before. Such wire wind pressure tables are always calculated for single wires, but where stranded cables are used the equivalent diameter of the whole increases much less rapidly than the number of wires used. It is well known that only certain numbers of equal wires will strand smoothly and without wasting space. The main numbers of wires used in stranded cables and the ratio of the over-all diameter to the diameter of the component wires, assuming proper stranding, are shown in Table II.

TABLE II.

Number of wires stranded.	Ratio $\frac{\text{Over-all dia. cable}}{\text{dia. single wire}}$
1	1
7	3
19	5
37	7
61	9
91	11

Thus 91 wires, stranded to a regular cable, offer only 11 times the wind resistance of any one of the wires alone. This fact is of great importance when the mechanical and electrical disadvantages of large solid wires are remembered.—L. C.

Question No. 1,191.—An electromagnetic clutch, transmitting about 4 h.p., requiring to be frequently and rapidly reversed has to be worked under conditions necessitating the use of a rather delicate switch and under circumstances rendering the renewal of the contacts very troublesome. What would be the best practice to follow to prevent the ill-effects of self-induction and maintain the switch contacts in good working condition? Remark on the subject generally, and more especially as to the use of a condenser, and give a diagram. Clutch takes about 80 watts, voltage 110.

Answer to No. 1,191 (awarded 10s.)—The two alternatives by which the injurious effect of inductance in causing sparking at the contacts may be overcome are: (1) by shunting the switch contacts by a condenser of suitable capacity; (2) by using a high non-inductive resistance as a permanent shunt path. Of the two methods the condenser device is probably preferable owing to its higher efficiency and greater compactness. A few years ago the high cost of condensers would have made it too costly to employ them for the present purpose in the majority of cases, but the use of hand-built mica or paraffined paper condensers has given way to the use of machine-made rolled foil or metallised paper condensers for all commercial purposes. The prevention of sparking by the use of capacity would probably only require a few microfarads in this case, but the exact amount necessary naturally depends on the inductance of the clutch coils, which cannot be calculated from the data given The energy stored in the magnetic field of the clutch is given by $\frac{1}{2} L C^2$ ergs (where L = inductance of winding in henries and C = current carried in amperes). In order that this energy may not be restored as a spark at the moment of opening the switch, it must be either received by a condenser or dissipated in a shunting resistance as shown. In the former case the energy stored in a charged condenser $= \frac{1}{2} K V^2$ (K = capacity farads, V = volts), and this must be at least $= \frac{1}{2} L C^2$ if sparking is to be prevented; otherwise a surplus of energy will remain, and though sparking will be reduced it will still occur. By equating $K V^2$ to $L C^2$ the value of K (L being known) at once follows Where there are no ohmic losses in the circuit the energy stored in the magnetic field would oscillate between it and K indefinitely, the conditions of the energy surging being as in Fig. 2. This state of affairs is aimed at in the resonant loops of wireless telegraph circuits, but is here undesirable. The resistance losses are in the present case large, the resistance of the clutch winding being about 150 ohms, so that, apart from the hysteresis losses (magnetic and electrostatic), rapid damping out of the current occurs. Under these conditions the condenser may have as high absorption losses as are consistent with reasonable temperature rise in service. The dielectric strength must be high, since the strain on the insulation is very severe at the moment of opening of the main circuit. The condenser should be tested to at least 1,000 volts, and if the clutch circuit is very inductive and the circuit is opened very rapidly, the

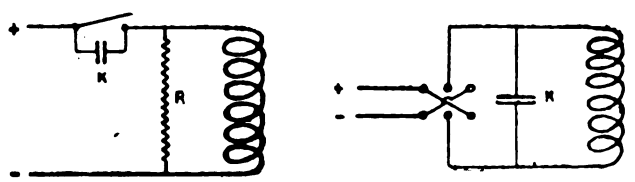

FIG. 1.

test voltage should be still higher (such test voltages are conveniently obtained by using the condensers in the oscillating arm of "musical" arc circuits, where pressures usually rise to these values). So much depends on the precise rapidity with which the circuit is opened and on the ohmic resistance, that no exact calculation of the capacity necessary can be made, and in no case is such an estimate relied on to give more than the *order* of the capacity required. The final magnitude of the condenser is determined by trial, suitable auxiliary condensers being added in parallel till sparking ceases. A few microfarads as a maximum will usually suffice in such a case.

Elaborate specifications as to the electrical properties of the condensers used are not necessary in such service: for estimating purposes it may be taken that six cubic inches space must be allowed per microfarad, that the weight per microfarad will be 4 oz. to 5 oz., and the cost per microfarad 2s. to 3s. (a great reduction in the costs obtaining a few years ago, and, of course, only applying to machine-made sets—hand-made mica or paper condensers still cost £1 to £2 per microfarad). The condenser used should be of the paper dielectric type, and will probably need to be stronger (as regards its dielectric) than the Post

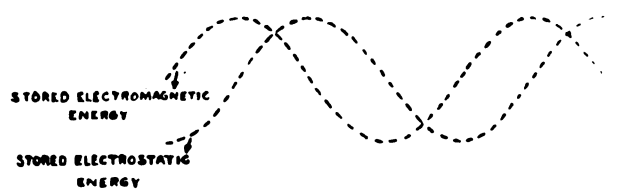

FIG. 2.

Office telephone condensers. Owing to the low cost of the latter it would be well worth trying one (or more in parallel), unless the "break" spark voltage is known to be such as would certainly puncture it. The condenser, presumably being in use in an engine-room, will be exposed to considerable variations in temperature, but these will be unimportant in the present connection, the temperature coefficient of good paraffined paper condensers being about 0·04 per cent. per 1 deg. C. and negative. On the basis of the loss in charge after 60 seconds, the insulation resistance of condensers falls in the ratio of about 3 : 1 if their temperature rises from 50 deg. to 80 deg F.—a fact which must be remembered in the present connection. The absolute value of this insulation, R, depends on the construction employed, and varies from 2,500 megohms per microfarad for Mansbridge telephone condensers to 22,000 or 36,000 megohms per microfarad for good testing condensers (for cable work), the temperature being 50 deg. F. in both cases (and the respective costs per microfarad being 2s. and £1. 10s. to £2). The use of

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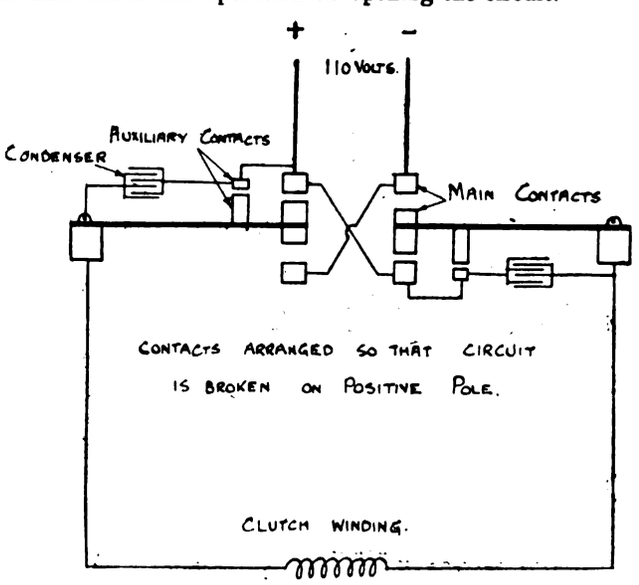
mica, glass, or electrolytic condensers is, of course, not to be thought of in this connection, the objections being, briefly, the cost of these types and the messiness of the electrolytic pattern.

If it be preferred to use a resistance in place of the condenser, this will be more efficient, as regards prevention of sparking, the lower its resistance, but the lower R the greater the operating loss, assuming the resistance to be always in shunt across the clutch winding. In this case it should not consume more than four to eight watts—*i.e.*, 5 to 10 per cent. of the energy taken by the clutch—hence its resistance = 1,500 to 3,000 ohms. If the shunt resistance be connected to an auxiliary pair of contacts, and the reversing switch be fitted with spring blades, so that the shunt resistance, though normally disconnected, can be put into circuit before the main contacts are opened, then a lower and hence more effective resistance can be used, and with less energy loss.

Other means whereby sparking at the contacts can be avoided include the use of carbon break switches, or the use of relay switches controlling oil-immersed main switches. The use of oil-covered mercury contacts is messy, and unsatisfactory from the point of view of permanently good contact. The use of magnetic blow-outs will hasten the extinguishing of the spark or, rather, *arc* on opening the circuit, but *preventing the formation* of this arc is the only sound principle.

This prevention is equally well effected by a shunting condenser or resistance, the efficiency of such devices having been recently proved, under much more trying circumstances, by Mr. Mordey, Pres.I.E.E, in his work on the G.B. stud system (Mile End-road). Whereas a few years ago a shunt resistance would have been the only feasible means of dealing with a spark representing much energy, so great has been the development in condenser manufacture that the use of a capacity is now more convenient and practically as cheap as that of a resistance for such purposes as the present.—L. C.

Answer to No. 1,191 (awarded 5s.).—Experiments have been carried out in connection with the question of sparking which occurs on interrupting the flow of an electric current. One of the results of these experiments has been to provide automatic circuit breakers, with magnetic blow-out coils, for extinguishing the arc formed when the breaker comes into operation in opening the circuit.



Such a method cannot be applied to a case where the arc is comparatively of short length, and occurring, probably, at very frequent intervals, such as in the case under consideration. It has been the practice to use with spark coils and similar apparatus a condenser connected in shunt across the arc contacts for reducing sparking, the condenser acting as a medium through which the induction in the primary winding caused by breaking the flow of current may discharge itself, the energy being expended in charging the condenser. The condenser for the same purpose is also used with the well-known Tirrill voltage regulator, it being connected in shunt across the relay contacts, which are alternately short-circuiting and opening the field rheostat in the machine field circuit. Contacts for such a purpose are generally provided with platinum or German-silver tips, and which are renewable.

In the article on "The Technical Aspect of the G.B. System of Electrical Tramways," appearing in the *Electrical Engineer* of June 11, reference is made to the question of condensers to extinguish arcs between metals, together with some experimental figures regarding the capacity of the shunting condenser. The paragraph of conclusions at the end of the article is interesting, and if a suggestion may be put forward based on these conclusions and applicable to our particular case, it would be that the switch used for breaking circuit be fitted with secondary or auxiliary contacts of cored carbon, across which would be connected a shunting condenser of several microfarads capacity, the best value of the capacity being found by experiment. By arranging these secondary contacts so that the break takes place on the positive side, two condensers only will be required, and would be connected as shown in sketch, which is diagrammatic. Should it be found for any reason impracticable to fit cored carbon auxiliary contacts to the switch, platinum contacts shunted with condensers as shown in the sketch would undoubtedly be used with advantage.—X.

A.E.G. Pamphlets.

We recently received a batch of pamphlets from the A.E.G. Electrical Company of South Africa, Limited, Caxton House, Westminster, describing the most recent productions from the Berlin works of their principals, the A.E.G. One pamphlet deals with three-phase, two-phase, and single-phase induction motors, ranging in size from 7·5 h.p. to 100 h.p., and designed to combine output and overload capacity with compact form, to simplify starting, and to reduce the attention required when running. Another pamphlet is devoted to slow-speed three-phase motors, while a third describes small continuous-current motors and generators, giving outputs up to 7 h.p. and 5·75 kw. These lists give very complete information as to sizes, weights, speeds, outputs, energy consumption, and efficiency. The constantly increasing use of electricity in industrial work, and on account of the higher working pressures frequently used and the dust and dirt which is caused in such work special interest attaches to the pamphlet dealing with iron switch cases for pressures up to 7,500 volts. In all switch cases the inspection door is interlocked with the switch in such a manner that the renewal of fuses, adjustment of the circuit breaker, etc., can only be carried out when the current is cut off. On the other hand, it is impossible to switch in while the door is open. Two further pamphlets deal respectively with electric annealing and tempering plants and lift-controlling gear.

Siemens's Miniature Posters.

Owing to the exceptionally large demand, Messrs. Siemens Bros. inform us that they have been compelled to obtain a fresh supply of their "Satisfied Consumer" adhesive labels. These labels are becoming known to the trade as "sticky backs," and seem to enjoy never-ending popularity. They are supplied free of charge to the electrical contractor, and are suitable for attaching to correspondence, packages, etc. They certainly provide him with a means of keeping "Tantalum" lamps before his clients, and doubtless result in increased business.

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CONTENTS.

Water Power — A Set-Back and Possibilities	113	Railway Goods Clearing House	126
The Ritten Electric Railway	114	Personal	126
Insulating Materials	115	Correspondence	127
Storage Batteries	117	Publications Received	127
The Electrical Operation of Textile Factories	117	Press Telegraphic Rates to the Far East	128
Electric Lighting for Motor-cars	120	Legal Intelligence	128
A New Method of Preserving Wooden Poles	121	Companies' Meetings and Reports	128
Electrical Inventions at the White City	122	Southend Electricity Supply	128
New Motor-Starting Switch for Printing Machines	123	Progress in Victoria	128
Headlight Testing Rack	123	New Companies Registered	130
Tantalum and its Industrial Applications	123	Liens Registered	130
Technical Problems, with Solutions by Practical Men	125A	Lighting Notes	130
Electricity in New South Wales Coal Mines	126	Traction Notes	132
American Notes	126	Appointments Vacant	132
		Contracts for Electrical Supplies	133
		Provisional Patents, 1909	137
		Companies' Stock and Share List	138
		Traffic Returns	140

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "THE EDITOR, *149, Fleet Street, London, E.C.*" *Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TRADERS' EXAGGERATIONS.

SIR,—An intending consumer who has decided to install motors has been made to think very long and deeply, after almost having placed the order for his motors, by receiving a letter from one of the best-known firms of gas-engine makers, who have a branch office in the far northern district of England. The intending consumer has asked me to help him in his difficulty, and with this object in view has kindly given me a copy of the letter, which I enclose. I think this letter would prove interesting reading to the suppliers and users of electricity if you could publish it. For obvious reasons I must ask that all names and addresses must not be published, including that of myself.—Yours, etc., BOROUGH ELECTRICAL ENGINEER.

July 26, 1909.

"Dear Sir,—*Re* our conversation with you this afternoon, we have pleasure in giving you figures showing the comparison between your using gas-engine or electric motor to drive your printing machinery.

"The number of hours you run per day being 9½ for 5½ days per week, for 50 weeks per year will equal 2,612½ hours. A gas-engine of 8 b.h.p. running these number of hours at full load will consume 120 cubic feet of gas per hour, which equals 313,500 cubic feet of gas, and taking gas at Stockton at 1s. 8d. per 1,000 cubic feet, your yearly account will equal £26. 2s.

"With regard to the electric motor we may say an electric unit is equivalent to 1½ b.h.p., but, as you know, the current is run through the meter before entering the coils of the motor, and the loss of current in very large motors is estimated by a prominent local electrical engineering firm at about 20 per cent.—that is to say, should your meter register, say, 10 units, you would only be developing eight units of power, two units being absorbed in the coils. It is, therefore, not unlikely that for every unit registered at your meter you would only develop 1 b.h.p., but, taking one unit to equal 1⅓ b.h.p., we are giving the motor the benefit, so that an 8-b.h.p. motor will consume six units of electricity per hour; and taking electricity at 2d. per unit for the same number of hours' run as the gas-engine, it works out at 1s. per hour, or £130. 12s. 6d. per year.

"You will notice there is a tremendous difference when looking at the figures in the most favourable light, the saving being £104. 10s. 6d. per year.

"The average life of a dynamo or motor is five years—that is to say, the armature, which is the main part of these machines. The tremendous speed at which they go is accountable for the short life.

"We shall be glad to go into the matter again with you when our representative calls upon you next Monday, and we trust you will now be able to favour us with your valued order, which we can assure you would have our best attention.—Yours faithfully,

"(Signed) ———."

IS CENTRAL STATION WORK PLAYED OUT

SIR,—As a station man I was rather interested in the above article by "S. L." I had the pleasure of writing in this column in the early part of last year on the same subject. The correspondence was on "The Staffs of Small Central Stations," and I suggested therein that what was needed was a professional union to protect us against traitors to our profession. I refer chiefly to a certain class of incompetent men who hold positions as "chiefs" in electrical undertakings, men who we see so frequently advertising for premium pupils, and who, as soon as they get good jobs themselves—usually by influence—endeavour to keep down the salaries of their brother engineers who have been less fortunate. "S. L." gives an instance where two shift engineers objected to a premium pupil, and were practically told to "Take it or leave it."

It is no use grumbling. We shall do no good until we combine, like the medical profession and the law, etc. I really thought that, as a result of the correspondence last year, we had succeeded in making a start. An old-established engineering society took the matter up, but this society has changed its views and the matter has dropped, so we are as backward as ever. I think nothing but a new independent institution of our own will do any good, and surely there are enough of us to support such an undertaking.

I think another source of harm may be found in some of the numerous correspondence schools who advertise nowadays. These schools are, no doubt, excellent in some ways, especially for really ambitious men who are fitted for the profession but who cannot, for various reasons, study in any other way. These schools are, like everybody else, in business to make money, and they misrepresent the state of the profession. I have before me a booklet from one of the most prominent of these schools, from which I extract the following: "What a man's earnings will be in the electrical field depends on himself. *As an electrician* he will find it difficult to earn more than *four or five pounds a week.* If he becomes an electrical engineer, he may climb to a salary of *two thousand a year or more*" To anyone not knowing the facts this is a gross misrepresentation. How many electrical engineers, not minding electricians, get four or five pounds a week?—Yours, etc.,

ELECTRICITY SUPPLY.

PUBLICATIONS RECEIVED.

Transactions of the North-East Coast Institution of Engineers and Shipbuilders, July, 1909. Vol. xxv., parts 7 and 8. London and Newcastle-on-Tyne: Andrew Reid and Co., Limited.

Proceedings of the Royal Society of Edinburgh, vol. xxix., part 5. Edinburgh: Robert Grant and Son, 107, Princes-street. Price 6s. 11d.

"ENGINEERING UNITS OF MEASUREMENT" (with symbols and abbreviations, British and metric equivalents), by John Ramsay, A.M.Inst.C.E. Glasgow: John Smith and Son (Glasgow), Limited, 195, George-street and 19, Renfield-street. Price 1s. net.

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SOUTHEND ELECTRICITY SUPPLY.

At a meeting of the Southend Town Council the Light Railways and Electric Lighting Committee presented a report by Mr. Robert Birkett, the borough electrical engineer. It is considered probable that at some future time electricity will be supplied to Leigh, and to Hadleigh or Rochford, whilst further extensions to Burnham and for the supply of current for part of the light railway to Colchester may eventually be required. For these purposes the present system (three-wire direct-current with 460 across outers) is unsuitable, alternating current, transmitted to sub-stations at high pressure, being the most practicable method.

Such a scheme could only be carried out by installing alternating plant for generating purposes. In view of the high cost of land, coal, and water at the existing works Mr. Birkett recommends a new central station, the existing site being utilised as a sub-station and car-shed. The report shows how the scheme may be economically carried out by the removal of the present boilers and engines, whilst the dynamos would be coupled to alternating motors fixed to the engine foundations. The new station is estimated to cost £41,000 (not including land) for a capacity of 3,400 kw., while the total cost, including cables and sub-stations for meeting the demand in Southend for the next 10 years, is placed at over £73,000. The scheme would be carried out gradually, thus economising in capital outlay until the demand increased. As to the immediate requirements, the report recommends the laying down of one battery sub-station in the neighbourhood of Chalkwell-park, having a capacity of 500 kw. for three hours, to be followed by a similar installation of 100 kw. capacity for the Thorpe Hall estate when required.

PROGRESS IN VICTORIA.

Mr. H. R Harper, Melbourne city electrical engineer, in his presidential address before the Electrical Association of Victoria, stated that 21 orders in Council had been issued, granting powers to municipalities, and in some cases to private enterprises, for the public supply of electricity. Some of the towns concerned had a population of 1,000, and on this basis there were 44 towns likely to require electricity in the future. The total capital expenditure in Victoria on electrical generating and distributing plants, including tramways, approximated £1,600,000, and the capacity of plants installed was about 16,000 kw., of which 11,000 kw. was installed in the metropolitan area. The gross revenue was about one-quarter million sterling. A comparison of Melbourne with leading British towns showed that, with respect to electrical connections per 1,000 inhabitants, British towns were, on the average, 80 per cent. ahead of Melbourne, and 45 per cent. ahead as regards the amount sold per inhabitant. As far as electrical tramways were concerned, there was little progress to report. Much of the backwardness of Melbourne was due to the fact that in many metropolitan districts, though statutory powers have been obtained, no public supply was yet available. For instance, in the cases of Hawthorn, Williamstown, Footscray, Port Melbourne, and Brighton, orders had been granted, but so far no supply was available. In his opinion, the bodies concerned should be compelled to work their orders or have them cancelled to leave the field open for private enterprise. Although the population of the Melbourne area was over half a million, yet the population in the areas in which a supply was available amounted to only 260,000. In regard to the competition of electricity with other forms of energy, its ability to do so could not be doubted. In regard to factories, the actual horse-power of all kinds used in Melbourne amounted to 35,000, of which 27,000 was steam, 4,000 oil and gas, and 4,000 electricity. Deducting the steam required for power-houses, there would be 20,000 h.p. now generated by steam and 4,000 by oil and gas making; altogether 24,000 h.p. as a possible field for electrical development. Mr. Merz had estimated that by 1916 the additional power required in Melbourne would amount from 20,000 to 25,000.

PRESS TELEGRAPHIC RATES TO THE FAR EAST.

It is reported from St. Petersburg that the Council of Ministers has decided upon the establishment of Press rates on the Western Siberian telegraph lines between Western Europe and the Far East. The share of the rate for such messages falling to Russia will be 58 c. per word. Under the existing tariff the Russian administration receives 1 fr. 75 c. The reform will have to receive the approval of the Emperor.

LEGAL INTELLIGENCE.

DISCOUNT CLAIM.

In the City of London Court last week, before Mr. Registrar Wild, a claim was made by the General Electric Co., 71, Queen Victoria-street, E.C., against Mr. W. T. Bridges, of 157, Hoe-street, Walthamstow, for the sum of £1. 8s. 2d.

Mr. STROUTS, solicitor, who appeared for the plaintiffs, said the question in dispute was one of trade discount. The defendant was a draper, and had bought certain Osram electric lamps from the plaintiffs and claimed to be entitled to a trade discount. The defendant, however, not being an electrician was not entitled to the discount. It appeared that on previous transactions the discount had been allowed to the defendant in error. The plaintiffs' ledger clerk said that the defendant was supplied with electrical goods in November and December last to the amount of £4. 14s. 6d. Invoices were sent in for that amount. Of that sum there was a discount allowed to those in the trade. On the occasions when discount had been allowed to the defendant the plaintiffs were under the impression that he was an electrician. The electric lamps in question it was presumed were for his own use. If he was entitled to any discount he had deducted 33⅓ per cent., but the plaintiffs could only allow 20 per cent. discount upon Osram electric lamps.

The DEFENDANT said he was perfectly willing to alter the rate of discount which he claimed to be entitled to. For a long period over several years he had been trading with the plaintiffs. He had been supplying electrical goods in fairly large quantities to theatres and private consumers. He had had correspondence with the late manager of the plaintiff company's lamp department, and had been negotiating with him regarding further business he was trying to get for the plaintiffs. It was distinctly understood he had been acting with the plaintiffs' late manager as the agent for the plaintiffs. And working as their agent he did not do that for nothing. The fact that he also dealt in drapery goods was only part of his trade. Mr. Barfield, the late manager of the plaintiffs' lamp department, was said to deal with the Robertson and not the Osram lamp.

The REGISTRAR said he saw by the correspondence which the defendant had had with the plaintiffs they had been acknowledging his right to discount. He thought it was rather late now to say he was a draper, and, therefore, not entitled to it.

Mr. STROUTS said that if the defendant swore he had sold the lamps in the trade, he did not think the plaintiffs would have anything further to say, except that a lesser rate of discount was allowed upon Osram lamps. The plaintiffs' witness said if the defendant had used the lamps in the way of trade they were prepared to allow him 20 per cent.

Eventually judgment was entered for the plaintiffs for 11s. 2d. The defendant applied for costs. The Registrar said upon the defendant's own admission there was something due to the plaintiffs. The defendant said the question was whether he was entitled to a discount. He had never been informed that he had made a mistake in the percentage.

The plaintiffs' witness said they were under the impression that the defendant was not legally entitled to any discount at all.

The REGISTRAR: These are subtleties of the trade, not law. Keep them to yourself.

COMPANIES' MEETINGS AND REPORTS.

NATIONAL TELEPHONE.

The ordinary general meeting of the National Telephone Co. was held at Hamilton House, Victoria-embankment. Mr. George Franklin occupied the chair.

The PRESIDENT stated that the income accrued in respect of the business of the half-year ended the 30th ult. was £1,546,837, being an increase of £94,268 over the figures for the corresponding period last year. This improvement was less than in several preceding half-years, and indicated a check in the rate of progress, largely owing to the depression in trade, and, to some extent, to the necessity the Company was now under of making its capital expenditure coincide with the needs of the remainder of its licensed period. The Post Office royalties had amounted to £148,951, an increase of £9,419. One item which went to swell their expenses was that of rent and maintenance of Post Office wires, and this amounted to £42,679, and might be compared with £27,619 a year ago. That was owing to the fact that the Company had to pay rent and some contribution for capital which the Post Office had laid out—capital which was practically lines, wires, etc., leased to the Company. The bearing of it was seen

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when they turned to the percentage of working expenses, because it would be noticed that the item was really in the nature, to a large extent, of a capital charge, for if the money had been provided by the shareholders, it would have been taken away in the form of interest and would not have come in the form of a working expense. The amount expended on capital account during the half-year was £313,393, showing a reduction on the figures of the June half of 1908 of £183,191. This pointed to the restriction in capital expenditure now going on, and it was owing to the necessity of spending only such capital as would be reproductive within the period of the Company's licence, which would expire on Dec. 31, 1911. After referring to the legal proceedings in which the Company had been involved, in which the House of Lords had decided in favour of the Postmaster-General, reversing the decision of the Court of Appeal, he remarked that the shareholders might have noticed an important statement made by the Postmaster-General in the discussion of the Post Office estimates to the effect that an earlier purchase of the Company's property and plant than that provided for by the purchase agreement of 1905 was advisable from the public point of view. There had since been certain *pourparlers* between the Post Office and the Company, but the latter awaited definite proposals. They did not want to stand in the way of the public interest if it were the public interest to acquire the business earlier, but they would expect to be compensated for the licensed period which they were asked to surrender for the benefit of the public interest. He concluded by moving a resolution for the adoption of the report and the payment of the dividends recommended.

Mr. S. H. SANDS seconded the motion, which was carried.

AFRICAN TRANSCONTINENTAL TELEGRAPH.

From the report of the African Transcontinental Telegraph Co. for the year ended March 31 last, presented at the meeting held on Wednesday, it appears that the northern terminus of the line is still at Udjidji, on the east coast of Lake Tanganyika, as no arrangements have yet been found possible for the provision of funds for its further construction northwards. The whole position is engaging the attention of the Board. On the other hand, gaps in the British East Africa Administration's telegraph have been further reduced within the last year, and the distance to be covered before Cape Town and Cairo are joined by an unbroken line of telegraph has now been reduced to about 520 miles. The annual working expenditure of the line is not yet balanced by the revenue, and the deficiency continues, as before, to be advanced by the British South Africa Co. The deficit on the working of the line for the year covered by the accounts shows a considerable decrease compared with that of the previous year, and there will be a further decrease in the year 1908-9. It has been decided to raise the tariff rates for code and cipher messages by 50 per cent.—that is to say, from 3d. a word to 4½d. a word. This has been rendered necessary by the general adoption of the five-letter combination codes, compiled to take full advantage of the new regulation with regard to the transmission as single words of any pronounceable combinations of 10 letters—a regulation that increases the liability to errors in transmission and, in effect, reduces the number of code words transmitted. The new tariff will come into operation as soon as the necessary notices have reached the various administrations concerned; and, although some slight falling off in the number of coded messages may at first take place, it is hoped that an appreciable increase in revenue will result. No alteration is contemplated in the tariff for messages in uncoded language.

CITY AND SOUTH LONDON RAILWAY.

The ordinary general meeting of the proprietors of this Company was held on Tuesday, the Right Hon. C. R. Stuart Wortley, K.C., M.P. (chairman of the Company), presiding.

The CHAIRMAN, in moving the adoption of the report and accounts for the half-year ended June 30, 1909, said there were many gratifying features in the working of the past half-year. There was a net increase of £1,062 in gross receipts and a net decrease of £989 in expenses, so that they were in a position to carry to net revenue account the balance increased by £2,051, and there was an increase in the balance available for dividend of £1,662. They had £269 more to pay than last year in dividends on preference stocks, so that there was a final result in improvement of £1,393 in the sum available for the ordinary shareholders. By carrying forward only £457 less than they did this time last year, they were able to find the £1,850 necessary to provide the extra ¼ per cent. which they now recommended that the ordinary shareholders should receive. The result was satisfactory as showing not only a larger amount of gross receipts and a larger number of passengers carried than in any previous half-year in the history of the railway, but also because the percentage of working expenses showed a decrease, as between the June half-years of 1908 and 1909, from 46 28 per cent. to 44·63 per cent. As showing economy in management, the service had been kept going with 92,673 trains, as against 94,636. The number of passengers carried per train was 121·15, against 115·09. The receipts per train were 18s. 3·64d., against 17s. 9·04d.; and per train mile 2s. 5·93d., against 2s. 5·03d. The receipts per passenger had gone down from 1·75d. to 1·72d., showing that the average distance travelled had been shorter. On the other hand, all the expense ratios showed decreases—namely, total expenses per train mile 1s. 2·11d., against 1s. 2·16d.; locomotive expenses per train mile 4·52d., against 4·68d.; and traffic charges 6·13d. per train mile, against 6·27d. Competition with the County Council tramways and motor omnibuses continued to be so severe that the Board had under consideration the question of revising, in favour of their passengers, certain fares and season-ticket rates. All through the early hours of Sunday, from 8 o'clock to nearly 12 noon, when no City and South London trains were running, the County Council tramways used to the full a monopoly of the business of carrying South London people to the Elephant and Castle Station and to London Bridge, as well as to all such places on the north side of the river as could be reached by the Westminster Bridge tramlines and their extensions. At the Elephant they found connecting trains all Sunday morning to all stations on the Bakerloo line and lines connected with it; at London Bridge they found facilities for Sunday excursions by the Brighton Railway and South-Eastern and Chatham and Dover Railway to places in Kent and Sussex, and for embarking hard by on the excursion steamers for various places on the East Coast. Most of those opportunities were past and gone by the time that the City and South London Sunday trains began to run. On all the four West-end tube railways, as well as on the great railways having termini in London, trains were running on Sunday morning, too, during most of the time that on the City and South London Railway business was at a standstill. The Company had arranged with the Great Northern and City Tube Railway, which joined up to their station at Moorgate, to start running on Sundays at about the same time as they did, the City and South London trains beginning in future from Euston and Clapham Common at about 8.15 in the morning. They proposed to defend themselves against that particular competition by modifications of their Sunday time-tables, which they hoped would shorten the actual hours of Sunday duty work by individual members of their staff, yet would preserve to the great majority of them the alternate Sunday off which they now enjoyed. Six months ago he enlarged fully on the projected high-level subway to connect their station at the Bank with the stations of the Central London and Waterloo and City lines. Parliamentary sanction to that scheme might be regarded now as practically assured.

The report was adopted, and a resolution passed authorising the payment of dividends on the 5 per cent. preference stocks, 1891, 1896, 1901, and 1903 for the half-year ended June 30, 1909, together with a dividend at the rate of 1¾ per cent. per annum on the consolidated ordinary stock of the Company.

RIO DE JANEIRO TRAMWAY LIGHT AND POWER.

The annual report for 1908 states that the hydro-electric plant at Rio das Lages is practically finished, all of the machinery and electrical apparatus having been installed in the power station, and the hydraulic and other outside work completed, except as regards minor details. The transmission lines have been completed and an independent telephone line constructed during the year, connecting the power-house at Rio das Lages with the terminal station at Rio de Janeiro, to assure communication at all times between the stations in the case of the lines being affected by lightning or other causes. The terminal station building has been finished, with the exception of painting and other details of interior finish, and the electrical equipment for the high and low tension alternating-current section has all been installed and is now in regular use, and there remains to be done only the adjustment of this apparatus and the completion of the wiring about the station. Three 600-kw. motor-generators have been installed for the tramway service, and the sub-foundations and other preliminary work have been completed in this building for the additional machinery which will be required for the operation of the entire tramway system. The sub-foundations have also been completed for the gas-engine units which will be installed in this building as a reserve for the public street lighting. While the new electric lines were opened late in the year and it has been impossible to utilise the electric cars to their full advantage on account of the reconstruction, and consequently to reduce operating expenses to any material extent, yet the ratio of the net income to gross income of the tramways has been increased from 38 61 per cent. in 1907 to 42·19 per cent. in 1908. It cannot be expected, however, that a very noticeable benefit from the electrification of the lines will be obtained until all of the electrification is completed and the entire system can be operated as a whole without the expenses and interference attendant upon mule operation. Close attention has been paid by the Company to the development of its power business. Until Jan. 1, 1908, the various companies which are controlled by this Company were operated as separate concerns, but from this date the operation of these companies was taken over by this Company under operating contracts and leases, so that the earnings of the various companies appear for the first time in the financial statements of this Company. During the past year the Company has sold 956,600 dol. first mortgage bonds, this being the remainder of the total issue. There were also sold during the year 35,000,000 fr. of the French issue of the second mortgage bonds, and £900,000 of the sterling bonds of this same issue were sold by public issue in London. Since the date of the public issue a further amount of £50,000 of this issue has been sold by private sale, making a total amount of £950,000 outstanding of these sterling bonds on Dec. 31. The net revenue from operation, after deduction of operating expenses, maintenance, taxes, and other fixed charges in Rio de Janeiro, was 2,730,434 dol., from which must be deducted the fixed charges and interest on loans at head office, leaving a net surplus, after the payment of all expenses and fixed charges for the year, of 870,236 dol. An opportunity being presented of acquiring about 75 per cent. of the shares of the Jardim Botanico Tramways Co., thus assuring a controlling interest of this company, the Board considered it wise to purchase these shares, as that company has a large and lucrative business in one of the best residential sections of the city, and can be operated to good advantage in connection with the other tramway systems under the control of this Company, as well as assuring to this Company an important contract for the power required for the operation of this system. The combination of these lines with the others should also prove of great public benefit, as an interchange of traffic by means of through cars can be effected, which should prove a great convenience to the travelling public.

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DUBLIN AND LUCAN ELECTRIC RAILWAY.

After providing for debenture interest there is an available balance of £1,153. 10s. 9d. for the half-year ended June 30 last, out of which the directors recommend the payment of the usual half-yearly dividend on the 5 per cent. preference shares, which will absorb £475; that £250 be allocated to Messrs. Dick, Kerr, and Co. further on account of the sum still due to them on account of electrical equipment, thus reducing that debt to £350; and that the balance of £428. 10s. 9d. be carried forward to next half-year.

LIVERPOOL OVERHEAD RAILWAY.

The accounts of this Company for the past half-year show an available balance of £7,696. 4s. 8d., and the directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the (1892) preference shares, leaving a balance of £4,676. 4s. 8d. to be carried forward.

NEW COMPANIES REGISTERED.

Sheffield Wire Rope Co., Limited.—Registered June 29. Capital, £15,000 in £1 shares. Objects: to carry on the business of wire rope makers, engineers, founders, smiths, machinists, manufacturers, patentees, etc. Private company. Registered office: Darnall, Sheffield.

Electric Ordnance Co., Limited.—Registered June 24. Capital, £10 000 in 8,000 cumulative participating 10 per cent. preference shares of £1 each, and 40,000 ordinary shares of 1s. each. Objects as indicated by the title. Minimum cash subscription, £7. Registered office: Ingram-court, Fenchurch-street, E.C.

Wortley Iron Co., Limited.—Registered June 26. Capital, £15,000 in £1 shares. Objects: to take over the business of ironfounders carried on by J. Birdsell, G. Birdsell, C. Birdsell, and H. Birdsell at Wortley, near Sheffield, as Wortley Iron Co. Private company. Registered office: Wortley Ironworks, Wortley, near Sheffield.

Sanderson Bros., Limited.—Registered June 30. Capital, £3,000 in £1 shares. Objects: to adopt an agreement with R. Sanderson and J. Sanderson, and to carry on the business of engineers, millwrights, smiths, builders and repairers, engine manufacturers, etc. Private company. Registered office: 42, Railway Arches, Pilgrim-street, Newcastle-on-Tyne.

Charles E. Gibbs and Co., Limited.—Registered June 24. Capital, £1,000 in £1 shares. Objects: to acquire the business carried on by C. E. Gibbs at 87, Eyre-street, Sheffield, as Charles E. Gibbs and Co, and to carry on the business of ironfounders, engineers, manufacturers of agricultural implements and other machinery, tool makers, etc. Private company.

Trinidad Oil Exploration Syndicate, Limited.—Registered July 3. Capital, £26,250 in 25,000 ordinary shares of £1 each and 25,000 deferred shares of 1s. each. Objects: to acquire and turn to account any property containing or supposed to contain petroleum or other oils or shale, coal, lignite, asphalt, bitumen, or any bituminous or petroliferous substances. Minimum cash subscription, half the shares offered to the public.

Smith's Patent Vacuum Machine Co., Limited.—Registered June 19. Capital, £1,500 in £10 shares. Objects: to adopt agreements (1) between H. Heymann, H. Hey, J. Smith, H. L. Mitchell, W. H. Askham, and E. Appleyard, and (2) between J. Smith, H. L. Mitchell, W. H. Askham, H. Hey, and E. Appleyard, and to carry on the business indicated by the title and that of founders, engineers, tool makers, metal workers, machinists, fitters, etc. Private company.

Midland Heating and Ventilation Co., Limited.—Registered June 26. Capital, £6,000 in £1 shares (2,500 preference). Objects: to acquire the business carried on at 83, Upper Trinity-street, Birmingham, as the Midland Heating and Ventilation Co.; to adopt an agreement with J. J. Moffatt, W. Moffatt, and W. L. White; and to carry on the business of manufacturers of and dealers in appliances and apparatus for heating, cooking, and ventilation, etc. Private company.

Power Transmission Syndicate, Limited.—Registered June 18. Capital, £40,000 in 39,500 cumulative preferred participating ordinary shares of £1 each and 10 000 deferred shares of 1s. each. Objects: to adopt an agreement with E. Hess-Remanda, and to carry on the business of electricians, generators, accumulators, distributors, and suppliers of electricity, engineers, proprietors of tramways and railways, etc. Minimum cash subscription, 10 per cent. of the shares offered to the public.

Ferrabamba Copper, Limited.—Registered June 17. Capital, £5,000 in £1 shares. Objects: to acquire any mines, mining rights, metalliferous and other land in Peru and elsewhere, and to carry on the business of copper and general miners, smelters of and dealers in ores of all kinds, etc., and to adopt agreements (*a*) with J. W. Coom Kittelson and (*b*) with W. E. G. Firebrace. Private company. Table A mainly applies. Registered office: Finsbury House, Bloomfield-street, E.C.

Anglo-Asiatic Manganese Co., Limited.—Registered June 5. Capital, £20,000 in £1 shares. Objects: to acquire a certain mining lease and concession in respect of mining, exploring, and prospecting for manganese ore and other minerals and products in Smyrna, Turkey-in-Asia; to adopt an agreement with G. S. Pitcairn, W. J. Eales, W. L. Findlay, and L. Turing, and to carry on the business of manganese, iron ore, gold, and general miners, winners and workers of gold, gold quartz, copper, and other minerals, dealers in precious metals and stones, etc. Private company. Registered office: 41, Gracechurch-street, E.C.

Liens Registered, etc.

Submarine Railway, Limited.—Debenture to bearer, dated July 5, 1909, to secure £600, charged on the company's undertaking and property, present and future, including uncalled capital.

Talbot-Stead Tube Co., Limited.—Particulars of £5,000 5 per cent. debentures, created June 18, 1909, filed pursuant to Section 93 (3) of the Companies (Consolidation) Act, 1908, the whole amount being now issued. Property charged: the company's undertaking and property, present and future, including uncalled capital. No trustees.

Huinac Copper Mines, Limited.—Charge, created by receiver pursuant to order of court, dated July 7, 1909, to secure £2,050. Property charged: whole of the company's property in Peru and other assets and undertaking (except unissued and uncalled capital and any property acquired by means of such unissued and uncalled capital). Holders: Matheson and Co., 3, Lombard street, E.C.

Mexican Railway Co., Limited.—Particulars of £1 000,000 second debentures, created March 18, and secured by trust deed dated July 8, 1909, filed pursuant to Section 93 (3) of the Companies (Consolidation) Act, 1908, the amount of the present issue being £500,000. Property charged: the company's original railway, telegraph, and undertaking (subject to trust deed of May 1, 1880, covering £2,000,000 6 per cent. debenture stock), except properties described in fourth schedule to deed of July 8, 1909, and the Pachuca Railway and Zacatlan branch (as a first charge). Trustees: Right Hon. Baron Aldenham, W. Plender, and H. P. Sturgis.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Hornsey.—The Council electricity supply undertaking this year shows a net profit of several hundred pounds over that of last year.

Santa Fe.—The Santa Fe Government have given 40,000 dol. gold to the Santa Fe Municipality for new machinery for their electric light station.

Blaenau Festiniog.—The Yale Electric Power Co. are about to commence laying a new main to increase the voltage in the Tanygrisiau district.

Cordoba.—The Cordoba Government have fixed the definite capital of the Cordoba Electric Light and Power Co. as being £476,683. 9s. 10d.

Buenos Ayres.—The directors of the United River Plate Telephone Co. have, at the request of the public, resolved to construct a line from Buenos Ayres to Mar del Plata.

River Plate.—The Government have ordered a contract to be drawn up in connection with the concession granted to Mr. A. Limousin for an electric light station in La Plata.

Bath.—The Rural District Council have decided to invite the Bath City Council to purchase the order authorising the Rural District Council to supply electricity within their district.

Kensington and Knightsbridge Electric Lighting Co.—The directors have declared an interim dividend on the ordinary shares for the half-year ended June 30 at the rate of 8 per cent. per annum.

Dunstable.—The Town Council, having received notice of the intention of private parties to seek a provisional order to supply electricity within the borough, have decided to oppose the application.

Buxton.—The Urban District Council have decided to make application to the Local Government Board for sanction to the borrowing of £500 to meet the estimated requirements of mains and services for three years.

Monte Video.—Plans have been prepared, and approved by the Uruguayan Government, for the establishment of a State telephone service for the department of Monte Video. The expenditure on the work is estimated at about £320,000.

Watford.—The electrical engineer reported at the last meeting of the Electricity Committee that 18 consumers had been connected to the system since the previous meeting, making a total of 789 connected to date, equivalent to 52,128 32-watt lamps.

Chopwell.—The Chopwell miners have now decided to have the electric light placed in their houses. The rate of payment is for a 16-c.p. light 4d. The question of lighting the village more efficiently will be brought before the Blaydon District Council.

Fulham.—Mr. A. Carson Roberts, the district auditor, reporting on the electricity undertaking of the Fulham Borough Council, states that during the year just closed—the fifth of full working—it had for the first time paid its way, there being a profit of £3,606.

Totnes.—At the last meeting of the Town Council the town clerk reported the receipt from the Board of Trade of a copy of a letter addressed to the Totnes Electricity Supply Co., which called attention to special electric lighting regulations, and this was handed to the surveyor.

Preston.—For some years there has been an agitation in Preston in favour of the Corporation purchasing the undertaking of the National Electric Supply Co., and much disappointment was expressed last week when it was announced that the committee have decided that they cannot recommend its purchase.

Morecambe.—The Council have authorised the Electricity Committee to seek the advice of an expert to report generally as to any alteration which can be made in the present electrical plant and system of distribution and other matters, with a view to securing a more economical working of the electric light department.

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Glamorgan.—With a view to aiding the study of engineering, authority has been given by the Board of Education for the establishment as an experiment of a laboratory for mechanical and electrical engineering, and the chief education official has been directed to report in detail upon the whole of the cost of hiring and equipping such a centre.

Hoddesdon.—The Hertfordshire County Council have given permission to the erection by the National Telephone Co. of a line of poles and wires along the High-street, Hoddesdon, under the terms of the existing agreement between the County Council and the company, subject to the poles being placed in positions to the satisfaction of the county surveyor.

South Shields.—The Town Council have confirmed the settlement arrived at between the Tramways and Electrical Committees with regard to the dispute as to the account for current for travelling purposes. The Council also sanctioned the laying down of a duplicate cable which was found to be necessary owing to the increased demand for current for power purposes.

Dinas Powis.—A meeting of the Dinas Powis Parish Council was held on Monday, when a further resolution was passed requesting the Rural District Council not to proceed with the electric lighting scheme for Whitchurch on the ground that the scheme was sure to be a failure, and that the burden would fall on the ratepayers in all the parishes within the Rural Council district.

Bournemouth and Poole Electricity Co.—The directors have authorised the payment of the interim dividends upon the 4½ per cent. preference shares, and the 6 per cent. second preference shares of the company, less income tax, for the half-year ended June 30, 1909, and have declared an interim dividend on the ordinary shares at the rate of 5 per cent. per annum, less income tax, for the same period, all payable on Aug. 15.

Edinburgh.—At a meeting of the Electric Lighting Committee of the Town Council it was intimated that the surplus this year amounted to £2,071. 16s. 4d. Mr. A. A. Murray moved that the surplus be applied towards the redemption of the capital debt on the undertaking, while Mr. Lyon, seconded by Mr. Rawson, moved that it be applied towards the relief of the rates. By seven votes to six Mr. Lyon's motion was carried. It was agreed to recommend that the rate of charge for lighting be allowed to remain unaltered.

Hanley.—The monthly report of the electricity department for May, 1909, was submitted to the last Council meeting. In that month 105,383 units were sold, against 88 909 in May, 1908. The total generated were respectively 125,174 and 112 468 units, and the maximum loads 829 kw. and 826 kw. The coal consumption per unit was 9 30 lb, against 10·30 lb. a year ago, and the works cost ·999d. compared with 1·302d. per unit sold, notwithstanding several items being charged to revenue instead of to capital, but the amount of repairs in hand was less than in 1908.

Huddersfield.—The Electricity Committee have decided to introduce the system of prepayment meters in the Longwood district. There are now 2,977 consumers, an increase of 134 for the half year, and the number of lamps connected is 276,515, an increase of 32,352 on the past six months. Arrangements have been made for a supply of energy to the premises of Read Holliday and Sons. Extensions are to be carried out from Elmfield-road to Ashfield-road, Fartown, and to Snow Lea, Longwood. The mayor, chairman, and deputy chairman, with the borough electrical engineer, have been appointed to deal with the application of the leading stokers for increased pay.

Bray.—At the last meeting of the Urban District Council the report of the Electric Light Committee was submitted, in which it was stated that a letter had been received from the Local Government Board with reference to the application of the Council for a loan of £2,600 for extensions at the electric light works. The letter stated that the Board could not, with propriety, sanction a loan in respect of works carried out in 1904, 1905, and 1906—three or four years having elapsed since their completion. The cost of the switchboard, £460, being a maintenance charge, would have to be defrayed out of revenue. The Board were prepared to sanction a loan of £1,000 in respect of gas plant, disconnecting boxes, and contingencies.

Mexborough.—The Electric Lighting Committee reported at the last Urban District Council meeting that the Local Government Board's inspector, after making a visit for additional information, had agreed to the loan being raised from £4,100 to £4,820, chiefly for prospective extensions to the distribution cable and public lighting cable and lamps The committee recommended that application be made to the Local Government Board for an additional £720 to be borrowed, made up as follows: £370 for prospective extensions to distribution cable, £300 for prospective extensions to public lighting cable and lamps, and £50 for extras in connection with the new office. It was also recommended that the work in connection with the new office and storeroom be proceeded with at once. The report was adopted.

Sheffield.—Mr. H. R. Hooper, of the Local Government Board, on Friday conducted an inquiry into an application by the Corporation to borrow £56,000 for purposes of the electrical department. It was stated that the undertaking had £170,600 unproductive capital, against which they had no assets. The sum of £225 had been paid by the Corporation for every £100 raised by the old company owning the electric light works. The town clerk mentioned that, although they had to work in competition with a gas company whose charges were the lowest in the kingdom—1s. 4d. per 1,000 ft., and down to 1s. for large quantities—the demand for electricity was growing, and funds were needed in order that customers' demands might be readily met. They were also seeking to make an extension to Tinsley, which was in the area of the Yorkshire Electric Power Co., but owing to the supply station being so far away, they were willing that Sheffield hould provide the supply.

Stoke-on-Trent. — The Electricity and Destructor Committee reported at the last Town Council meeting that the electrical engineer presented his quarterly report in which he stated that during the quarter ended June 30, 188,382 units had been supplied, an increase on the corresponding period of last year of 66 per cent., and that the number of consumers now on the books was 454, representing a total of 17,719 32-watt lamps for lighting and heating, and 826¼ h.p. in motors. The town clerk read a letter from the Local Government Board referring to the visit of one of the Board's inspectors to the electricity works with reference to the Council's application for sanction to borrow £650 for the installation of a water-cooling plant there, declining at the present time to sanction such a loan. The electrical engineer reported on the amended regulations made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, for securing the safety of the public and for ensuring a proper and sufficient supply of electrical energy. The report was adopted.

Tynemouth.—At the last Town Council meeting the Electrical Committee presented a special report with reference to various matters in difference between the Corporation and the Newcastle-on-Tyne Supply Co. The company offered, on the Corporation agreeing to withdraw their claim on account of delay in commencing the supply, to relieve the Corporation of the obligation to run the generating plant for two years. The committee recommended that, in view of the fact that the Corporation was now taking a bulk supply from the Newcastle Co., and of the general reduction in the staff at the works, and also in view of the state of the works and the fact that they are not to be run for two years, that the salary of the electrical engineer should be reduced from £300 to £250 per annum, and that should a credit balance be shown in the accounts for the year ending March next the question should be taken into consideration with a view to an increase of salary. The committee also recommended that the salary of the station superintendent should be reduced from £3 to £2. 10s. per week, and that the wages of every man employed in the engine-room should remain as at present. The report was adopted without discussion.

Derby.—The Town Council having recently applied to the Local Government Board for permission to borrow £7,300 for the purposes of their electric light undertaking, Mr. H. R. Hooper, M.Inst.C.E., held an inquiry on the 21st inst. at the Guildhall into the subject matter of that application. There was no opposition. The town clerk explained that the present application was made under the Electric Lighting Act of 1882, and the £7,300 which they now desired to borrow was made up as follows: mains, £5,000; services, £500; motors, £900; radiators, £100; transformers and chambers, £500; and pipe lines, £300. This £7,300 was the estimated capital expenditure in connection with the undertaking for the current financial year. The electrical engineer supplied details of the growth of the undertaking under his control, and said it was increasing considerably. It was stated that the number of units of electricity sold the year before last was 3,320,074, and last year the total was 3,957,797, an increase of 637,000 units, and this was the largest increase there had been in any year since the works commenced. The greater part was in connection with the supply of energy for power purposes, and in addition to the number of units now supplied, there were connections being arranged for 600 h.p.

York.—The Electricity Committee have prepared a report in which they state that the city electrical engineer has laid before them a report upon the proposed lighting of streets along the routes of the electric tramways by the substitution of electricity for the present gas lamps, utilising the tramway posts for the electric lamps. It has already been arranged in connection with the tramways contract for the laying down of the requisite cables for the proposed alteration of the existing system of lighting in the streets referred to. The city electrical engineer in his report states: "The total number of gas lamps between the end of the existing public electric lighting and either the city boundary or the ends of the tramway routes along each route is 89. The cost to the city is £2. 12s. 9d. per post, or for the 89 posts £234. 14s. 9d. per annum. These 89 gas lamps could be substituted by Osram lamps of the same candle-power and burning the same number of hours, if placed on alternate tramway posts, at the same cost per post. The cost of providing and fixing the requisite electric light lanterns and lamps would be £289. 5s., and if the alterations are carried out I would suggest that this expenditure be met out of revenue account. Among the advantages to be obtained by substituting electric lighting is that the lighting is then not affected by the wind on stormy nights and the number of poles along the footway are reduced to a minimum. No doubt when the time comes to erect the tramway poles it will be found that it is necessary to fix some of them in positions now occupied by gas lamp-posts, and the latter will have to be removed. If the extension of electric street lighting is adopted it will be possible to avoid all the expenses of removing and re-erecting the gas-posts. The total consumption of the proposed electric lamps will be approximately 20,000 units per annum." The committee have adopted the city electrical engineer's report and have referred it to the Streets and Buildings Committee with a recommendation for its approval by them, so that the work may be carried out in conjunction with the laying down of the tramways.

Stock Exchange. — Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the Chiswick Electricity Supply Corporation's £80,000 4½ per cent. first mortgage debenture stock. The committee has also been asked to appoint a special settling day in the Glenshiel Rubber Estates Co.'s 20,809 shares of £1 each, 15s. paid, Nos. 1 to 7 8,008 to 21,813, 21,455 to 22,544, 23,014 to 23,633, and 23,915 to 30,000; Ledbury Rubber Estates' 41,661 vendors' shares of £1 each, fully paid, Nos. 40,001 to 81,661; Northern Copper (B.S.A.) Co.'s further issue of 19,000 shares of £1 each, fully paid, Nos. 205,631 to 224,630; Sumatra Consolidated Rubber Estates' 34,254 shares of £1 each, fully and partly (7s. 6d.)

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paid, Nos. 1 to 34,254; Sumatra Proprietary Rubber Plantations' 60,000 shares of £1 each, fully and partly (10s.) paid, Nos. 1 to 60,000; Tebrau Rubber Estates' (1909) 50,000 shares of £1 each, 5s. paid, Nos. 1 to 50,000; Ulu Rantau Rubber Estates Co.'s 10,007 shares of £1 each, fully paid, Nos. 14,376 to 24,382, and 5,549 shares of £1 each, fully paid, Nos. 24,383 to 29,931. The committee has further been asked to allow the United Sumatra Rubber Estates' 65,000 shares of £1 each, fully paid, Nos. 1 to 65,000 (special application), to be quoted in the official list. The committee have appointed special settling days as follows: July 30—Bombay Electric Supply and Tramways Co.'s script, fully and partly paid, for £150,000 5 per cent. second mortgage debentures; Southern Electric Tramways Co. of Buenos Ayres (Compania de Tramways Electricos del Sud) script, fully paid. for £100,000 5 per cent. first mortgage debentures, Nos. 1 to 800 of £100 and 801 to 1,800 of £20 each. Aug. 5—Widin Copper Syndicate's 7,700 shares of £1 each, fully paid, Nos. 1 to 6,701 and 16,708 to 17,707. Aug. 5—Pataling Rubber Estates Syndicate's 225,000 shares of 2s. each, fully paid, Nos. 1 to 225,000 (ex all dividends paid or declared up to and including Aug. 11, 1909); Selangor Rubber Co.'s 300,000 shares of 2s. each, fully paid, Nos. 1 to 300,000 (ex all dividends paid or declared up to and including Aug. 11, 1909). The committee has also ordered the following securities to be quoted in the official list: Bombay Electric Supply and Tramways Co.'s scrip, partly paid, for £150,000 5 per cent. second mortgage debentures; Southern Electric Tramways Co. of Buenos Ayres (Compania de Tramways Electricos del Sud) scrip, fully paid, £100,000 5 per cent. first mortgage debentures, Nos. 1 to 800 of £100 and 801 to 1,800 of £20 each.

TRACTION.

Imperial Tramways Co.—The directors announce that no interim dividend will be paid at this time on either class of shares.

Mont Blanc.—The first section of the tramway from Le Fayet to Mont Blanc, which goes as far as Col de Voza, has been opened for traffic.

Chile.—The Chilian Government have signed the contract for the construction of the line from Arica to La Paz (Bolivia), the work to be terminated in three years.

City of Buenos Ayres Tramways Co. (1904).—The directors have declared a dividend of 1s. 3d. per share, less income tax, for the three months ended June 30 last.

Liverpool Overhead Railway Co.—The directors recommend a dividend at the rate of 5 per cent. per annum on the 1892 preference shares for the past half-year, carrying forward £4,696.

Portsmouth.—The Corporation tramways have earned a profit of £2 297. 6s. 4d., after setting aside £10,900 for maintenance, £2,500 for insurance, and allowing for interest and sinking fund.

Derby.—The receipts of the Corporation tramways during the three weeks ended July 17 were £2,564. 1s. 10d, being a decrease of £147. 18s. 3d. as compared with the corresponding period last year.

Hull and Barnsley Railway.—The Bill promoted by the company, asking for power to construct 23 miles of new lines in South Yorkshire, has passed the Unopposed Committee of the House of Lords, and has been ordered to go forward for third reading.

Bow Bridge Tramway.—It is expected that the reconstruction of the tramway lines between Aldgate and Bow Bridge, to take the place of the stud system, will be completed by the end of this week. The entire work is being carried out by Messrs. Dick, Kerr, and Co., of Abchurch-yard.

New London Tramway Route.—A new line of London County Council electric tramways has been opened this week for public service from King's Cross to Park-street, Camden Town. This new line connects Holborn with Camden Town. It is expected that the work of electrifying the whole line from Holborn to Hampstead, *via* Great College-street, and from Euston-road to Hampstead will be completed very shortly.

Keynsham.—The Council have received notice of an application by the Bath Electric Tramways, Limited, to the Board of Trade for the extension of the time granted by the Bath Electric Tramways (Light Railway Extensions) Order, 1906, to construct two light railways in the rural district of Keynsham, authorised by the order. The time for construction expired on Aug. 18 next, and the company are desirous of obtaining a further period in which to complete the railways.

Cannock Chase.—In a report presented at the last meeting of the Walsall Town Council the Walsall Corporation Tramways Committee state that they had before them a suggestion that the tramways should be extended from Walsall Wood through Brownhills, Chasetown, Chase-terrace, and Heath Hayes to Cannock, and from there back to Bloxwich, and that they have appointed a sub-committee to report on the subject. The extension, if carried out, would open up the most populous portion of Cannock Chase.

Gwendraeth.—The official inspection of the Burry Port and Gwendraeth Valley Railway as a light railway to the Gwendraeth Valley was made by Colonel Druitt, of the Board of Trade, on Tuesday. The inspector was conveyed over the system from Burry Port to Pontyberem by special saloon, accompanied by Mr. H. F. Stephens, consulting engineer, and Mr. Arthur Morgan, general manager, and Mr. Jno. Eager, residential engineer. A minute examination was made of the new work, which has been executed in accordance with the light railway order, and found to be highly satisfactory, the inspector consenting that the railway be opened for passenger traffic forthwith.

Rawmarsh.—At the last Urban District Council's meeting the clerk referred to the alleged claim by the Greasborough Council of a portion of the rent from the trams running through their district. The Rawmarsh Council had previously replied that they could not see their way to pay to Greasborough any portion of the rent that they received from the tramway people. He read a letter from the Greasborough Urban District Council's clerk in the following terms: "Tramline Rental.—I am directed by my Council to acknowledge the receipt of your letter of the 19th ult. *re* the above. I am to say that the Council have now no other alternative but to lay the whole of the correspondence before the County Council. The roadway over which the trams are running being a main road, any rental received would have to be handed over to them as wayleave.—Yours faithfully, JOHN H. JACKSON, clerk."

Elsenham.—The agreement between the Great Eastern Railway Co. and the promoters of the Elsenham and Thaxted Light Railway for the construction of the proposed line has been exchanged. The line will open up a large area of rich agricultural land in North Essex, which is badly in need of better railway facilities. It will be about five miles long, and will cost about £33,000. A short time ago it seemed almost impossible that the agreement would ever be exchanged, but owing to the Treasury making a further grant of £500, in addition to the £15,000 previously granted, and owing to Sir Walter Gilbey, Bart., undertaking to bear a very considerable proportion of the balance, in addition to the sums he had already promised and the land he had given, the construction of the railway has now become a practical certainty. Land has also been given by the Countess of Warwick, Lord Strathcona, Mr. E. W. Collin, and Mr. A. P. Humphrey, and subscriptions have been promised by a large number of residents and others interested in the district.

Horncastle.—A largely attended meeting to consider the proposal to construct a light railway from Sleaford to Kirkstead was held at Horncastle on Friday evening, Mr. John Day, J.P., presiding. The details of the proposals were explained by Mr. S. V. Hotchkin, J.P. (Woodhall Spa), Mr. R. Pattinson (Ruskington), and Mr. E. H. Godson (Sleaford), and Mr. Baker (London). The Chairman said the new railway would prove very beneficial to Horncastle, and the scheme had been taken up by gentlemen who had themselves paid the preliminary expenses. It would pass through a country rich in produce, and would open up a direct route from Horncastle to Sleaford, and thence to the Midlands. As a corn merchant he had attended Sleaford Market for nearly 40 years and knew what a great deal of corn was grown in the district through which the railway would pass. A resolution in support of the scheme was passed unanimously, and an influential committee was formed with the object of ascertaining the financial support likely to be forthcoming locally.

Colinton.—The Tramways Committee of the Edinburgh Town Council last week visited the prospective route of the proposed Colinton tramways. It is understood that attempts to arrive at an agreement between the promoters and the Corporation have so far not been successful. The former body have behind them the desire of the War Office for an early commencement of the work in the interests of the building of Redford barracks, and it is understood that they have made demands on the Corporation which the latter deem it impossible to accept. One of the conditions, it is understood, sought to be imposed on acceptance of the agreement was that the promoters should have powers to at some future time run lines into the centre of the city, a condition which the Corporation cannot concede during the existence of the present cable tramway lease without the consent of the lessees. At the close of their visit of inspection of part of the proposed route, the committee decided to submit certain proposals to the promoters with the view of arriving at an agreement.

Merthyr.—At the last meeting of the Town Council the Watch Committee reported having received a letter from the Merthyr Electric Traction Co. with reference to the overcrowding of trams, and that the same had been referred to the chief constable with instructions to take any necessary proceedings to prevent overcrowding. Councillor Isaac Edwards said that if councillors used the trams often they would know that overcrowding only occurred during pouring rain. There were times, he urged, when a little discretion should be exercised. The previous Thursday night a Dowlais party arrived late at the Merthyr Station, and though rain was falling fast the conductor of the car refused to allow the party on board the tram as he said the car had its full complement. The party had, therefore, to walk to Dowlais in the rain. Chief Constable Wilson, in reply to questions, said the cars were regulated by the by-laws. The attention of the company had been called to the overcrowding of the Dowlais cars, as the Board of Trade had regard to the dangerous inclines. But the Board of Trade referred particularly to the crowding on the outside, as it would be difficult to get to the brakes in case of accident. He did not think the Board would object to people standing inside the cars in wet weather. Councillor Edwards said he was glad to hear that remark, and he hoped it would be noted.

APPOINTMENTS VACANT.

Chair of Engineering. Vacancy at the University of Melbourne, Victoria. The salary attached to the position is £1,000. Applications to the Agent-General of Victoria, Melbourne-place, Strand, W.C.

Electrical Engineering Principal, Sunderland Technical College. Salary, £250, rising to £300. Applications must be sent to Mr. T. W. Bryers, secretary, Education Office, 15, John-street, Sunderland, by Aug. 23. See advertisement in last issue.

Professor of Physics. The Department of Agriculture and Technical Instruction for Ireland invite applications for the professorship of physics in the Royal College of Science. Testimonials must be sent to the Secretary, Department of Agriculture and Technical Instruction for Ireland, Upper Merrion-street, Dublin, by Aug. 16 See advertisement in last issue.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

Salford.—The Electricity Committee of the Corporation invite tenders for the purchase of a direct-coupled steam dynamo of 150 kw. capacity. Tenders by Aug. 9.

Altrincham.—Tenders are invited for an electrical installation at the new higher elementary school, Hale (deposit £1. 1s.). Particulars from the Clerk, Education Department, Altrincham, Cheshire. Tenders by July 30.

Dewsbury.—Persons desirous of tendering for the electric lighting of the nurses' home at the Dewsbury and District Infirmary must send their names and addresses to Messrs. Kirk, Sons, and Ridgway, F.R.I.B.A., architects, Dewsbury.

Great Yarmouth.—The Corporation invite tenders for the supply of uniform clothing for the tramway staff. Particulars from Mr. F. L. Turner, general manager, at the tramways depôt on Caister-road. Tenders to the Town Clerk by Aug. 3.

London, S.W.—Tenders are invited for the supply of telephone material and switchboards to the Postmaster-General's department in New South Wales, for the Commonwealth of Australia. Tender form and specifications obtainable at the Commonwealth Office, London.

Burslem.—The Corporation invite tenders for the wiring and lighting of the technical school, Wedgwood Institute. Tenders to Mr. A. Ellis, town clerk, Town Hall, Burslem, by July 30. Particulars obtainable from Mr. F. Bettany, borough engineer and surveyor, Municipal Offices.

London, W.C.—The Postmaster-General invites tenders for creosoting telegraph poles. Forms of tender, containing all particulars, obtainable from Mr. G. Morgan, controller of stores, Stores Department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders must be sent in by Aug. 9.

Salford.—Tenders are invited for the supply of 1,100 tons of oxide of iron purifying material to the Gas Committee of the Corporation. Particulars obtainable on application to Mr. Wm. W. Woodward, engineer, Gas Offices, Bloom-street, Salford. Tenders to Mr. L. C. Evans, town clerk, by Aug. 12.

Carlisle.—The Burial Joint Committee invite tenders for the installation of new heating apparatus in the chapels at the Carlisle Cemetery. Particulars obtainable from Mr. H. Little, East Norfolk-street. Endorsed tenders must be sent to the Clerk of the Committee, 34, Lowther-street, by July 31.

Manchester.—The Waterworks Committee invite tenders for the supply of about 940 tons of cast-iron water-pipes, 24 in. diameter, with about 20 tons of special castings. Specifications, etc., obtainable from the Secretary, Waterworks Offices, Town Hall, Manchester, on payment of 10s. (returnable). Tenders by July 31.

Bradford.—The Tramways Department invite tenders for eight automatic point controllers. Tender forms and further particulars obtainable from Mr. C. J. Spencer, tramways general manager, Tramway Offices, 5 and 7, Hall Ings, Bradford. Tenders to the office of Mr. Frederick Stevens, town clerk, Town Hall, Bradford, by July 30.

Bury.—The Education Committee of the Corporation invite tenders for heating and ventilating a new secondary school to be erected in the borough. Particulars, conditions, and outline plans obtainable from Mr. Robert Wilkinson, director of education, Education Offices, 8, Bank-street, Bury, on payment of £1. 1s. (returnable). Tenders by Aug. 21.

Hastings.—The Corporation invite tenders for the supply of best Welsh smokeless coal to the electricity works during the period of 12 months from Sept. 1. The estimated quantity required is from 1,300 to 1,500 tons. Forms of tender obtainable from Mr. Russell F. Ferguson, borough electrical engineer, Electric Light Works, Hastings. Tenders by Aug. 3.

Keighley.—The Corporation invite tenders for two 1,000-kw. turbo-alternators with condensers and two water tube boilers. Specifications obtainable at the Borough Electrical Engineer's Office, Coney-lane, Keighley, on deposit of £1. 1s. (returnable). Tenders, addressed to the Chairman of the Electricity Committee, Town Hall, Keighley, must be sent in by Aug. 7.

Plymouth.—Tenders are invited by the Education Authority of the Corporation for the installation of (*a*) electric light and (b) intercommunication system of telephones at the new offices in Rowe-street. Specifications and plans can be seen at the Clerk's Office. Tenders to Mr. E. Chandler Cook, education secretary, 18, Princess-square, Plymouth, by July 30.

Bury.—The Corporation invite tenders for the supply and erection of three water-tube boilers, each capable of evaporating 25 000 lb. of water per hour. Copy of the specification and form of tender obtainable from Mr. S. J. Watson, M.I.E.E, engineer and manager, Electricity Works, Bury, on a deposit of £2. 2s. (returnable). Tenders to the Town Clerk, Bury, by Aug. 16.

London, E.C.—The South Australian Government invite tenders for the supply and delivery of steel railway sleepers. Copies of specification, conditions of contract, and drawings can be obtained, on payment of £1, from the office of Mr. A. A. Kirkpatrick, Agent-General for South Australia, 28, Bishopsgate-street Within, London, E.C., where tenders must be sent by Aug. 4.

Sligo.—The Asylums' Committee invite tenders for the supply of materials for and fitting up of two independent hot-water installations in the male and female hospitals of the District Lunatic Asylum. Particulars and conditions of contract obtainable from the architect, Mr. Anthony Scott, 49, Upper Sackville-street, Dublin. Tenders must be sent to the above committee by Aug. 10.

London, S.W.—The Directors of the Madras and Southern Mahratta Railway Co. invite tenders for the supply of miscellaneous tools and stores, as per the specifications, which can be seen at the offices of the Company. The charge for the specifications is £1. 1s., which will not be returned. Tenders to Mr. H. Bonham-Carter, secretary, 91, York-street, Westminster, S.W., by Aug. 10.

Enniscorthy.—Tenders are invited for electrically lighting Kilcarberry House from existing plant, for the Committee of Management of the Enniscorthy District Asylum, according to specification obtainable from the Clerk, District Asylum, Enniscorthy. A deposit of £1 (returnable) will be required with applications for specifications. Tenders must be sent to the Asylum Office by Aug. 18.

Sheffield.—The Tramways Committee of the Corporation invite tenders for the general building work and structural steelwork required in the erection of new central tramways depôt at Shoreham-street and Leadmill-road. Drawings can be seen and bills of quantities and forms of tender obtained on application to the City Architect, Town Hall, Sheffield. Tenders to the City Architect's Office by Aug. 5.

London, W.—The Directors of the Great Western Railway Co. invite tenders for the supply of 110 tons of steel bridge girders and other iron and steel work of British manufacture. Plans and specification can be seen and forms of tender and bills of quantities obtained at the office of the Engineer at Paddington Station. Tenders to Mr. G. K. Mills, secretary, Paddington Station, London, by Aug. 2.

London, E.C.—Tenders are invited for the delivery of 287 tons wrought iron to the Directors of the Bengal and North-Western Railway Co., as per specification to be seen at the Company's Offices. For each specification a fee of 10s. will be charged (not returnable). Endorsed tenders must be sent to Mr. Alexander Izat, managing director, 237, Gresham House, Old Broad-street, London, E.C., by Aug. 6.

Small Heath.—The Directors of the Great Western Railway Co. invite tenders for the reconstruction of Golden Hillock-road Bridge, at Small Heath Station, near Birmingham. Plans and specification can be seen and forms of tender and bills of quantities obtained at the office of the New Works Engineer, Paddington Station. Tenders to Mr. G. K. Mills, secretary, Paddington Station, London, by Aug. 2.

Manchester.—The Electricity Committee of the Corporation invite tenders for the supply, delivery, and erection at the Dickinson-street generating station of three five-wire balancers. Specifications and form of tender obtainable from Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Further particulars obtainable from Mr. S. L. Pearce, chief electrical engineer. Tenders by Aug. 4.

Dublin.—The Directors of the Midland Great Western Railway of Ireland Co. invite tenders for the supply of from 50,000 to 60,000 tons of best quality South Wales steam coal for locomotives, subject to specification. Form of tender and specification obtainable from Mr. R. L. Badham, secretary, Broadstone Terminus, Dublin. Tenders, addressed to the Chairman, Broadstone Terminus, Dublin, must be sent in by Aug. 3.

Eastbourne.—The Highways and Drainage Committee invite tenders for the supply of about 465 tons in all of cast-iron pipes, 4 ft. to 5 ft. internal diameter. Drawings and specification can be seen and forms of tender and copies of the specification obtained at the Borough Engineer's Office on payment of £2. 2s. (returnable). Tenders to Mr. A. Ernest Prescott, borough engineer, Town Hall, Eastbourne, by July 31.

London, E.—The Guardians of Mile End Old Town invite tender for the supply of six Aron type wattmeters of the following description—viz.: watt-hour, shunted-pattern, switchboard meters, mounted in threes on two polished slate slabs, 3 ft. 4 in. by 3 ft. 8 in. by 1¾ in., with shunts fixed on back of slabs ready for connections and with cyclometer dials, and to be of 100-ampere capacity at 105 volts. Further particulars obtainable from the Master of the Workhouse.

Gretna and Carluke.—The Directors of the Caledonian Railway Co. invite tenders for the work to be executed in the renewal of the superstructures of 10 underbridges on the main line between Gretna and Carluke. Drawing can be seen at the offices of the Company's District Engineer, Princes-street Station, Edinburgh, where copies of the specification and schedule can be obtained on payment of £2. 2s. (returnable). Tenders to Mr. J. Blackburn, secretary, 302, Buchanan-street, Glasgow, by Aug. 2.

Huddersfield.—The Tramways Department of the Corporation invite tenders for painting the overhead tramway poles and waiting-rooms, situate along the various routes of the tramway system. A contract will require to be executed, a draft of which can be inspected at the Town Clerk's Office, Town Hall, during office hours. Specifications and particulars can be obtained on application at the offices of the Tramway Manager, Northumberland-street. Tenders to Mr. J. Henry Field, town clerk, Town Hall, Huddersfield, by Aug. 5.

Southport.—The Southport, Birkdale, and West Lancashire Water Board invite tenders for the construction of an engine and boiler house. Drawings can be seen and a copy of the specification and form of tender, with schedule of quantities, obtained at the offices of Messrs. H. Rofe and Son, civil engineers, 8, Victoria-street, Westminster, S.W., and Oxford-chambers, Victoria-square, Leeds, upon deposit of £5. 5s. (returnable). Tenders to Mr. Alleyne Brown, clerk to the Board, 11, St. George's-place, Lord-street, Southport, by Aug. 9.

Southport.—The Southport, Birkdale, and West Lancashire Water Board invite tenders for the supply and erection of two beam pumping engines, three Lancashire boilers, and other machinery required at the Bickerstaffe pumping station. Drawings can be seen and a copy of the specification with form of tender obtained at the office of Messrs. H. Rofe and Son, civil engineers, 8, Victoria-street, Westminster, S.W., upon a deposit of £5. 5s. (returnable). Tenders to Mr. Alleyne

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Brown, clerk to the Board, 11, St. George's-place, Lord-street, Southport, by Aug. 9.

Huddersfield.—The Corporation invite tenders for the erection of telephone lines from the Central Police Station to the Mold Green, Deighton, and Lockwood Police Stations. A contract will be required to be executed, the draft of which can be inspected at the Town Clerk's Office, Town Hall, during office hours. Specifications, and general conditions can be seen and bills of quantities and forms of tender obtained on application at the offices of the Borough Electrical Engineer, St. Andrew's-road, Huddersfield. Tenders to Mr. J. Henry Field, town clerk, Town Hall, by Aug. 4.

Sheffield.—The Tramway Committee invite tenders for the installation of heating and hot-water supply apparatus at the proposed new car depôt, Shoreham-street. Specifications, forms of tender, and copies of the plans obtainable from the City Architect, Town Hall, Sheffield, on deposit of £1. 1s. (returnable). Tenders to Mr. R. M. Prescott, town clerk, Town Hall, Sheffield, by Aug. 5. The City Council's form of clauses respecting wages, hours, and conditions of labour and prohibition against assigning or sub-letting to be complied with, which can be seen on application at the Town Clerk's Office.

London, W.C.—Tenders are invited by the Postal Authorities for the supply of telegraph poles of (*a*) home-grown larch or fir; (*b*) Swedish, Norwegian, Finland, or Russian red fir. The poles are to be delivered at any one or more of the following ports as may be directed: London, Tilbury, Grimsby, Hull, West Hartlepool, North and South Shields, Ellesmere Port, Swansea, Cardiff, Newport, Southampton, Leven (Fifeshire), Ardrossan, Belfast. The poles to be felled during the winter of 1909-10, and to be delivered during the following summer. Butt sections, 2 in. thick, stamped with the shipper's or tenderer's mark from not fewer than three poles, to show the quality of the timber offered, must precede or accompany the tender of any person who has not already supplied the Postmaster-General with poles. Forms of tender, containing all particulars, obtainable from Mr. G. Morgan, controller of stores, Stores Department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders by Aug. 9.

COLONIAL AND FOREIGN.

Cadiz—The Harbour Board invite tenders for the supply of two automobile steam cranes. Tenders by Aug. 10.

Victoria.—The Postmaster-General invites tenders for the supply of 5,000 telephones complete. Tenders by Aug. 10.

Berne.—The Municipality invite tenders for the construction of an electric mountain railway, estimated to cost £26,000.

Offenbach.—The Municipality invite tenders for the construction of tramways in the district. Estimated cost, £755 000.

Cologne.—The Municipality invite tenders for the erection of four harbour cranes, electrically driven. Tenders by Aug. 25.

Mannheim.—The Municipality invite tenders for the construction of a light railway to Schriesheim. Particulars from Rathaus.

Mexico.—Tenders are invited by the Mexican Tramways Co. for the equipment of new lines and the provision of rolling stock.

Charlottenburg.—Tenders are invited for pumping machinery, boilers, crane, etc., by Aug. 4. Particulars from the Municipality.

Brussels.—Tenders are invited for the construction of a section of the Vicinal Railways from Ardoye to Iseghem. Tenders by Aug. 25.

Madrid.—The Public Works Department invite tenders for the construction of a line from Noguera to Pallarese. Tenders by Aug. 12.

Brussels.—The Belgian State Railways Department invite tenders for the supply of wheels for carriages and wagons. Tenders by Aug. 25.

New South Wales.—The Postmaster General invites tenders for the supply of 10 switchboards for 100 metallic circuits. Tenders by Sept. 10.

Russia.—Tenders are invited by the Governor of Jekaterinoslaw for the lighting of the streets of Bachmut by electricity. Tenders by Sept. 13.

Saarbrucken.—The Prussian State Railways invite tenders for pumps and compressors by Aug. 3. Particulars from K. Eisenbahn Direction.

Bukarest.—Tenders are invited for the supply of copper tubes for locomotives and tenders for the Roumanian State Railways. Tenders by Aug. 9.

Prahran.—The Prahran and Malvern Tramways Trust invite tenders for the supply complete of 12 electric tramcar bodies. Tenders by Aug. 27.

Brussels.—The Belgian State Railways Department invite tenders for the construction of a section of the Schaerbeck-Hal line. Tenders by Aug. 14.

Brussels—Tenders are invited for the construction of a section of the Soire sur-Sambre to Bersillies for the Vicinal Railways. Tenders by Aug. 17.

Madrid—The Public Works Department invite tenders for the construction of a narrow-gauge line from Petro Abad to Martos. Tenders by Aug. 28.

Durban.—The Natal Government invite tenders for carrying out various railway constructional works, including the provision of new rolling stock.

Wiesbaden.—The Provincial Government invite tenders for the construction of tramways from Quierschied to Eppelborn, estimated to cost £50,000.

Wilhelmshaven.—Tenders are invited for the supply of broad-gauge ammunition railway wagons to the Marine Artillery Depôt. Tenders by July 31.

Madrid.—Tenders are invited by the Public Works Department for the construction and working of a railway from Villajoyoso to Denia. Tenders by July 31.

Madrid.—The Public Works Department invite tenders for the construction of a narrow-gauge line from Fortuna to Caravaca. Tenders by Sept. 4.

Rome.—Tenders are invited for 600 mounted axles for goods wagons for the Italian Government Railways. Tenders by Aug. 8 to Ferrovie dello Stato.

Dresden.—The Municipal Council invite tenders for the supply of two 700-kw. single-phase alternating-current dynamos, switchgear, etc. Tenders by Aug. 4.

Rome.—The Italian State Railways Department invite tenders for six electrically-worked hammers. Particulars from Ferrovie dello Stato. Tenders by Aug. 18.

Bukarest.—The Roumanian State Railways Department invite tenders for the supply of copper tubes for locomotive and tender funnels. Tenders by Aug. 19.

Rome.—Tenders are invited by the Italian Government Railways for 50,000 kilos mild-steel plates for boilers. Particulars from Ferrovie dello Stato. Tenders by Aug. 1.

Madrid.—The Public Works Department invite tenders for the construction and exploitation of a narrow-gauge railway from Palma to Saller Harbour. Tenders by Aug. 14.

Ixelles.—The Municipality invite tenders for the installation and working of electric light and power supply in the district. Particulars from the Secretaire Communal, Brussels.

Paris.—Tenders are invited by the Under Secretary for Posts and Telegraphs, 103, Rue de Grenelle, for 75 stamping machines worked by electric motors. Tenders by Aug. 18.

Brussels.—Tenders are invited for the annual supply of accessories of Vignoles rails for the Belgian State Railways. Specification from 11, Rue de Louvain. Tenders by July 31.

Rome.—The Public Works Department invite tenders for the supply of Mannesman tubes, etc., in connection with the Lagonegro water-supply scheme. Tenders by Aug. 4.

Harlem.—The Municipality invites tenders for the supply of steam-boiler, superheater, and accessories. Particulars from the Secretaire Communal. Tenders by Aug. 3

The Hague.—Tenders are invited by the Colonial Authorities for the supply of 300 trucks with brakes for railway wagons. Particulars from Van Cleef Frères. Tenders by Aug. 10.

Willemsvord.—Tenders are invited for the supply of bronze, copper, iron, lead, steel, tin and zinc, and copper tubes, screws, and bolts to the Marine Depôt. Tenders by Aug. 5.

Rome.—The Italian State Railways Department invite tenders for supply of 40 tons of homogeneous iron. Particulars from Ferrovie dello Stato, Sezione Contratti. Tenders by Aug 8

Brussels.—The Directors of the Belgian State Railways invite tenders for the supply of steel washers and other materials. Specifications from 11, Rue de Louvain. Tenders by Aug. 18.

Narvik.—Tenders are invited by the Commissioners of the Norwegian State Railways for the supply of 15 tons of firebars. Particulars from Ofotenbahn, A. Tenders by July 30.

Alicante.—The Harbour Commissioners invite tenders for the supply of three centrifugal pumps and three gas-motors. Particulars from Junta de Obras del Puerto. Tenders by Aug. 12.

Brussels—Tenders are invited for the supply of heating apparatus for use on the Belgian State Railways. Specification No. 730 can be obtained from 11, Rue de Louvain. Tenders by Aug. 11.

Brussels.—Tenders are invited by the Société des Chemins de Fer Vicinaux for extensions of lines, etc., at Bressaux-Trou-Loette. Particulars from 14, Rue de la Science. Tenders by Aug. 3.

Paris.—Tenders are invited by the Direction de la Manufacture d'Aimes, at Châtellerault (Vienne), for cables, copper wire, and dynamo construction material (11 lots). Tenders by Aug. 11.

Hanover.—The Prussian State Railways invite tenders for copper sheets, copper plates, copper bars, copper tubes, and copper wire. Particulars from K. Eisenbahn-Inspection. Tenders by July 30.

Winnipeg.—Tenders are invited for the hydraulic and electric equipment of the generating station now under construction on the Winnipeg River at Thirty foot Falls. Tenders by Aug. 2 and 16.

Paris.—The Postmaster-General invites tenders for the supply of telegraph and telephone material. Tenders to Sous-Sécrétariat de l'Etat des Postes et Télégraphes, 103, Rue de Grenelle, by Aug. 5.

Brussels.—Tenders are invited for the supply of permanent-way material to the Belgian State Railways. Specifications Nos. 249 and 252 can be obtained from 11, Rue de Louvain. Tenders by Aug. 14.

Berlin.—Tenders are invited by the Prussian State Railways Department for the supply of screw bolts, fishbolts, bolts for sleepers, and crossings. Particulars from K. Eisenbahn-inspection. Tenders by Aug. 4.

Brussels.—Tenders are invited for the supply of tirefonds, bolts, and nuts to the Belgian State Railways Department Specification No. 237 can be obtained from 11, Rue de Louvain. Tenders by Aug. 4.

Robida.—The Public Works Department, Madrid, invite tenders for the construction of a railway to Robida. Particulars from the Direccion de Obras Publicas, Ministerio de Fomento. Tenders by Aug. 20.

Rome.—Tenders are invited for the supply of electric cable to the Italian Government Railways Department. Particulars from Ferrovie dello Stato Segretariato Generale, Sezione Contratti. Tenders by Aug. 10.

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Victoria.—The Postmaster-General invites tenders for the supply and delivery at the post office, Hawthorn, of eight sections of a common-battery switchboard and subscribers' apparatus. Tenders by Sept. 14.

Santa Cruce.—The Municipality of Santa Cruce, Tenerifa, invite tenders for the provision of suction dredger and pontoon with steam-engine. Particulars from the Junta de Obras del Puerto. Tenders by Aug. 27

Santiago.—Tenders are invited by the Chilian Railways Department for the supply of rails, fishplates, dog-spikes, and bolts. Particulars from the Direccion-General de Obras Publicas. Tenders by Sept. 1.

Belgium.—Tenders are invited by the Direction Générale des Ponts et Chaussées for the equipment of a transformer sub-station at the harbour at Ostend. Tenders by Aug. 4 to the above-named at 38, Rue de Louvain.

Wevelghem.—Tenders are invited by the Vicinal Railways Department, Brussels, for the construction of a line to Wevelghem. Specification, price 10d., can be obtained from 14, Rue de la Science. Tenders by Aug. 4.

Brussels.—Tenders are invited for the construction of a section of the Vicinal Railways from Anderlues to Lobbes. Particulars from Direction Générale des chemins de fer Vicinaux, 14, Rue de la Science. Tenders by Aug. 24.

Constantinople.—The Department of Commerce and Public Works invite tenders for the construction and exploitation of a railway from Pandermaa, *via* Balikresi, to the Soma Station. Particulars from Ministere du Commerce.

Madrid.—The Public Works Department invite tenders for the construction and exploitation of electric tramways in Barcelona. Tenders by Aug. 27. Particulars from Ministerio de Fomento, Direccion de Obras Publicas.

Ostend.—The Roads and Bridges Department, Brussels, invite tenders for electrically equipping a new sub-station at Ostend. Specification No. 103, price 4d., can be obtained from 15, Rue des Augustines. Tenders by Oct. 8.

Chatellerault.—Tenders are invited for the supply of ammunition factory, cables, and copper and bronze wire, electrical apparatus, and iron and steel constructional material. Particulars from Manufacture Nationale d'Armes. Tenders by Aug. 11.

Spain.—The Direccion General de Obras Publicas, Madrid, invites tenders for an electric tramway concession for 60 years (between Monachil and the suburbs of Gabia Grande, Granada Province). Tenders, with £130 deposit, by Aug. 26.

Bukarest.—Tenders are invited for steel bars for bolts, etc., mild hammered steel for machinery parts, also steel for tools, for the Roumanian State Railways. Particulars from the General Director of Roumanian Railways. Tenders by Aug. 3.

New South Wales.—The Postmaster-General invites tenders for the supply, delivery, and erection of a branching multiple-magneto switchboard at the Edgecliffe telephone exchange in accordance with Specification No. 247. Tenders by Sept. 29.

Barcelona.—The Public Works Department, Madrid, invite tenders for the construction and exploitation of electric tramways in Barcelona. Particulars from the Direccion-General de Obras Publicas, Ministerio de Fomento. Tenders by Aug. 27.

Rome.—The Public Works Department invite offers for the purchase and exploitation of a railway line from Ponte Galera to Fiumicino. Particulars from the Ministero dei Lavori Pubblici, Segretariato Generale (Servizio Contratti). Offers by Sept. 4.

Madrid.—The Madrid Public Works Department invite tenders for the construction of narrow-gauge line from Petro Abad *via* Bujulance and Porciana to Martos. Particulars from the Direccion de Obras Publicas, Ministerio de Fomento. Tenders by Aug. 25.

Charlottenburg.—Tenders are invited for the supply of four steam-pumps, four two-flame boilers, and one six-ton travelling crane to the waterworks. Specifications (price, 10s.) can be obtained from Aktien-Gesellschaft Charlottenburger Wasserwerke Westend. Tenders by Aug. 6.

Madrid.—The Public Works Department invite tenders for the construction and exploitation of an electric tramway between Monarhil and the suburbs of Gabia Grande, Granada. Particulars can be obtained from the Commercial Intelligence Department of the Board of Trade. Tenders by Aug. 26.

Santiago.—The Chilian State Railways invite tenders for the supply of five locomotive tenders, in accordance with the specifications, which can be obtained at the Servicio de Materiales, Santiago. A deposit of 500 pesos (£37. 10s.) for each locomotive tender will be required to qualify any tender. Tenders to the office of the Dirección Jeneral de los Ferrocarriles del Estado, Santiago, by July 31.

Buenos Ayres (Argentine).—The Ministry of Public Works invite tenders for the supply of seven locomotives for the Patagonian Railways, in accordance with plans and specifications (in Spanish), copies of which can be seen on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C. Tenders to the Direccion General de Ferrocarriles, Buenos Ayres, by Aug. 21.

Oporto (Portugal).—The *Diario do Governo* of July 10 publishes a notice, issued by the Portuguese State Railways, inviting tenders for the construction of a section of line, nearly five miles long, from Valenca to Moncao, being part of the Valenca to Melgaco Railway. To qualify any tender a deposit of 1,482 milreis (about £300) will be required, to be increased by the successful tenderer to 5 per cent. of the accepted contract price. Tenders to the Direccao do Caminho de Ferro do Minho e Douro, Oporto, by Aug. 3.

Melbourne (Australia).—The Corporation invite tenders for the supply of one overhead travelling crane. Tender form, conditions of tendering, specification, and plans, etc., can be obtained on application to Messrs. McIlwraith, McEacharn, and Co., Billiter-square-buildings, London, E.C., agents for Melbourne City Council, by depositing the sum of £1. 1s., which amount will be returned on receipt of a *bona fide* tender. Tenders to the Chairman, Electrical Supply Committee, Town Hall, Melbourne, by 2 p.m. on Aug. 4.

Brisbane (Australia).—The Board of Waterworks invite tenders for the supply of 42-in. and 48 in. steel pipes, or alternatively 42-in. and 48-in. wrought-iron pipes or 42 in. and 48-in. cast-iron pipes. The whole of the material to be used in the manufacture of the pipes must be the product of the United Kingdom or of the Commonwealth of Australia. Specifications and drawings can be obtained on application at the office of the Engineer to the Agent-General for Queensland, 409 and 410, Strand, London, W.C., on payment of a fee of £3. 3s Tenders must be sent to the Secretary, Brisbane Board of Waterworks, Brisbane, Queensland, by Sept. 1.

Rome (Italy).—The Rome *Gazzetta Ufficiale* of June 17 announces that tenders are invited for the construction of the Ostiglia-Nogara section of the Bologna-Verona Railway, nine miles long, and of various junctions. The upset price is placed at 3,650,000 lire (£146,000), and the competition will turn on the percentage of reduction offered thereon. To qualify any tender a deposit of 182,000 lire (£7,280) will be required, to be increased by the successful tenderer to 365,000 lire (£14,600). Tenders must be enclosed in sealed envelopes, marked on the outside "Offerta per Asta: tronco Ostiglia-Nogara," and addressed to Direzzione-Generale delle Ferrovie dello Stato (servizio 1, ufficio contratti), *via* Ludovisi 4, Rome, where they will be opened on July 31. Tenderers will be required to furnish certificates of competency. The award in respect of this competition will no doubt involve the purchase of a substantial quantity of permanent-way material, which may have to be obtained wholly or in part out of Italy. The *Gazzetta*, containing further particulars, can be seen by British firms interested on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

RESULTS OF TENDERS.

Barnstaple.—The Town Council have accepted the tender of H. R. Williams and Co. for the provision of a new boiler at the soup kitchen.

Shrigley.—The Down County Council have accepted the tender of J. Martin and Co. for the erection of electric lamp standards at Shrigley.

Billericay.—The Board of Guardians have accepted the tender of Meldrum Bros., Bradford, at £40, for the supply of patent blast for boiler furnaces.

Droitwich.—The Board of Guardians have accepted the tender of S. Smith and Sons, Smethwick, at £58. 10s., for the installation of heating apparatus.

Aberystwyth.—The tender of Dargue, Griffiths, and Co., Liverpool, amounting to £245. 10s., has been accepted for installing heating apparatus in Alexander Hall.

Spalding.—The Urban District Council have accepted the tender of the Holwell Iron Co., Melton Mowbray, for the supply of cast-iron pipes and specials for £5,586.

Derby.—The Electric Lighting Committee recommend the acceptance of the tender of the Chloride Electrical Storage Co. for the renewal of the tramway battery.

Erith.—The Urban District Council have accepted the tender of the Woodville Electric Co. for the supply of three auto-transformers at the sanatorium for £4. 12s. 6d.

Canterbury.—The Town Council have accepted the tender of Tice and Co., Canterbury, for the supply of a lathe, with reversible chuck and motor, for £64. 11s. 2d.

Torquay.—The Town Council have accepted the tender of S. L. Harding, Torquay Ironfoundry, for the supply of ironwork for the shelter on Haddon pier, at £69. 10s.

Derby.—The Tramways Committee have accepted the tender of Howitt and Mee for the rights of advertising on the tramcars, at £900 per annum, for a period of five years.

Keighley.—The Town Council have recommended for acceptance the tender of Clapham Bros., Keighley, at £357. 6s. 2d., for the supply of iron pipes and special castings.

Keighley.—The Town Council have accepted the tender of McPhail and Simpson, of Wakefield, for the supply of three superheaters and steam-pipes for the sum of £303. 18s. 6d.

Buxton.—The Electricity Committee recommend the Urban District Council to accept the tender of Day and Ferguson for the supply of coal for use at the generating station.

Leamington.—The D.P. Battery Co., of Bakewell, have received an order from the Midland Electric Light and Power Co., of Leamington, to install and maintain a storage battery for 10 years.

Bradford.—The tender of Gent and Co., Leicester, has been accepted by the Town Council for the supply of 100 electric impulse clocks, with master clock and wiring, for the sum of £194.

Hambledon (Surrey).—The Rural District Council have accepted the tender of Manlove, Alliott, and Co., at £3,929, for the provision of the ejectors and air main in connection with the Shalford sewerage system.

Minworth.—The Birmingham Tame and Rea District Drainage Board have accepted the tender of the General Electric Co., Witton,

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at £423. 10s, for providing and fixing motors and pumps at Minworth.

Victoria.—The Department of Home Affairs have accepted the tender of Messrs. Rowe, Drew, and Co., Melbourne, for the installation of heating apparatus in the Federal Parliament House for the sum of £360.

Mexborough.—On the recommendation of the Electric Lighting Committee, the Urban District Council have accepted the tender of Cliffe and Smart for the provision of engine and pump foundations at the works for £32.

Saltley.—The tender of Crompton and Co. has been accepted by the Birmingham Tame and Rea District Drainage Board for providing and fixing motor and pump at the pumping station, Saltley, for the sum of £877.

London.—The Stores Committee of the London County Council recommend the acceptance of the tender of J. R. Collins and Co., Alliance Steam Mills, Windus-road, Stamford Hill, N., for the supply of chemical apparatus (Schedule No. 5A).

Smethwick.—The Birmingham Education Committee have accepted the tender of Hollings and Guest, Birmingham, for providing and fixing low-pressure hot-water heating apparatus in the new technical school, Smethwick, for the sum of £670.

Ilford.—The Education Committee have accepted the tender of Watkin and Son, Wood Green, N., at £59. 18s. 6d., for the supply and delivery of a Robin Hood boiler, and for incidental work in connection therewith, at the Cleveland-road Council School, Ilford.

Cardiff.—For the supply of cast-iron pipes and about 30 tons of irregulars and special castings to the Corporation, the tender of Jordans, Limited, Newport, Mon., at £1,883, has been accepted. Note.—Twelve tenders submitted, highest amounting to £2198. 12s.

Wimbledon.—The Borough Council have accepted the following tenders: British Westinghouse Electric and Manufacturing Co., Norfolk-street, Strand, 13 circuit breakers, 10s. each; Strode and Co., Regent's Park, N.W., heating apparatus at Queen's-road School, £379.

Christchurch.—The Corporation have accepted the tender of T. B. Cooper and Co., Sun Buildings, Clare-street, Bristol, for carrying out a main drainage scheme, including the laying of cast-iron rising and air mains, and the provision of hydro-pneumatic ejectors, ejector chambers, air-compressing plant, etc.

Wishaw (Scotland).—The Corporation have accepted the following tenders for the supply and erection of plant: R. Dempster and Sons, Rose Mount Ironworks, Elland, Yorks, Livesey washer £125, and one set of condensers £264; Parkinson and W. and B. Cowan, Buccleuch-street Works, Edinburgh, two retort-house governors, £139. 13s. 6d.

London.—The Metropolitan Water Board have accepted the following tenders for the provision of two steam tractors and trailers and two motor lorries, with trailers: Aveling and Porter, two lorries and two trailers £1,035, one tractor with awning and trailer £452. 10s.; J. Fowler and Co., one tractor with awning and trailer, £450. 10s.

Woolwich.—The London County Council have accepted the tender of Dick, Kerr, and Co. for the execution of roadwork and platework and the overhead electrical work connected with the reconstruction of the tramways from the present terminus at Beresford-square, westwards along Beresford-street and High-street, Woolwich. The price is about £5,350.

Ilford.—The Education Committee have accepted the tender of E. C. Porter, High-road, at £333. 8s., for installing electric light wiring and fittings for about 200 lamps of 16 c.p. and emergency gaslight service at the Goodmayes School, Ilford, and that of Pemberton, Arber, and Co., Holborn, E.C., at £295. 14s., for the provision of heating apparatus in the same school.

Victoria (N.S.W.).—The Railways Department have accepted the following tenders for supplies: British Insulated and Helsby Cables, one mile lead-covered cable, £160; Dorman, Long, and Co., mild-steel girders and iron clips; E. Duckett and Sons, steel boiler plates; W. M. Russell, 200 tons of foundry pig iron, £4. 5s. 6d. per ton; Briscoe and Co. and Cohen and Sons, block tin; Johnson and Sons Proprietary, mild-steel guard forgings; F. Long and Co., wrought-iron forgings.

Southwark.—The Borough Council have received the following tenders for the supply of the standard length of 110 yards of ·3 × ·3 × ·125 paper-insulated and lead-covered cable:

British Insulated and Helsby Cables*	£56	0	0
Johnson and Phillips	56	15	0
Siemens Bros. and Co.	56	12	6
Western Electric Co.	56	0	0

* Recommended for acceptance.

Leicester.—Tenders have been received from the following for the erection of new heating chamber at the Leicester Museum and Art Gallery:

J. C. Kellett	£600
A. and W. Chambers	598
Tyers and Yates	595
W. Smith	587
F. Elliott (accepted)	576

Tottenham.—The Middlesex County Council have received the following tenders for the installation of new heating apparatus at the High School for Girls:

W. Bailey and Son	£944	1	3
Wontner-Smith and Co.	599	0	0
Rosser and Russell	596	0	0
W. J. Fox	460	0	0
G. N. Haden and Son*	340	0	0

* Recommended for acceptance.

Hampton.—The Water Examination Committee of the Metropolitan Water Board have received the following tenders for the supply and installation at Hampton for the purposes of comparison of their respective mechanical filter apparatus:

Bell Bros.	£350	0	0
Candy Filter Co.	337	10	0
Mather and Platt	212	0	0
Pulsometer Engineering Co.	200	0	0

(Accepted for one filter from each of the firms invited to tender.)

Tasmania.—The Postmaster-General has accepted the following tenders: Western Electric Co., Australia, etc., 163, Pitt street, Sydney, one c.b. switchboard, of eight sections in all, together with all associated frames, racks, power plant, and parts, £3,019, 600 telephones, wall sets, £1,237. 10s., 100 telephones, table sets, £188. 6s. 8d., 750 protectors £93. 15s., 50 telephones, wall sets, for party lines, £143. 15s., 20 telephones, table sets, for party lines, £46; and that of the British Insulated and Helsby Cables for 100 extension switch and bell sets, complete, £165, 15 switchboards for four lines £66, eight switchboards for six lines £50. 12s.

Maidstone.—The Corporation have received the following tenders for the supply of feeder cable:

Union Electric Co.	£317	11	0
Western Electric Co. (accepted)	397	0	0
Callender Cable Co.	408	18	2
Henley's, Limited	412	0	0
Johnson and Phillips	412	0	0
British Insulated Co.	412	10	6
W. T. Glover and Co.	414	17	0
Electrical Co.	424	10	9

Bermondsey.—The London County Council have received the following tenders for the provision and fixing of a new boiler at the "Chaucer" Council school:

Tilley Bros, 53, Kingsland-road*	£196	0	0
W. Truswell and Son, Durham Foundry, Sheffield	197	6	0
Strong and Collings, Bermondsey-street	199	15	0
Shelby Manufacturing Co., Hanover-street, Peckham	205	10	0
J. Yetton and Co., 4, Carr-street, Limehouse	213	0	0
Strode and Co., 48, Osnaburgh-street	233	0	0
Stevens and Sons, 239, Southwark Bridge-road	243	0	0
W. Simmons, Frederick-street, Stratford	243	10	0

* Recommended for acceptance.

Fulham.—The London County Council have received the following tenders for the provision and fixing of a new boiler at St. Dunstan's-road Council school:

Comyn, Ching, and Co., 54, Castle-street, Long-acre*	108	10	0
Brightside Foundry and Engineering Co., 28, Victoria-street, Westminster	109	0	0
F. W. Brock, 287, Shirland-road, Paddington	109	15	0
G. Davis, Church-street, Kensington	112	0	0
H. J. Cash and Co., Carton House, Westminster	112	15	0
Cannon and Hefford, Stanbury-road, Peckham	121	0	0
Davis, Bennett, and Co., Horseferry-road	128	0	0
Korting Bros, 53, Victoria-street	138	17	6

* Recommended for acceptance.

Hoxton.—The London County Council have received the following tenders for the provision and fixing of a new boiler at the Chatham-gardens School:

Tilley Bros.*	£101	10	0
Brightside Foundry and Engineering Co.	107	0	0
Palowkar and Sons, 90-91, Queen-street	107	0	0
T. S. Knight and Sons, 222, Great Portland-street	111	2	6
J. Grundy, 393A, City-road	117	0	0
A. Macintosh and Sons, Market-place, Cambridge	117	16	0
Strode and Co.	123	0	0
J. Yetton and Co.	129	8	6
B. Harlow and Son, Macclesfield	139	0	0
W. Simmons (recommended for acceptance)	142	0	0

Brighton.—The Education Committee have received the following tenders for (*a*) the installation of electric light in the Ditchling-road Council School, and (*b*) for lighting the carpenters' shop in Richmond-street School:

(*a*).

G. Virgo	£248	10	0
Reed and Sons	234	9	6
Page and Miles	207	10	0
Adams Bros. (accepted)	198	12	6

(*b*).

Adams Bros.	12	0	0
Page and Miles	10	6	8
G. Virgo	9	0	0

All of Brighton.

Southwark.—The Borough Council have received the following tenders for (*a*) the erection of an addition to the electric light station on the site of 18, Penrose-street, and (*b*) the supply, erection, and maintenance of a battery on the site:

(*a*).

Battley, Sons, and Holness	£1,147	0	0
F. and H. F. Higgs	1,190	0	0
W. Downs	1,177	0	0
J. Marsland and Sons*	1,120	0	0

* Provisionally accepted.

(*b*).

Hart Accumulator Co.	394	16	0
Chloride Electrical Storage Co.	390	0	0
Tudor Accumulator Co.	351	0	0
D.P. Battery Co.	280	0	0
Premier Accumulator Co.	263	0	0
Electrical Power Storage Co.	247	0	0

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St. Pancras.—The Borough Council have received the following tenders for the supply of arc lamp carbons during the ensuing year:

W. Geipel and Co.	£362	3	4
Sloan Electrical Co.*	382	1	8
H. G. Mayer and Co.	420	0	0
Crompton and Co.	424	8	4
G. Braulik	452	5	0
Andrew and Suter	467	0	0
General Electric Co.	498	0	0
Sirius-Werke (M. Seeck)	513	6	8
Ship Carbons, Limited	516	5	0
Siemens Bros. Dynamo Works	672	5	0
Piggott Electrical Co. (Smith Bros.)	758	0	0

* Recommended for acceptance.

Haslingden (Lancs.).—The Corporation have received the following tenders for the supply of sub station equipment with battery and reversible booster in connection with the electric tramways:

Glass cells.

Premier Accumulator Co., Cattle Market-road, Northampton	£598	10	0
D.P. Battery Co., Lumford Mills, Bakewell, Derbyshire	554	0	0
Chloride E.P. Storage Co., Pendlebury, near Manchester*	610	16	0
Electrical Power Storage Co., 4, Great Winchester-street, London, E.C.	670	0	0
Ditto (alternative)	602	0	0
Ditto (alternative)	832	0	0
Tudor Accumulator Co., 119, Victoria-street, Westminster, London, S.W.	598	0	0
Electric Construction Co., Dashwood House, 9, New Broad-street, London, E.C.	680	0	0

Teak cells.

Premier Accumulator Co.	610	0	0
D.P. Battery Co.	620	0	0
Hart Accumulator Co., Marshgate-lane, Stratford, London, E.	696	18	0
Chloride E.P. Storage Co.	699	16	0
Electrical Power Storage Co.	716	0	0
Ditto (alternative)	648	0	0
Ditto (alternative)	878	0	0
Tudor Accumulator Co.	724	0	0
Electric Construction Co.	726	0	0
Ditto (alternative)	691	0	0
Ditto (alternative)	693	0	0
Crompton and Co., Salisbury House, London-wall, London, E.C.	865	0	0

* Accepted; voltage regulation within 1 per cent.

PROVISIONAL PATENTS, 1909.

JULY 16.

16575. Improved instrument for collecting atmospheric electricity. Frederick Harrison Glew, 156, Clapham-road, London.

16576. Appliance for the rapid launching of lifeboats at sea, power to be electricity or steam. James Guthrie, 5, Bond-street, Grays, Essex.

16584. Improvements in or appertaining to electric terminals or binding screws. George Whitley Mickleth wait, 9, Tempest Hey, Liverpool.

16621. Improved electrical device chiefly designed for use in indicating the speed of vehicles. John Rennie, 11, Southampton-buildings, London.

16630. Improvements in and relating to the regulation of electric installations. Akt.-Ges. Brown, Boveri, et Cie., 18, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Sept. 16, 1908, being date of application in Germany.) (Complete specification.)

16631. Improvements in and relating to the control of dynamo-electric machinery in electric lighting installations worked with accumulators. Akt.-Ges. Brown, Boveri, et Cie, 18, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Sept. 14, 1908, being date of application in Germany.) (Complete specification.)

16641. Portable telephone transmitter mouthpiece attachment. William Aitken and British Insulated and Helsby Cables, Limited, Milton-road, Edge-lane, Liverpool.

16642. Improvements in telephone switchboards. William Aitken and British Insulated and Helsby Cables, Limited, Milton-road, Edge-lane, Liverpool.

16643. Improvements in telephonic sub-station switching systems. William Aitken and British Insulated and Helsby Cables, Limited, Milton-road, Edge-lane, Liverpool. (Complete specification.)

16645. Improvements in and relating to electric distribution systems. Dalziel's Constant Voltage Patents, Limited, and James Dalziel, 467, Finchley-road, London.

16649. Improvements in quick make and break electric switches. Allan West, Broad Sanctuary-chambers, Westminster, London.

16662. Improvements in or relating to the manufacture of electrical condensers and similar apparatus. Joseph Arthur Lovel Dearlove and Sidney George Brown, 7, Southampton-buildings, London.

JULY 17.

16678. Improvements in multiple electric switches and automatic circuit breakers especially applicable to motor starters. Percy Smith Brook and John Arthur Hirst, 34, Castle-street, Liverpool.

16679. Improvements in electric batteries. Frank Richmond, 54, Colne-road, Burnley.

16682. Improvements in trolley heads employed for electric traction. Frank Jackson, 4, St. Ann's-square, Manchester.

16690. Improvements in portable electric hand-lamps. Herbert Osborn Wraith, 24, Norfolk-row, Sheffield.

16702. Improvements in or relating to electric batteries. Harold Harman Simmons, St. John's House, Sevenoaks, Kent.

16709. Improvements in electric igniting apparatus. Nobel's Explosives Company, Limited, and William Tuxford Evans, 65, Chancery-lane, London.

16728. Improvements in and relating to means for making electrical connections. Albert Vandam, 322, High Holborn, London.

16732. Improved amplifying device for use in high-tension electric spark-ignition apparatus Marcel Delage and Paul Woog, 6, Lord-street, Liverpool. (Date applied for under Section 91 of the Act, Oct. 12, 1908, being date of application in France.) (Complete specification.)

JULY 19.

16811. Improvements in and relating to alternating-current electric induction motors. Siemens Bros. Dynamo Works, Limited, and Emil Otto Kieffer, Caxton House, Tothill-street, Westminster.

16812. Improvements in fans for cooling dynamo-electric machines and for other purposes. Siemens Bros. Dynamo Works, Limited, and Emil Otto Kieffer, Caxton House, Tothill-street, Westminster.

16823. Improvements in conduits and adaptors for electrical conductors and the like, and in the method of protecting the latter. Harry Moss, 77, Market-street, Bradford.

16855. Improvements in or connected with the production of electric light between the electrodes of arc lamps. Ges. für Elektrotechnische Industrie m. b. H. and Johann Gyuris, 115, Cannon-street, London. (Complete specification.)

JULY 20.

16894. Improvements in magnetic plugs. Herman Harold Duden, 15, Park-lane, London.

16895. Improvements relating to electromotors and to the production of sound waves for signalling to a distance. Sydney Evershed, Willie Dickson Kilroy, and Evershed and Vignoles, Limited, 18, Southampton-buildings, London.

16904. Improvements in electric arc lamps. Siemens Bros. Dynamo Works, Limited, 139, Queen Victoria-street, London. (Siemens-Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

16912. Improved hygienic guard for the talking funnels of telephone apparatus. Emanuel Sand, 345, St. John-street, London. (Complete specification.)

16924. Improvements in electric arc lamps. Frank Proctor, 2, Jackson-road, Holloway, London.

16926. Arrangement of connections for automatic sub-station switchboards with several exchange double leads in which the selection of the subscriber is effected from the exchange by means of alternating currents of different frequencies. Siemens und Halske Akt.-Ges., Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Aug. 20, 1908, being date of application in Germany.) (Complete specification.)

16931. Improvements in electroplating baths. Benjamin Joseph Barnard Mills, 23, Southampton buildings, London. (Abraham Van Winkle, United States.) (Complete specification.)

16943. Electric controlling and distributing mechanism for sparking devices. George Dando Rogers, Chancery-lane Station-chambers, London. (Date applied for under Section 91 of the Act, Aug. 7, 1908, being date of application in United States.) (Complete specification.)

16950. Improvements in or connected with electric wiring and switching systems. Bernard Page Scattergood and Thomas George Bray, Norfolk House, Norfolk-street, Strand, London.

JULY 21.

16985. Improvements in insulating former-wound coils or the like. Siemens und Halske Akt.-Ges., Caxton House, Westminster. (Date applied for under Section 91 of the Act, July 21, 1908, being date of application in Germany.) (Complete specification.)

17023. Method of obtaining from or impressing upon electric dynamos or motors electrical pressures of various magnitudes. William James Bransom, 75, Kyrle-road, Clapham Common, London.

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16990. Improvements in and relating to electric mechanism for writing and colour-changing signs. Robert Francis Venner, 20, High Holborn, London.

17031. Improvements in and relating to protective devices for electrical transmission and distribution systems. British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London.

17043. Improvements in or relating to small transformers. Alfred Julius Boult, 111, Hatton-garden, London. (Deutsche Elektro-Sparlicht G. m. b. H., Germany.) (Complete specification.)

JULY 22.

17101. Improved insulating device for electric lampholders. Hugo Hirst and Herbert John Coats, Peel Works, Adelphi, Salford, Manchester.

17104. Improvements in telephone exchanges. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

17106. Improvements in or relating to crossings and junctions for electric traction systems. Edward May Munro and Railless Electric Traction Company, Limited, Chancery-lane Station-chambers, London.

17107. Improvements in intercommunication telephone instruments. John Alexander Romer, 1A, Lausanne-road, Peckham, London.

17114. Improvements in or relating to electrically-operated switches suitable for use in connection with train lighting and for other purposes. Matthew William Walbank Mackie, 46, Lincoln's-inn-fields, London.

17137. Improvements in sound intensifiers for telephone mouthpieces and the like. Herman Foss, 18, Southampton-buildings, London. (Complete specification.)

17138. Improvements in electric meters indicating maximum consumption. Compagnie pour la Fabrication des Compteurs et Materiel d'Usines a Gaz, 70, Chancery-lane, London. (Date applied for under Section 91 of the Act, Aug. 3, 1908, being date of application in France.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Aug. 5.)

1908.

8210. Electric aural instrument for the alleviation of deafness. Warn.

14852. Manufacture of bodies of metallic titanium, particularly for filaments for electric incandescent lamps. Trenzen and Pope.

14853. Manufacture of metallic filaments for electric incandescent lamps. Trenzen and Pope.

14934. Electric time switches. Rosenbusch.

14949. Sound signalling. Sefton-Jones. (International Marine Signal Company.) (Application for patent of addition to No. 14663/07.)

15017. Alternating electric current distribution systems. Peck.

15054. Armoured electric cables. Gray.

15186. Coin-controlled mechanism for gas, electricity, and other meters. Stoneham and Stoneham.

15268. Method and means for controlling or braking electrically-operated machinery. Birkett.

15275. Regulation or control of electric motors. Johnson-Lundell Electric Traction Company and Price.

16144. Electric driving of spinning frames and similar machines. J. and T. M. Greeves, Limited, and Eves.

20758. Electrical fuses. Thomas and Thomas.

21951. Sand gear "sanding pipe" for electric tramcars, motor omnibuses, wagons, and the like. Kenworthy.

26916. Tape transmitter for multiplex telegraph systems. Murray.

1909.

103. Means for indicating faulty leads in telephone exchanges. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

3252. Electric flash lamps. Whyte.

3511. Armatures for magneto-induction machines. Firm Robert Bosch. (Date applied for under International Convention, Nov. 20, 1908.)

3517. Multiple switch starting devices for electric motors. Lake. (Cutler-Hammer Manufacturing Company.)

9999. Sheet-metal telephone cases. Bilton.

11904. Commutators for dynamo-electric machines. Siemens-Schuckertwerke Ges. (Date applied for under International Convention, July 31, 1908.) Application for patent of addition to No. 4240/07.)

13231. Brush-holders for dynamo-electric machines. Allgemeine Electricitats Ges. (Date applied for under International Convention, June 6, 1908.)

13762. Alternating electric current distribution systems. Peck. (Date applied for under Rule 13, July 15, 1908.)

13763. Alternating electric current distribution systems. Peck. (Date applied for under Rule 13, July 15, 1908.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos 1-70,000	1	–	½-⅝
—— Ord., 1,125,000	1	–	½-⅝
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	½-¾
—— Ordinary, Nos. 1-125,000	1	–	⅜-½
British Aluminium Co., Ordinary, 2,001-40,000	5	–	2-2½
—— 7 per cent. Cum. Pref., 1-40,000	5	–	1½-1⅝
—— "A" 5 per cent. Cum. Pref., 1-20,000	5	–	3-3½
—— 4 per cent. Funding Certificates, 1-20,000	5	–	2½-3½
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	82-87
—— 5½ per cent. Loch Leven Deb. (Reg.), Red., 1-5,000	100	–	94-99
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	7⅛-7⅜
—— 6 per cent. Cum. Pref., 1-100,000	5	–	6⅛-6⅜
—— 4½ per cent. Mortgage Debentures	100	–	103 106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	91-96
British Westinghouse Elec. and Manuf. 10 per cent. Pref. 275,001-475,000	5	–	3/16-7/16
—— 4 per cent. Mortgage Debenture Stock	100	–	38 42
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	–	0-½
—— Non. Cum., 6 per cent., Pref.	2	–	0-½
—— 4½ per cent. 1st Debenture Stock	100	–	43 48
—— 4½ per cent. 2nd Debenture Stock	100	–	27-31
Callender's Cable, Debentures	100	–	105-107
—— Ordinary	5	–	10 10¼
—— 5 per cent. Pref.	5	–	5¼ 5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1	–	7/16-9/16
Crompton and Co., Nos. 1-85,000	5	..	¾-1
—— 5 per cent. 1st Mort. Reg. Debs., Nos. 1-900 of £100, and 901-1,100 of £50, Red.	—	–	91-94
Dick, Kerr, and Co., Ordinary, 1,260,000	1	–	1 1/16-1¼
—— 6 per cent. Cum. Pref., 1-305,000	1	–	1 3/32-1 7/32
—— 4½ per cent. Debenture Stock, Red.	100	–	99-102 xd
Edison and Swan United, 'A" Shares, 1-99,261	5	–	¾-⅞
—— 'A" Shares, 01-017,139	5	–	1½-2¼
—— 5 per cent. Debentures	100	–	68 73
—— 4 per cent. Deb. Stock, Red.	100	–	93-96
Electric Construction, Nos. 1 to 112,100	2	–	7/16 ⅛
—— 7 per cent. Cumulative Pref.	2	–	1 7/16-1 11/16
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	63 67
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	71-77
General Electric Company (1900) 5 per cent. Cum. Pref.	10	–	7½-8
—— 4 per cent. 1st Mort. Deb. Stock	100	–	85-88
W. T. Henley's Telegraph Works, Ordinary	5	–	12-12¾
—— 4½ per cent. Preference	5	–	5¼-5½
—— 4½ per cent. Debentures	100	–	105½-107½
India Rubber, Gutta Percha, and Telegraph Works	10	–	14½-15½
—— 4 per cent. Debentures	100	–	98-101
National Electric Construction Co., 1-170,000	1	–	½-⅝
Telegraph Construction and Maintenance	12	–	34-36
—— 4 per cent. Bonds	100	–	99½-101½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	–	9-10

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	–	5½-5⅝
Bournemouth and Poole, Ordinary	10	–	9⅜-10½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9⅜-10½
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	10½-10⅝
—— 4½ per cent. Debenture Stock, Red.	100	–	99-103 xd
Bromley (Kent) Electric Light and Power Co.	5	–	4½-5
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	93-96
Brompton and Kensington, Ordinary	5	–	8 8¼
—— 7 per cent. Preference	5	–	8-8¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-100,000	5	–	5⅜ 6¼
Cambridge Electric Supply Company, £10 Ord.	8	–	12½-13½
Canadian General Electric Co., Common Shares	$100	–	123-127
—— 7 per cent. Cum. Pref. Stock	$100	–	116-118
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	–	97-100
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	–	3⅞-4⅛
—— 4½ per cent. Cum. Pref., 1-80,000	5	–	4½ 5
—— 4 per cent. Debenture Stock, Red.	100	–	96-99 xd
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000	5	–	3¾-4⅛
Chelsea Electricity Supply	5	–	3⅜-4
—— 4½ per cent. Debentures	100	–	100-103 xd
City of London, Ordinary	10	–	10½-11
—— 6 per cent. Cumulative Pref.	10	–	12-12½
—— 5 per cent. Debenture Stock	100	–	121-124
—— 4½ per cent. 2nd Deb. Stk., Red.	100	–	99-102 xd
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	–	90-93
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	–	3⅜-3½
—— 5 per cent. Preference, 1-50,000	5	–	3½-3⅝
County of London Elec. Supply, Ordinary	10	–	8¼-8⅜
—— 6 per cent. Cum. Pref.	10	–	10⅜-11¼
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	–	105-106
—— 4½ per cent. 2nd Debentures Prov. Certs	100	–	100-103
Edmundson's Electricity Corporation, Ordinary, 1-80,000	5	–	5/16-5/16
—— 6 per cent. Cum. Pref.	5	–	⅜-½
—— 4½ per cent. First Mort. Deb.	100	–	59-62
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	—	..	84½-85½ p.c.
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	–	85½-88½ xd
Folkestone Electric Supply, Ord., Nos. 1-10,000	5	–	4½-5
—— 5 per cent. Cum. Pref., Nos. 1-10,000	5	–	5-5¼
—— 4½ per cent. First Deb. Stock, Red.	100	–	98-101
Hove Electric Lighting, Ord., 1-13,000	5	–	7½-7
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	5	–	1½-2
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100	–	74-79
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	–	25/32-¾
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5	–	6¼-7
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red	100	–	98-101

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Name.	Amount paid. £	Last price. £
London Electric Ordinary	5 —	1⅞-2¼
—— 6 per cent. Pref.	5 —	5⅛-5⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red	100 —	93-97
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100 —	76-80
Metropolitan Ordinary, 100,001-300,000	5 —	4 5/16-4 11/16
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	105-108 xd
—— 4½ per cent. Cum. Pref.	5 ..	4⅜-5⅛
—— 3½ per cent. Mortgage Debenture Red.	100 ..	83½-86½
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-5,000 ($500) M 1-4,400 ($1,000) ($500), 4,001-14,000 ($1,000)	— ..	82-84 p.c.
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	88½-89½
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-87,500	5 ..	94-97
—— do. 87,501-137,500 (issued at £1 prem.). All paid (Prov. Certs.)	5 ..	4⅜-5⅛
—— do., 5 per cent. Pref., 1-87,500 (Prov Certs.)	2 ..	4⅜-5⅛
—— 5 per cent. Pref., 87,501-137,500 (Prov. Certs.)	4 ..	4⅜-5⅛
Notting Hill Electric Lighting	10 ..	11⅛-12½
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6-5½
—— 4 per cent. Debenture Stock	100 ..	94-97
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1 ..	1⅛-1 7/16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	1 1/32-1 5/32
—— 5 per cent. Debenture Stock, Red	100 ..	102-105 xd
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20,000	5 ..	5⅛-6
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5 ..	5⅛-6
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	102-104
Shawinigan Water and Power. Co., 5 p.c. Cons. 1st Mt. Bds.	— ..	104-106 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	9/16-13/16
South London, Ordinary	4 ..	2¼-3¼
South Metropolitan Electric Light and Power, Ord.	1 ..	5/16-9/16
—— 7 per cent. Cum. Pref.	1 ..	1 3/16-1 5/16
—— 4½ per cent. 1st. Mort. Deb.	100 ..	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	8⅜-9⅛
—— 7 per cent. Pref.	5 ..	7⅛-7⅜
—— 3½ per cent. Deb.	100 ..	84-88
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	¼-1
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	1⅝-2⅛
—— 4½ per cent. First Mort. Debenture Stock, Red.	100 ..	79-85
Westminster, Ordinary	5 ..	8⅛-9⅛
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 —	4⅛-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007	5 ..	9¼-9½
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	91-92
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	101-103
Bath Elec. Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	¼-⅜
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1 ..	9/16-11/16
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100 —	87-91
Blackpool and Fleetwood Tramroad	10 —	13⅜-13⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	10 —	9¼-10
—— 4½ per cent. Deb. Stock., Red.	100 —	93½-95½
Brisbane Tramway Invest., Ord., 1-75,000	5 —	6⅛-6⅜
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 —	5-5⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	100½-104½
British Columbia Electric Railway Co., Ord. Def.	100 —	143-147
—— Ord. Pref.	100 —	122-126
—— 5 per cent. Cum. Perpetual Pref. Stock	100 —	107-110
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 —	102-104
—— 4½ per cent. Vancouver Power Deb.	100 ..	101-104
British Electric Traction, Ord. 1-30,000 & 60,001-90,000	10 ..	½-⅞
—— 6 per cent. Cm. Pf., 30,001-60,000	10 —	2½-2⅝
—— 5 per cent. Perpetual Debenture Stock	100 ..	86-90
—— 4½ per cent. 2nd Deb. Stock	100 ..	66-70
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100 ..	81-86
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100 ..	102-107
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100 ..	103-106
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 —	99-101
Calcutta Tramways Ord., Nos. 1-137,610	5 ..	4½-4⅝
—— 5 per cent. Cum. Pref., Nos. 1-30,000	5 ..	4⅜-5
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	97-100
Cape Electric Tramways, Nos. 1-480,000	1 ..	⅛-⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	4⅛-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	97-101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5 11/16-5 13/16
—— 4 per cent. Deb. Stock, Red. (1985)	100 ..	98-101 xd
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	98-101
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 per cent. Cum. Pref.	10 ..	12⅜-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	12½-13½
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100 ..	90-95
Hastings and Dist. Elec Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	75-80
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,967	$1,000 ..	91-94
Imperial Tramways, Ordinary	all ..	13-13
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 —	⅛-1⅜ xd
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 —	1/32-3/32
—— 5 per cent. "A" Deb. Stock	100 ..	90-93
—— 6 per cent. "B" Deb. Stock	100 ..	64-68
Kidderminster and District Lighting and Traction, Pref.	5	9 15/16-10 3/16
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100 —	88½-90½
—— £286,500 2nd Mort. Deb. Stock	— —	—
—— £83,330 Deferred Deb. Stock (all fully paid)	— ..	—
bon Electric Tramways, Limited, Ord., Nos. 1-594,188	1 —	15/16-1 1/16
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1 —	15/16-1 3/16
—— 5 per cent. Mort. Deb., 1-5,000, Red.	100 —	96-10

Name.	Amount paid. £	Last price £
London United Trys. (1901) 5 per cent. Cum. Pref.	10 —	2-2½
—— 4 per cent. 1st Mt. Db. Stock, Red	100 ..	68-71
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100 ..	93-96
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000 ..	96 97
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5 ..	4½-5
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	86-91
Metropolitan Elec. Trams., Defd., 1,000,001-1 314,016	1 ..	1/32-5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1 ..	23/32-27/32
—— 4½ per cent. Deb. Stock, Red.	100 ..	95-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	— —	92½-94½
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort. Bonds (1926) 1-5,500 and 7,001-8,000	$1,000 —	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922)	100 —	102-104
New General Traction, 5 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 —	⅛-¼
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mort. Deb. Stk.	100 ..	100½-103½
Potteries Electric Traction, Ordinary, 1-245,000	1 —	⅛-¼
—— 5 per cent. Cum. Pref., 300,001-545,000	1 —	⅛-¼
—— 4½ per cent. Debenture Stock	100 ..	86-89
Provincial Tramways Co., Ordinary, 1-24,912	10 ..	4-4½
—— 6 per cent. Cum. Pref., 1-10,000	10 —	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5 ..	5⅛-5⅜
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100 —	99-101
Sao Paulo Tramway, Light, and Power Co.	$100 ..	149-152
—— 5 per cent. 1st Mort. Deb., Red. (1929) 1-12,000	$500 ..	97-99 p.c
South Metropolitan Electric Tramways and Lighting Co. 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	⅛-⅜
—— 4 per cent. Deb. Stock, Red. (1940)	100 ..	70-74
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red, 1-1,500	100 ..	82-86
Yorkshire (West Riding) Elect. Tram. Co., Ord., 70,001-110,000	5 ..	⅛-¼
—— 6 per cent. Cum. Pref., 1-46,261	5 ..	1⅜-2⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	82 86

Electric Railways.—

Name.	Amount paid. £	Last price £
Central London, Ordinary	100 ..	61-63
—— 4 per cent. Pref.	100 ..	83-85
—— " " deferred	100 ..	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 —	99-101
City and South London, Consolidated Ordinary	100 —	31½-32½
—— 4 per cent. Debenture Stock	100 ..	99-101
—— 5 per cent. Pref. Stock '91	100 —	110-113
—— " " " '96	100 —	106-109
—— " " " '01	100 —	102-105
—— " " " '03	100 —	94-97
Liverpool Overhead, 5 per cent. Pref.	10 —	10-10½
—— Ordinary, 1-50,000	10 —	3⅜-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— —	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	— —	102½-103½

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price £
Amazon Telegraph Co., 1-25,000	10 —	2⅜-3½
—— 5 per cent. Debs., Red., within 1-1,069	100 —	92-96
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000 —	97-99
Anglo-American Telegraph Co., Ordinary	100 —	58½-60½
—— 6 per cent. Preferred Ordinary	100 —	102½-103½
—— Deferred Ordinary	100 ..	17¼-17½
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100 —	103-105
Chili Telephone Co., 1-44,000	5 —	8¼-8½
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100 ..	89-91
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10 —	8⅛-8⅞
—— 10 per cent. Preference, 1-6,000	10 ..	17-18
Direct Spanish Telegraph Co., Ordinary	5 ..	2⅛-2⅜
—— 10 per cent. Cum. Preference	5 ..	8⅜-8¾
—— 4½ per cent. Debs., 1-600	50 ..	94-101
Direct United States Cable Co.	20 ..	12⅜-13⅛
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100 —	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000 (1909)	100 —	100-102
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	25 ..	103¾-105½
Eastern Extension, Australasia and China, 1-300,000	10 ..	11½-12
—— 4 per cent. Mort. Deb. Stock, Perp.	100 ..	104-106
Eastern Telegraph Co., Ordinary Stock	100 ..	125-128
—— 3½ per cent. Preference Stock	100 ..	—
—— 4 per cent. Mortgage Debenture Stock	100 ..	104½-106½
Great Northern Telegraph Co. (of Copenhagen)	10 ..	26-27
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100 ..	99-101
Indo-European Telegraph Co.	25 ..	51½-53½
Marconi's Wireless Telegraph Co., Nos. 256,128-384,190	1 ..	11/16-13/16
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	⅜-⅝
—— 5 per cent. Preference, 1-86,492	1 —	13/16-15/16
National Telephone, Preferred	100 ..	109-110½
—— Deferred Stock	100 ..	125½-127½
—— 6 per cent. Cum. First Pref.	10 ..	10½-11
—— 6 per cent. Cum. Second Pref.	10 ..	10½-11
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100 ..	97-99
—— 4 per cent. Deb. Stock, Red.	100 ..	99-101
Oriental Telephone and Electric Company	1 ..	1 5/16-1 7/16
—— 6 per cent. Cum. Pref.	1 ..	1 1/16-1 3/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red, 1-1,000	100 ..	99-101
United River Plate Tele. Co., Ordinary, 1-100,000	.. ..	7⅛-7⅜
—— 5 per cent. Cum. Pref., 1-40,000	5 ..	5⅛-5⅜
—— 4½ per cent. Debenture Stock, Red.	100 ..	102½-104½
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	99-101
West African Telegraph Co.	10 ..	12⅜ 13⅝
West Coast of America, 1-30,000 and 53,001-53,008	2½ ..	1⅜-1⅝
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	99-101
West India and Panama Telegraph Co., Ordinary	10 ..	¼-⅜
—— 6 per cent. Cum. 1st Preference	10 —	8-8½
—— 6 per cent. Cum. 2nd Preference	10 —	—
—— 5 per cent. Debs., Red., 1-800	100 ..	101-103
Western Telegraph Co., 1-207,930	10 —	13½-14
—— 4 per cent. Debenture Stock, Red.	00 —	90-92

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns week. Ending	1909.	1908.	Increase or decrease. Week.	Current year.	Miles of track open. 1909.	1908.	Accounts for past year. Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	Cost per car mile.
		£	£	£	£				£						
Aberdeen Corporation	July 21	1,894	1,890	– 96	– 207	87½	87½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5 93
Ayr Corporation	,, 24	875	891	– 15	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	,, 24	3,065	2,870	– 195	+ 425	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 25	1,062	1,077	– 15	– 457	23·53	23·53	—	—	—	—	—	—	—	
Birmingham Corporation	,, 17	6,700	6,765	– 65	—	56·792	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 21	1,149	1,280	– 130	– 628	23 8	28 3	—	—	—	—	—	—	—	—
Blackpool Corporation	,, 22	1,796	1,971	– 175	+ 627	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Aug. 8	2,304	2,329	– 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	July 18	2,435	2,432	+ 3	– 531	42	42	March 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	,, 21	1,681	1,723	– 42	– 23	29¼	29¼	,, 31	86,225	13,991,328	1,766,068	1 47	11·71	2,912	7·22
Bradford Corporation	,, 17	4,937	4,770	+ 169	+ 1,371	98¾	98¾	,, 31	235,258	47,839,569	5,331,007	1 17	10·59	2,378	—
Brighton Corporation	,, 25	1,028	1,065	– 37	+ 768	—	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	,, 23	5,973	5,783	+ 590	—	57	51½	Dec. 31	265,362	46,652 389	5,756 842	—	—	—	—
Burnley Corporation	,, 24	1,185	1,270	– 85	—	19½	19½	March 31	64,261	12,355,958	1,202,330	1·23	12 83	5,971	7·92
Burton Corporation	,, 23	278	280	– 2	– 134	10	10	,, 31	14,9 8	3,221,595	430,913	1·04	8 30	1,460	5 85
Cardiff Corporation	April 3	8,000	1,957	+ 43	—	—	—	,, 31	109,979	25,058,146	2,497,169	—	10 57	—	—
Carlisle Tramways Company	June 19	170	175	– 5	– 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	July 24	5,427	8,020	– 2,593	– 6,474	6 32	5·77	Dec. 31	350,150	41,838,373	1,456,781	2 01	5·769	55,404	30 27a
Charing X, Euston, & Hamp. Ry	,, 24	3 980	3,235	+ 745	+ 2,000	—	—	—	—	—	—	—	—	—	—
City and South London Railway	,, 25	2,986	2,754	+ 232	+ 637	—	—	—	—	—	—	—	—	—	—
Colchester Corporation	,, 14	200	219	– 19	—	8	—	March 31	10,983	2,308,721	349,539	1·09	7 74	1,477	6 56
Cork E. T. and L. Company	,, 22	580	514	+ 66	– 20	—	—	Dec. 31	24,044	5,737,478	896,945	—	6 43	—	4 43
Croydon Corporation	,, 16	1,455	—	—	—	11½	—	March 31	74,132	16,277,418	1,884,137	1 06	9 56	3,703	7 109
Darwen Corporation	,, 16	259	271	– 12	– 159	7·23	7·23	,, 31	13,893	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	,, 17	235	226	+ 9	– 346	7	—	,, 31	11,593	2,697,672	316,754	·98	8 78	—	—
Dublin and Lucan Electric Ry.	,, 23	159	162	– 3	+ 6	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	,, 16	5,681	5,434	+ 247	– 86	54¼	54¼	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 21	1,219	1,304	– 85	– 458	—	26½	May 15	60,573	16,367 911	1,281,552	·875	1·9	2,371	/ 46
East Ham Corporation	,, 21	1,167	866	+ 301	+ 2,616	15	15	March 31	47,430	15,355,703	1,091,586	·73	10 26	—	6 96
Glasgow Corporation	,, 17	15,961	17,286	– 325	– 2,745	185¼	179	May 31	907,494	226,948,290	20,756,722	·96	10 49	5,08	5 89
Gloucester Corporation	,, 21	301	298	+ 3	+ 185	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton.	,, 24	3,065	2,870	+ 195	+ 425	—	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	March 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	,, 17	1,626	1,550	+ 76	+ 564	28½	29½	,, 31	84,704	6 200.020	1,960,123	1·29	10 37	2,421	5 10
Hull Corporation	,, 24	2,516	2,441	+ 74	+ 403	26	26	,, 31	128,722	29,964,254	3,022,844	1	10·22	—	6 04
Ilford Corporation	,, 17	496	448	+ 48	+ 656	10	10½	,, 31	25,328	5,385,466	634,446	·87	9 58	2,066	6·42
Ilkeston Corporation	,, 21	141	146	– 5	– 173	4	4	,, 31	7,214	1,968,850	198,415	9 1	7·9	1,803	7·04
Kirkcaldy Corporation	,, 14	269	265	+ 4	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	,, 21	1,341	1,471	– 130	+ 110	39	39	Dec. 31	68,904	12,551,593	2,244,344	—	—	—	—
Leeds Corporation	,, 17	6 867	6,759	+ 108	+ 301	96½	96½	March 31	340,368	75,734,083	7,694,989	1·06	10 62	3,527	5 51
Leicester Corporation	,, 17	2,161	2,291	– 129	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 17	10,999	11,048	– 49	– 3,047	104	104	Dec. 31	572,822	124.043.239	12,231,799	1·108	11 24	5,508	7·94
Liverpool Overhead Railway	,, 25	1,410	1,487	– 77	– 43	6 65	2 40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	,, 10	36,843	36,841	+ 2	+18,397	121	115½	March 31	1274,660	279,166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	,, 17	215	258	– 42	– 743	3½	—	Sept. 30	11,399	2,645,206	370,32	1·03	7·36	2,279	6·12
Maidstone Corporation	,, 10	184	219	– 35	—	5¼	—	—	—	—	—	—	—	—	—
Manchester Corporation	,, 17	15,218	15,419	– 281	– 625	181	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	,, 24	10,846	9,093	+1,753	+ 3,285	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 25	16,333	15,975	+ 358	+ 1,010	24½	24½	June 30	680,357	99 846,735	—	1·46	—	—	—
Nelson Corporation	,, 24	133	158	– 25	– 108	2¾	2¾	March 31	7,362	2,060,712	204,74	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	,, 24	3,804	3,840	– 36	– 1,425	60¼	59¼	,, 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	,, 17	637	669	– 32	– 294	14½	14½	,, 31	35,531	8,174,003	798,029	1·04	9 89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	– 385	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	March 31	97,741	21,247,048	2,309,439	1·10	10·15	—	
Reading Corporation	July 22	668	678	– 10	+ 54	13½	13½	,, 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·93	20·93	,, 31	56,558	10,196,148	1,252,925	1·32	10 83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	– 32	—	—	—	—	—	—	—	—	—	—	
Salford Corporation	July 19	4,603	4,947	– 344	– 2,192	78	74½	March 31	244,065	45,771,511	5,486,150	1·25	10·67	3,185	
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Sheffield Corporation	,, 18	5,718	5,523	+ 190	– 1,112	68½	66½	March 25	289,745	17,568,686	7,065 380	·896	9 842	4,225	5·04
Southampton Corporation	,, 14	1,102	1,116	– 13	– 472	18	18	,, 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7 30
Southend-on-Sea Corporation	,, 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	March 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	– 26	– 7,584	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	July 7	127	162	– 35	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	,, 22	389	378	+ 11	—	5·16	—	Dec. 31	15,065	2,880,420	353,297	1·40	1 023	—	—
Wallasey U.D.C.	,, 24	983	1,018	– 35	+ 740	12 68	12·45	March 31	43,823	8,331,038	891,540	1·2	11·79	3,453	·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	,, 15	2,365	2,158	+ 206	+ 2,161	14·7	14·7	March 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	,, 21	867	825	+ 42	– 776	20½		,, 31	44,432	3,440,369	975,714	—	10·929	2,190	6·509

a Train miles. b Half-year's figures.

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NOTES.

THE COAL SETTLEMENT.

Unquestionably the satisfactory settlement of the Scottish coal crisis has saved us from what could only have proved the precursor of industrial disaster. There is a general, if slow, revival of trade, but such a movement could not have weathered the set back of a general strike in the coal trade, with its consequent high prices, universal shortage, quickly followed by coal famine. Everyone concerned is to be congratulated: the Scottish masters who have given way on the question of minimum wage; the men in promptly withdrawing their notices to cease work and making concessions as regards the increase of the maximum wage; and, above all, the Board of Trade in so successfully stepping into the breach and acting the part of conciliators. When we consider the gravity of the whole crisis—the making of a common cause among English, Welsh, and Scottish miners, involving the threat of 600,000 men to come out on strike over a local wages dispute—it is good to hear that the Conciliation Board is to be continued until August 1st, 1912, with the proviso of the appointment of a neutral chairman. It is no use disguising the fact, however, that the wages question is bound to crop up not only in Northumberland, but in other parts of England and Wales. There is, therefore, an urgent need for the establishment of a General Conciliation Board to take in the coal trade of the whole United Kingdom. Such a Board would make for a large mead of stability. Mr. Albert Stanley, M.P., of the Cannock Chase Midland Miners' Federation, is right when he points out that we cannot have coal up to 15s. and 16s. per ton one year and down to 6s. or 7s. the next without inflicting grave disorganisation upon the general trade of the country. Unfortunately, the electric supply industry is one of those which suffers heavily.

FUEL ECONOMICS.

Perhaps these repeated and alarming disturbances in the coal trade may ultimately force us to give serious heed to the study of fuel economics. There can be no doubt that, as a nation, we are unpardonably wasteful in the way we use coal. This applies not only to industrial circles, but to the general public. We persist in burning our coal in such a way that we waste a considerable percentage of caloric, and at the same time pollute the atmosphere. In the industrial world there is still room for a large measure of improvement in perfecting steam raising; but, as a matter of fact, imperfect though the science is, the higher range of present day efficiency is availed of by scarcely a tithe of our manufacturers. As regards the domestic use of heat, there would be an enormous gain as regards economy, efficiency, comfort, and health if coal was converted into energy practically at the pit's mouth, and distributed over the country. Something like a universal adoption of bulk electricity supply would prove an incalculable gain to the commerce and general well-being of the nation. Meanwhile, the question of fuel economy is one of immense importance to the electrical engineer. We may well envy our lucky brethren of France, Switzerland, Italy, and Scandinavia their extensive supply of "white coal" for motive force, but we may well ask if in this country we are utilising to the full extent such water power as we have. Certain municipal supply stations are in the happy position of being only partly dependent on coal supply for steam raising, obtaining a more or less heavy percentage of their fuel from refuse and compressed sludge, and in this direction there is also room for improvement.

ELECTRICITY IN MINING.

From practically all corners of the earth, but mainly from our Colonies, we receive gratifying reports of the ever-increasing use of electricity in mining operations with very satisfactory results. Not only is electricity used for hauling purposes, winding and pumping, but actually for mineral winning. It is recognised that in coal mining certain difficulties present themselves, and, unfortunately, experience at home has proved that the introduction of electricity in coal mines is not without danger. On the other hand, in New South Wales, where electricity has been used for winding, pumping, and for operating coal-cutting machines, no fatality has been recorded, and no case of firing has occurred. It is true that in the premier Australian State rigorous precautions are taken, and there such a case as the dual fatality at the Clifton Colliery, Nottingham, could not have happened. It is in the interests of the miners themselves, as well as of the electrical engineering industry, that we advocate the untiring observations of stringent regulations, and not least among these we must include the necessity of the installation being adequate for the work required of it, and that the appliances should be in charge of competently trained men. With these two points kept well in view and efficient inspection, there should be an almost unlimited scope for electricity in coal and other mining, where it is capable of conferring very substantial boons.

RAILWAY ELECTRIFICATION AND PROFITS.

Steam tramways are, to all intents and purposes, a thing of the past, for electricity is found to give better service and to pay better, too. The same transformation is bound to overtake the railway world, at all events so far as concerns urban and suburban traffic. Lord Claud Hamilton, speaking at the meeting of the East London Railway, made it quite plain that it was only a question of time before that line is electrified. The directors are merely awaiting the opening and operating of the South London section of the Brighton Railway, in order to form an opinion upon the relative merits of the overhead and third rail systems. The reports of three among the last comers of our tube railways issued on Friday are eminently encouraging, showing a uniform improvement on the corresponding half-year of 1908. The Charing Cross, Euston, and Hampstead is able to declare a dividend at the rate of ¾ per cent. per annum, the first distribution made on the Ordinary shares. The Great Northern Piccadilly and Brompton Railway announced a dividend at the rate of 1 per cent., as against ¾ per cent. for the first half of 1907; while the Baker-street and Waterloo Co. proposes to pay at the rate of 1½ per cent. on its Ordinary shares, as against ¾ per cent. last year. The distribution is to be made up to 3 per cent. per annum, except in the case of those shares held by the Underground Electric Railways Co. or its nominees. Although this is the same rate as was paid to the independent shareholders a year ago, the additional amount distributed on the stock as a whole clearly points to a better condition in the Company's position.

WIRELESS ELECTRICITY AND AERONAUTICS.

Experiments have been carried out in America, Germany, and Belgium to test the possibility of transmitting wireless telegraphic messages to and from floating balloons or airships. These have been eminently satisfactory. The *Condor* balloon, when recently passing over Brussels, was not only able to get into communication with a wireless

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station temporarily erected on the tower of the Palais de Justice, but also to intercept from and send back Morse messages to the Eiffel Tower in Paris." This will prove of great assistance to aeronautics, quite apart from any consideration of its use in warfare, for it will enable messages to be sent aloft giving warning of impending atmospheric disturbances, or transmitting instructions for a change of route. In fact, it places the aeronaut in direct communication with the earth, even when at a considerable altitude, in a way that could not be done by any other means of signalling.

GLOUCESTER'S BAD EXAMPLE.

Much has been said about the abuse arising from the appointment of pupils at Municipal Central Stations. When not properly safeguarded, it certainly often led to the letting loose on an unsuspecting world of callow youths possessing only the merest smattering of electrical practice, yet able to secure posts on the strength of their discharge certificates, which too frequently described them as "Assistants." Gloucester was among the cities who some time ago decided that there should be no more pupils at their station, yet we now learn that at a recent meeting of the City Council the Electricity Supply Committee obtained permission to introduce two holiday pupils. It appears that two sons of Gloucester citizens are studying electricity in London, and the Committee proposed that while the young men were holiday-making in the bosoms of their families they should attend the Electricity Works as unsalaried assistants in order to gain practical experience. It is good to know that there was some opposition to this, but less so to find that the Council consented. It is a bad precedent. Probably it will be of little use to the young men; it will almost assuredly be unsettling to routine work, and sets a bad example, which may ultimately develop into most undesirable channels.

ELECTRICAL SMELTING.

The British Consul at Stockholm, Mr. M. Villiers, in his annual report for 1908, says that it is now claimed that a commercially economical method of smelting iron ore by electricity has been discovered in Sweden by which it is hoped that with the aid of the vast water-power of the country its enormous mineral deposits of ore may be smelted without the importation of so much coal or such a consumption of charcoal. In an ordinary Swedish furnace £2 worth of charcoal is required to produce a ton of pig-iron. The cost of producing a ton of pig iron in the electric furnace is estimated to be about £1 12s. In addition, the life of an oven is considerably longer than that of a blast furnace. It is claimed that the product of the electric furnace is of excellent quality.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At a Special General Meeting of Members, Associate Members, and Associates of the Institution of Electrical Engineers, held on the 29th ult., the President gave the following address:—

"We have now reached a very important stage in connection with our new building on the Victoria Embankment.

"On June 30th, last year, at a Special General Meeting, authority was given for the purchase of the property for a sum of £50,000. This purchase was duly completed on June 1st this year, the purchase-money being provided as follows:—

From the accumulated funds of the Institution	£24,000
From a mortgage on the building	26,000
	£50,000

"Ever since the Meeting of June 30th last year, the Council have been engaged on the consideration of various schemes for adapting the building to the purposes of the Institution and they have finally decided that it will be in the best interests of the Institution to enlarge and improve the Entrance Hall and to rebuild the Theatre completely. Plans prepared by our Architect (Mr. Percy Adams), have been considered, and, finally, specifications have been issued and tenders obtained for the work. The result is that an expenditure estimated at £18,000 is necessary to cover these alterations in the building and the equipment and furnishing of the large Library on the first floor, and of the parts of the building to be occupied by the Institution, including also the cost of a lift and various other matters necessary to adapt the whole of the other parts of the building to the requirements of our tenants, the Colleges of Physicians and Surgeons.

"The new Theatre will be a very handsome one, appreciably larger than that of the Institution of Civil Engineers, in which we have for so long had the great privilege of holding our meetings. The modified entrance hall will provide a very attractive and convenient means of access to the theatre, library, offices, and public rooms.

"The funds of the Institution would be sufficient for the purpose of the required expenditure if we sold the Tothill-street site at the price we gave for it, viz., £17,500—a price which we are advised is a low one. It is believed that when the time is more favourable we shall be able to dispose of the site at a profit.

"Meantime we have arranged for a mortgage on the Tothill-street property of	£11,500
and have securities available amounting to..	4,000
A total of	£15,500
"As already explained— the estimated expenditure is about.. ..	£18,000
and adding for contingencies and margin ..	2,000
We require a total of ..	£20,000
"We are, therefore, short to the extent of about	£4,500

"The sale of Tothill-street at cost price would, after paying off the mortgage, yield £6,000. To meet this expenditure of £4,500, and to justify the Council in putting before the members a recommendation to proceed with the proposed alterations, the past and present members of the Council have guaranteed the difference between the assets and the requirements, on the understanding that if they are called upon to make any payments under this guarantee, they are to be repaid out of the funds of the Institution when available, either as a result of the sale of the Tothill-street property, or from contributions to the Building Fund, or otherwise.

"Two resolutions are before you: the first is necessary to meet the wishes of the Economic Life Assurance Society, from whom we have borrowed a sum of £26,000 on the security of the new building; the second is a resolution approving the proposed expenditure."

THE ELECTRICAL PROPERTIES OF FLAME.

BY PROFESSOR HAROLD ALBERT WILSON, M.A., D.SC., F.R.S., M.R.I.*

If a flame is brought near to an insulated conductor charged with electricity, the charge disappears. This is explained by supposing that the gases in the flame are partially dissociated into ions. A neutral molecule splits up into two ions, one having a negative charge and the other a positive charge. The conductor, if positively charged, attracts the negative ions out of the flame, and their charges when they reach it neutralise its charge.

If a plate of an insulator, such as ebonite, is placed between the flame and the charged conductor, the ions are still attracted through the plate; but when they reach it they cannot get through, and so remain on its surface. The side of the plate turned towards the flame thus gets a charge of opposite sign to that on the conductor. This shows that the disappearance of the charge in the first case was due to an opposite charge attracted out of the flame, and not to the charge on the conductor escaping into the flame.

* Paper read before the Royal Institution of Great Britain.

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We have a stream of gas rising from the flame, and the ions go up in the stream. The ions of opposite sign attract one another, and when two come together their charges are neutralised, and the two ions are said to have disappeared by recombination. Thus, as we go up in the stream of gas from the flame the number of ions diminishes. If the stream of gas is allowed to pass up a long tube containing along its axis a series of charged electrodes, then the bottom electrode will be discharged first, and then the next one, and so on. The ions are used up in discharging the electrodes, so that the electrodes are discharged in order, beginning with the lowest one. When the lower electrodes have been discharged, the upper ones begin to be discharged, but more slowly, because many of the ions disappear by recombination before they get far up the tube. Another effect also comes in; as the gases cool down the ions do not move so freely through them, and so are not so easily attracted by the electrodes. This makes the rate of discharge of the upper electrodes still slower.

Thus, as we go down towards the flame the number of ions and their mobility rapidly increases, and right inside the flame the number is so large that the flame behaves like a good conductor of electricity.

If the terminals of an induction coil are connected to two Bunsen burners, sparks can be passed from the tip of one flame to the tip of the other. The temperature of the flame is about 2,000° C., so that the density of the gases in it is about one-seventh of their density at the ordinary temperature. The potential difference required to send a spark through the flame is about the same as that required to send a spark through an equal length of air at one-seventh of ordinary atmospheric pressure. It appears, therefore, that the ions do not make it easier for a spark to pass. This is due to the fact that the current in the spark is greater than the ions can carry, so that the potential difference has to be enough to produce more ions, and so is the same in the flame as in unionised air at the same density.

To study the conductivity of flame, it is convenient to use a row of small Bunsen flames placed so that they touch each other. I use a row of fifty flames burning from quartz tubes 1 cm. apart. This gives a flame 50 cm. long, and about 10 cm. high. The quartz tubes insulate very well, so that a current can be passed along the flame horizontally from one end to the other.

If two parallel platinum electrodes immersed in the flame are connected to a galvanometer and battery, it is found that a measurable current is obtained. The relation between the current (i) and the difference of potential (V) between the electrodes is given by the equation $V = Ai^2 + Bdi$ where A and B are constants and d denotes the distance between the electrodes. If d is small, say one or two millimetres, the term Bdi is negligible (except when i is very small), and we get $V = Ai^2$. In this case the current is almost independent of the distance between the electrodes.

The reason for this peculiar relation between the current and potential difference becomes apparent when the variation of the potential along the flame from one electrode to the other is examined. An electro meter is connected to two platinum wires, which are immersed in the flame and can be moved along horizontally between the electrodes. Each wire takes up the potential of the flame at the point where the wire is situated, so the deflection of the electrometer indicates the difference of potential between the two points where the wires are put in. Suppose one wire is allowed to touch the positive electrode and the other is gradually moved along the flame from the positive to the negative electrode. It is found that in the space between the electrodes there is a small uniform potential gradient, but near each electrode there is a comparatively sudden drop in the potential. The drop near the negative electrode is much larger than the drop near the positive electrode. Thus, nearly all the electro-motive force of the battery is used up close to the negative electrode. This shows that nearly all the resistance offered by the flame to the passage of the current is close to the negative electrode. The positive ions in the flame move towards the negative electrode and the negative ions towards the positive electrode; in fact, the current is carried through the flame by these two streams of ions. Hence, close to the negative electrode the current must be carried entirely by positive ions moving towards it, and at the positive electrode the current must be entirely carried by negative ions. We find that the resistance near the negative electrode is much greater than near the positive electrode, so that we conclude that the negative ions carry the current more easily than the positive ions. With a given electric force, the negative ions move very much faster than the positive ions. It has been shown experimentally that the velocity of the negative ions is about 10,000 cm. per sec. for one volt per cm., while that of the positive ions is about 100 times smaller than this.

In the flame away from the electrodes the electric force is found to be proportional to the current, so that here the flame obeys Ohm's law like a metallic conductor. Its conductivity is about $10^{\prime\prime}$ times less than that of copper. In the equation $V = Ai^2 + Bdi$, the term Bdi is the part of the E.M.F. used up between the electrodes, so it is proportional to the current and to the distance. Professor Sir J. J. Thomson has shown theoretically that the drop of potential near the electrodes should be proportional to the square of the current, as is found experimentally to be the case.

The conductivity of a Bunsen flame may be compared with the conductivity of liquids, such as water. In pure water some of the molecules are dissociated into ions and the water is a conductor, although only a poor one. But if a salt like sodium chloride is dissolved in the water the salt dissociates into ions almost completely, and the conductivity is greatly increased. Suppose we hold a bead of salt on a platinum wire in a flame, then the salt volatilises and the flame is filled with its vapour, and just as with the water, the conductivity is enormously increased.

With the long flame and an electrode at each end, we can try the effect on the current of putting salt in different parts of the flame between the electrodes. In this way it is easy to show that the current is practically unchanged, unless the salt vapour is put in close to the negative electrode, but in that case it produces a very great increase in the current. This confirms the conclusion that nearly all the resistance to the passage of the current is situated close to the negative electrode. When the salt is put in anywhere it diminishes the resistance there to a small fraction of its value, but it is only close to the negative electrode that the diminution in the total resistance is appreciable. If we measure the potential difference between two points in the flame away from the electrodes, and then put salt vapour in the flame between them, we find that the P.D. drops to a small fraction of its value, although the current is the same as before. This shows clearly that the salt vapour greatly increases the conductivity wherever it is put in.

If some salt is put on the negative electrode, the sudden drop in potential there almost disappears, and we get a nearly uniform potential gradient from one electrode to the other, so that now the resistance is nearly uniformly distributed along the flame. If now salt vapour is put in anywhere between the electrode the current is increased. If, for example, we fill half the length of the flame with salt vapour, we nearly double the current.

When salt is put on one electrode, the flame can be used as a rectifier for an alternating current, for when the salted electrode is negative the resistance of the flame is much smaller than when it is positive.

I have measured the conductivities of a number of alkali salt vapours in a current of air flowing along a platinum tube heated in a gas furnace. An electrode was fixed along the axis of the tube, and the current from it through the salt vapour to the surrounding tube was measured with a galvanometer. It was found that at temperatures above 1,400° C., and with electro-motive forces of about 1,000 volts, the current was proportional to the amount of salt passing through the tube, and for different salts in equal quantities inversely proportional to the electrochemical equivalent of the salt. This shows that the quantity of electricity per molecue of salt is the same for all salts. It was also found that the quantity of electricity carried per molecule was equal to that carried

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per molecule when a solution of salt in water is electrolysed. It appears, therefore, that the laws of electrolysis discovered by Faraday for liquids apply also to salts in the state of vapour.

When a molecule of salt like sodium chloride dissociates into two ions in water, the sodium atom forms the positive ion and the chlorine atom the negative ion, and when a current is passed through the solution the sodium is attracted to the negative electrode and the chlorine goes to the positive electrode. We might expect the same thing to happen when a current is passed through the salt vapour in a flame. If we put two wires in the flame, and put some sodium salt on one and then connect them to an induction coil, and pass a discharge from the salted one to the other, we find that the yellow sodium vapour appears at it when it is the negative pole, but not when it is positive. This shows that in the flame the positive ions of the salt vapour contain the metal just as they do in solutions. The negative ions, however, do not appear to be the same in flames as in solutions. In flames the very high velocity of the negative ions indicates that they are the electrons whose properties have been investigated in vacuum tubes by Sir William Crookes and Sir Joseph Thomson. The positive ion, then, is an atom or molecule, while the negative ion is an electron, the mass of which is several thousand times smaller. This is the explanation of the fact that the negative ions move 100 times more quickly than the positive ions.

AUTOMATIC POINT WORKING ON ELECTRIC TRAMWAYS.

BY S. BRUÈRE.

The drawbacks of working the points on electric tramways are well known, and the danger of the older systems has been proved by the occurrence of many accidents. The attention of municipal bodies has been aroused, especially in Paris, where the tramway companies have been compelled to consider schemes whereby danger may be averted.

Many patents have been taken out for such schemes, but hitherto all the methods proposed have presented difficulties which prevent their adoption. Most of them provide for plots in the highway and for pedals which occupy too much of the small space that can be allotted to the driver, whereby costly and troublesome alterations were required in vehicles already on the road.

It is, therefore, worth while describing a new automatic system, protected by the Stoffel patents and employed in Holland, Amsterdam and Rotterdam and the Hague, and also at Cologne and Elberfeld in Germany.

The method is very easily worked. The driver controls the action of the points with a lever, whereby safety is fully assured. Besides, and this is an important matter from the economic point of view, all the apparatus for working the system is outside the car, so that no change in its construction is required to adapt it to the Stoffel system.

The Stoffel arrangement comprises two essential parts, viz. :—

(*a*) A box buried in the ground and containing two reels of a relay wire whereby the current can be cut off when required.

(*b*) A contact arrangement suspended from the overhead wire.

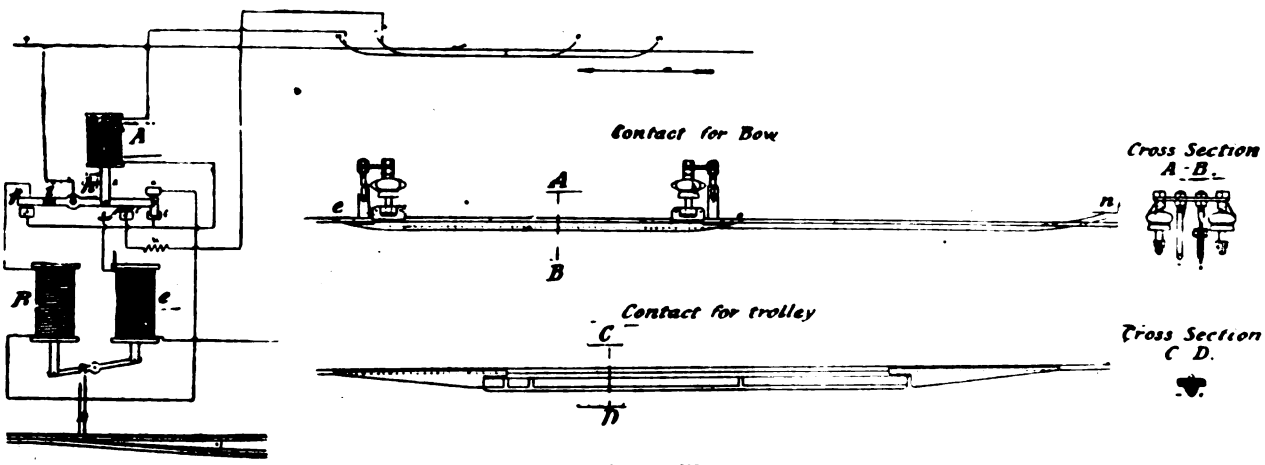
Our figure from left to right shows :—

(1) A diagrammatic general view of the system.
(2) Views in profile of the two forms which the contact arrangement assumes, according to whether a trolley or bow collector is employed.
(3) Sections through A B and C D of these two forms.

The two reels B and C are in the box, but B carries a thicker wire than C. Each is traversed from end to end by a soft iron core, which, according to whether one or the other reel is traversed by the current is drawn into the reel and works the points by a combination of levers. This is shown in the figures, where *a*, *b*, *c*, *d*, are contact pieces, *e* a contact-spring, and *f*, *g* contact-pieces insulated from each other by the insulator *i*. *h* is a soft iron core which, when raised by the reel A works the arm of the lever K, which, oscillating about *m*, lowers the contact piece *f*. *r* is an insulator. The lever K is permanently connected with the overhead wire.

The contact arrangement itself consists of two parts, insulated from each other and also from the overhead wire. One of them is longer than the other. Hence when a vehicle is travelling in the direction of the arrow, first one and then both the parts become connected with the arm whereby the current is transmitted to the motor. The longer of the two parts is connected to one end of the wire on A and the shorter to the contact piece *c*. The apparatus works in the following manner.

When a car comes between the contacts of the overhead wire, if the driver has not shunted the controller into the circuit, the relay, at the moment when the arm comes into contact with *n*, does not act, since there is no connection either between *n* and the positive pole (the overhead wire), or between *n* and the negative pole (the rail). Nevertheless, if the impetus of the car carries it under the contact *o*, the current passes from the overhead wire, through *r*, *g*, *b*, *a*, *n*, the stirrup of the arm and the trolley wheel, then through *o*, *c*, *e*, and the reel C to the rail. But the resistance coil W comes into action, so that the power is so regulated that enough current passes to work C, but not enough to work A. Hence the points cannot open except one way.



AUTOMATIC POINT WORKING.

On the other hand, when a car, with the controller in circuit, arrives at the *n* contact, all the current from the overhead wire passes to earth through *k*, *g*, *b*, the reel A and *n*. Hence there is force enough to enable A to lift *h*, whereupon *g* comes into contact with *a* and *f* with *d*, while *e* is cut off from *C*. From that time the current passes from the overhead wire through *k*, *g*, *a*, and the reel B towards *f*, *d*, and through A towards *n*, and thence through the car to the earth. The reel B attracts its core, and the points open automatically for the other direction. The reel B, connected in series with the reel A, is traversed by the whole of the current, and as, at the same time, *e* is put out of action, the spring-contact piece *l* being away from C and *g*, applies itself to *a* and *f* and *d*, before *g* is separated from *b*. Hence a spark, due to the breakage of contact, can never happen with the relay.

The action is, then, very simple, as is easily seen. Its automatic nature makes it a veritable safety appliance.

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ELECTRICAL CONDITIONING OVEN.

BY HENRY S. ELLIS.

(*Assistant Electrical Engineer, City of Bradford.*)

The object of the apparatus, details of the construction of which are shown on the accompanying diagrams, is to ascertain the percentage of moisture in any fabric which might be considered hygroscopic, as the presence of moisture not only affects the weight, but also the strength of the material. For instance, with regard to the sale of wool either in the raw state or otherwise, it is obviously necessary for the purchaser to satisfy himself that he is

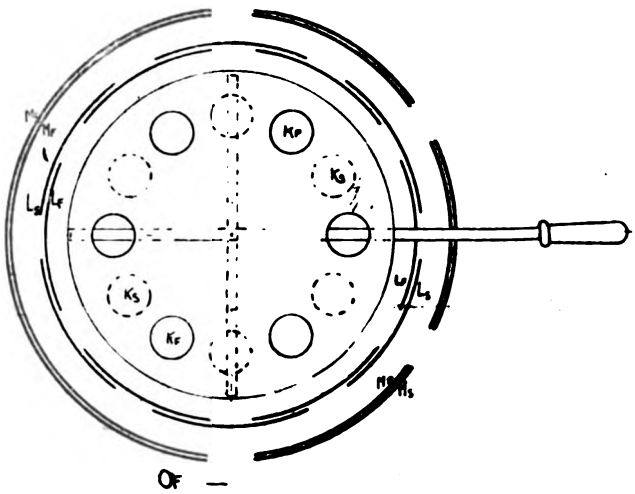


FIG. 1.

paying for wool, and not for wool and water; then again, when a merchant desires to buy cloth, he not only considers the appearance and weight of it, but is careful to test the strength of it. This is done by straining various samples of equal length and width between two jaws, the one fixed and the other moving along a screw to which is attached an indicator which records the breaking strain in lbs.

It is obviously unfair to the better class of cloth manufacturers for the merchant to ignore such a test as this, and it is just as unfair that such a test should be carried out unless the cloth has first been conditioned, as there are many cloths which have a lower breaking point when wet than dry.

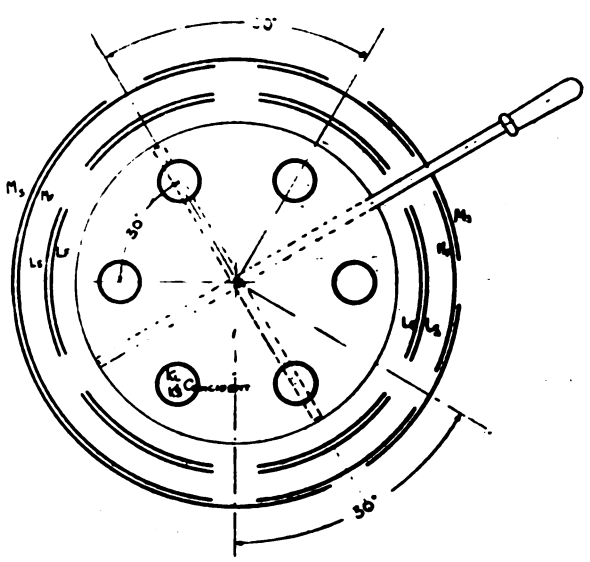


FIG. 2.

The conditioning oven then ensures that the fibre or cloth is free from moisture, or at any rate that the percentage of moisture remaining is such as to be a negligible quantity when considering weight or strength.

The object of all conditioning ovens is the same, but their construction differs slightly owing to the heating medium, which up to the present has been confined to gas or steam. The steam oven is used only where a supply of steam is available for power or heating purposes, but where steam is not available, gas is used. The efficiency of the gas-heated oven is naturally low, as the air passing through the wool must not be in contact with the flame or fumes. It is usually passed over a series of large copper plates on its way to the conditioning tank; this means, then, that by far the greater percentage of heat units passes away to the atmosphere.

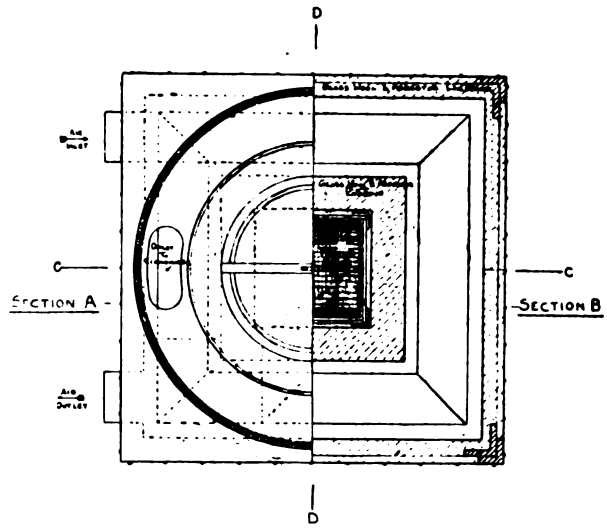
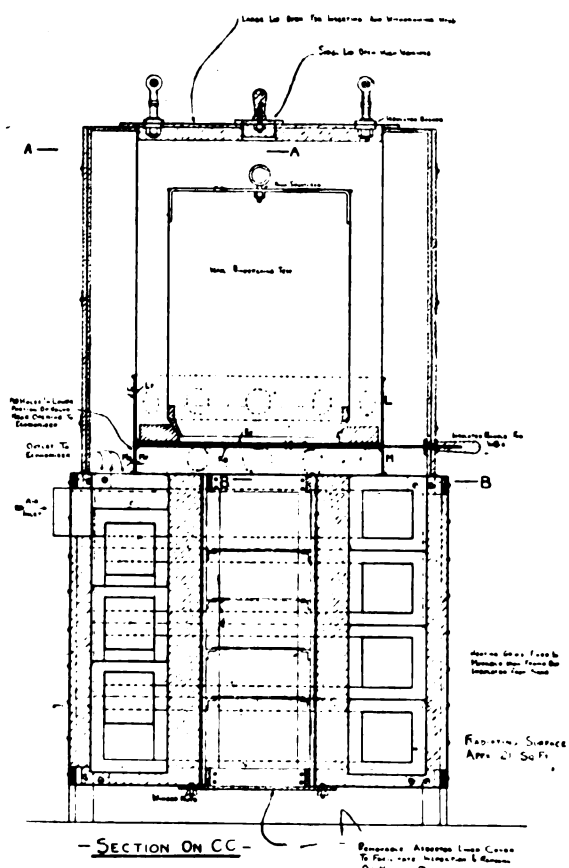


FIG. 3.

In most modern gas-heated ovens the hot air is driven through the wool by means of a fan or blower at a pressure such as will ensure that all moisture is taken away with it. Obviously, if electric heating was applied in the same way, the expense would prohibit its use, but, owing to the fact that the air comes in direct contact with the heating element in the new design, the efficiency is very considerably increased.



NOTE.—1¼ in. Dia. Holes in each of the Sliding and Fixed Parts of Valve with 3" between Centres and arranged to operate so that K and L are Open when M is Shut and vice versa. (See Diagram.)

FIG. 4.

Referring to the cross section on "D.D.," the rectangular-shaped box on the centre line contains a number of woven wire resistance mats arranged horizontally one over another. Surrounding this, and insulated from it by slag wool, is a chamber (also insulated on its outer edge) which is really

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a spiral surrounding the heater. In this spiral, which is square, is a 3 in. × 3 in. tube, which is also a spiral. These tubes form the economiser of the apparatus. Air is blown through the smaller tube by a fan, entering at the top (*see* view of complete oven) into the bottom of the heater, then up through the wire mats into the space at the top. From this point, by means of a series of ports, the air may be directed either through the wool, which is contained in the conditioning tin, or bye-passed into the annular space surrounding the oven, and thence down into the larger tube of the economiser. This latter method is adopted when the weighing operation takes place, as it would obviously be impossible to weigh the material with a pressure of air under the tin; furthermore, it is not advisable to switch the current off, as even while weighing takes place it is necessary to maintain the air temperature in the oven as normal as possible, otherwise the fabric would absorb moisture from the atmosphere, and so give a wrong result.

The material rests in the tin on gauze or perforated

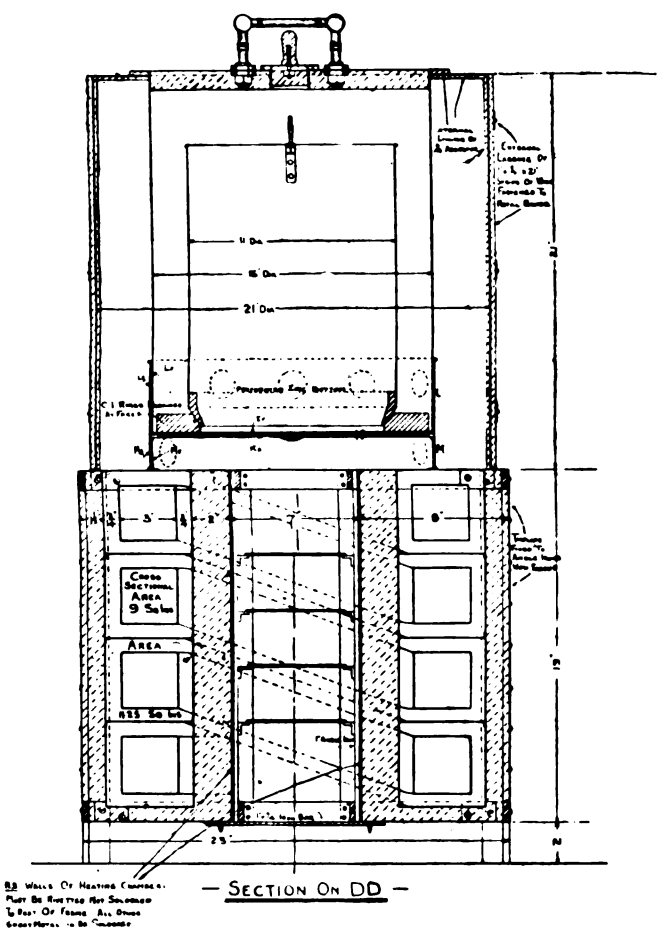

FIG. 5.

zinc of small mesh, and the usual quantity used for conditioning is ½ lb. This sample is taken from the inside of a bale indiscriminately, and the percentage of moisture in the sample represents the percentage of moisture in that particular bale. Directly above the tin there is a sensitive scale, and it is customary to keep the scale balanced throughout the test by adding weights on the wool side to make up for the loss of weight due to evaporation.

The whole apparatus is designed in a manner which ensures the highest possible efficiency, and that the result aimed at has been attained is easily proved by noting the temperature of the air at the outlet. The temperature of the oven is maintained at 220° Fahr. throughout the test, and yet the outlet temperature is but a few degrees above that of the inlet, and the difference can only be noted by taking a reading on a thermometer. This proves the value of the economiser, which it will be noted is similar in principle to a feed-water heater. A motor consuming about 60 watts is quite large enough for driving the necessary amount of air through the oven; the heaters consume only 1 unit per hour, so that the cost for current is but small, and is, in fact, less than that of gas in the most modern type of gas-heated ovens.

As most modern textile mills are fitted up with electrical plant, there should be no difficulty in adopting this type of oven generally, but even if no supply is available, it is a simple matter to run a small dynamo off the line shafting, to which also the fan could be coupled, since in such a case the dynamo would merely replace the motor. The extra cost, therefore, of such an arrangement would be small.

One great advantage that this oven has over the gas-heated oven is that it is ready for use in 5 minutes, whereas it takes from 30 to 45 minutes to thoroughly warm up the other, owing to the fact that a large mass of copper or other metal has to be heated up before the air blast can

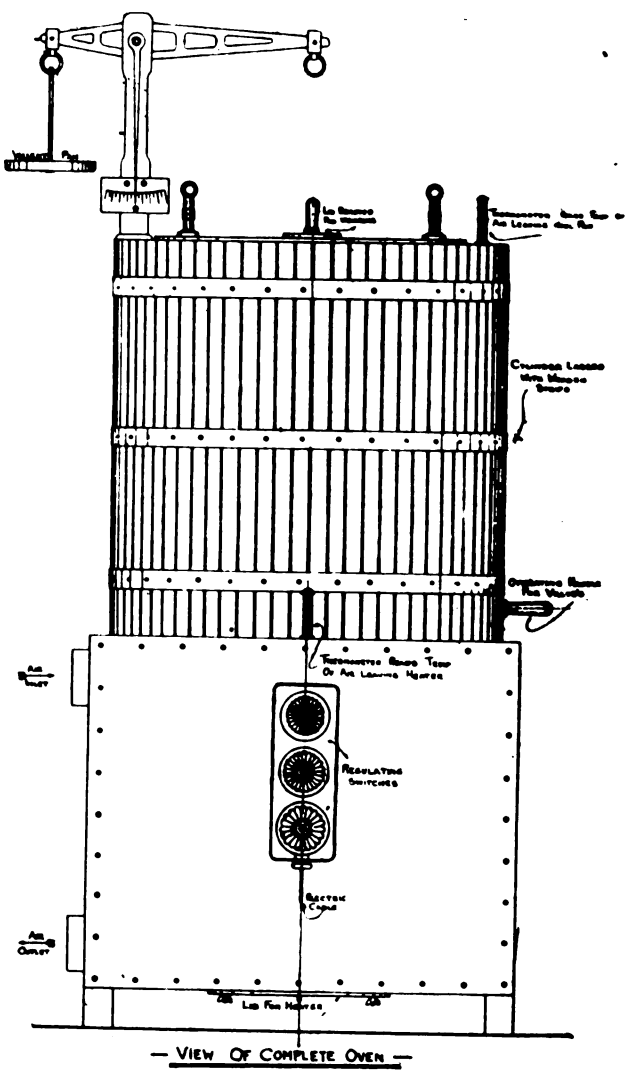

FIG. 6.

be applied. It has many other advantages, the chief of which are:—

It is compact.

It may be removed from place to place, and used without trouble, so long as there is a supply of current available, and a plug and flexible.

The temperature regulation is perfect, and may be controlled either by regulating the amount of air, or by switching the current on or off.

It may be used on alternating or direct current at any medium pressure.

Such apparatus is bound to interest central station engineers, especially those in the woollen and worsted districts.

The drawings give many particulars of the design not specially mentioned above.

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ELECTRIC FURNACE REDUCTION OF IRON ORE.

BY JOSEPH W. RICHARDS.*

In order that one can understand thoroughly the problems arising in the reduction of iron ore by carbon in an electrically heated furnace, he should first of all have a clear idea of how this reduction proceeds in an ordinary non-electrical blast furnace.

The iron ore contains iron oxide, with silica and clay as usual impurities, and more or less moisture; its phosphorus content may be low or high, but its sulphur content must be low, not over 0·5%. If the ore carries over 1% of sulphur it is given a preliminary roasting. In the furnace perhaps 99% of the iron oxide is reduced to metallic iron, 10 to 20% of the silica is reduced by carbon to silicon, which combines with the iron, all of the phosphorus is reduced into the pig iron, and a varying proportion of the sulphur, this proportion being smaller the more basic the slag is made with lime and the higher the running temperature.

Flux is added to make fusible slag by combining with the unreduced silica and the clay in the ore. Limestone, unburnt, is the usual flux, but magnesian limestone, carrying $MgCO_3$, is quite commonly used, the magnesia increasing the fusibility of the slag if not in greater proportion to the lime than the proportions 2CaO.MgO. The amount of flux added is variable; it depends on how basic the slag must be made. If the fuel is coke, and, therefore, considerable sulphur comes into the furnace, the slag formed must be nearly half lime and magnesia, to make low sulphur pig iron; if the fuel is charcoal, carrying almost no sulphur pig iron; if the fuel is charcoal, carrying almost no sulphur, and the ores carry none, the slag may be only one-third lime and magnesia and two-thirds silica and alumina, and make best quality pig iron. Such slag costs less for flux, and is more fusible than the basic lime slags.

Fuel is needed to provide heat and reducing effect. The heating effect is almost entirely produced by the combustion of the larger part of the fixed carbon (non-volatile carbon) of the fuel to carbon monoxide (CO) before the tuyeres. This combustion fills two functions: it provides the high temperature necessary to melt down the iron and slag, and it provides large quantities of reducing gas, practically identical in composition with producer gas (30 to 35% CO, 1 to 2% H_2, rest N_2), which performs in the upper part of the furnace the larger part of the reduction.

The amount of fuel used in a blast furnace is determined by the amount which must be burned at the tuyeres to produce the necessary smelting temperature, and not by the amount necessary to perform the reduction of the metallic oxides. The amount necessary for performing the reductions taking place in the furnace is only one-third to one-half of the amount necessary to be burned to provide the smelting heat. That this statement is true of the ordinary blast furnace may be seen from the fact that if the smelting zone is increased in temperature by heating the blast, the amount of carbon used in the furnace per unit of pig iron made is at once decreased. Or, if the heat available in the smelting zone is increased by drying the blast, and thus removing the strong cooling influence which the decomposition of the moisture of the blast exerts, economy of fuel at once results. In fact, any means of getting high smelting temperature without combustion of carbon before the tuyeres decreases at once the quantity of fuel necessary to use in the furnace, since the quantity used is determined by the heat requirements in the smelting zone, and not by the requirements for reduction, which are only a fraction to the former. The ash of the fuel is largely silica, with some alumina and lime, if coke, or alkalies, if it is charcoal. This requires flux to slag it, an amount which may be considerable when using poor coke high in ash. Regard for this item of cost should be had in purchasing or valuing the fuel.

The pig iron produced contains carbon between 2·5 and 4·5%, silicon in varying quantity 1 to 4%, according to the temperature and rate of running of the furnace, practically all the phosphorus of the charge, and one-tenth to one-fourth of the sulphur. Its melting point is about 1,200° C., and it runs from the furnace ordinarily at 1,500°C. to 1,600° C., carrying out as sensible heat 250 to 300 calories.

The slag may be basic or acid, as before explained, and these varieties will average in per cents.:—

	Basic Slag. High Sulphur Charge.	Acid Slag. Low Sulphur Charge.
SiO_2	35 ..	55
Al_2O_3	10 ..	10
CaO	40 ..	25
MgO	10 ..	5

These slags melt at about 1,350° C. and 1,200° C. respectively, and ordinarily run away from the furnace at 1,600° C. carrying out as sensible heat 500 calories.

The reduction of silica and phosphorus oxide in the furnace is accomplished by solid carbon in the smelting zone. A small part (10 to 20%) of the iron oxide in the furnace is also similarly reduced by fixed carbon; the rest is reduced in the upper half of the furnace by the excess of carbon monoxide gas. So much of the latter gas, however, is produced before the tuyeres in generating the temperature necessary in the smelting zone, that only a fraction of it is converted into carbon dioxide, CO_2, in reducing the iron oxides of the charge. This is the chief reason for the excess of unused carbon monoxide in the gases of the blast furnace, an amount whose potential calorific value often represents one-half of the calorific power of the fuel put into the furnace. It is true that all the carbon monoxide in the gases could not be utilised, no matter how small its amount, but that is a limit set by the principle of chemical equilibrium or mass acton, which ordinarily is not approached because of the excessive amount of carbon monoxide produced in the lower part of the furnace in the effort to get the requisite smelting heat and temperature. The proportions of carbon ordinarily consumed at the tuyeres are 9 atoms (108 parts) of carbon for each molecule of iron oxide (160 parts) reduced by the carbon monoxide gas. The chemical equation is: $Fe_2O_3 + 9\ CO = 2\ Fe + 3\ CO_2 + 6\ CO$. This equation shows us that only one-third of the carbon monoxide produced before the tuyeres in generating the smelting temperature is utilised in reduction, while two-thirds escapes unused.

Passing to the electric principle of smelting, we have here to deal with the case of all necessary heat supplied by electrical energy, no blast blown in, and, therefore, all the solid carbon utilised for reduction (always excepting the small amount which dissolves in the pig iron) in calculating the amount of carbon necessary to thus reduce the iron oxide, we meet at the outset with this difficulty. What proportion of the carbon will form CO_2, and what proportion CO? We know that when reduction takes place at a very high temperature, CO is almost the only product; but as this passes more or less slowly through the cooler portions of unreduced charge, CO_2 is formed in increasing amounts, until at a low red heat, given sufficient time, about half the CO may be converted into CO_2. The formulas corresponding to these two extremes are:

$$Fe_2O_3 + 3C = Fe_2 + 3CO.$$
$$Fe_2O_3 + 2C = Fe_2 + CO + CO_2.$$

Comparing these with the ordinary blast-furnace reaction, which requires 9 C put into the furnace for the reduction of Fe_2O_3, we see that 3 C, or one-third as much carbon, is the greatest amount necessary in the electric furnace reduction, and 2 C, or between one-third and one-fifth as much, is the smallest amount necessary. As will be further shown, the uncertainty as to how much CO_2 can be formed in the electric furnace reduction is perhaps the chief difficulty in running the electric furnace.

Example.—Iron ore is to be reduced to pig iron in an electric furnace, and the flux and charcoal on hand for the charge analyze as follows:—

Iron Ore.		Limestone.		Charcoal.	
Fe_2O_3	90	$CaCO_3$	90	Fixed .C	90
SiO_2	8	$MgCO_3$	3	Volat'e Mt'r ..	6
Al_2O_3	2	SiO_2	2	SiO_2	2
				Al_2O_3	1
				K_2O, Na_2O ..	1

Assume the pig iron made will contain 4% of carbon and 3% of silicon; that the slag may be 65% ($SiO_2 + Al_2O_3$);

* Paper read before the American Electrochemical Society, Niagara Falls.

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that the gases contain only the CO_2 from the limestone, and none from the reductions.

Required: (1) The weights of ore, limestone, and charcoal to charge per 100 of pig iron made; (2) the percentage composition of the gases; (3) the weight and percentage composition of the slag.

Solution: (1) The weight of ore needed is that necessary to supply the 93 parts (100 — 4 — 3) of iron in the pig iron. This will require 133 parts of Fe_2O_3, which will be contained in 133 ÷ 0.90 = 148 parts of ore.

The weight of charcoal needed is that necessary to furnish enough fixed carbon to reduce the iron oxide and that silica which is reduced, and to supply the carbon in the pig iron. These quantities are:—

Reduction of Fe_2O_3:	93 × 36/112	= 29.9
Reduction of SiO_2:	3 × 24/ 28	= 2.6
For carbon dissolved		= 4.0
Total requirement		= 36.5
Charcoal required 36.5/0.90		= 40.6

The weight of flux required is best found by calling it x, and then figuring out the slag, as follows:—

Silica in the slag will be that in the ore, flux, and fuel, minus that reduced to silicon. Therefore,

In ore	148 × 0.08	= 11.8
In flux	x × 0.02	= 0.02 x
In fuel	40.6 × 0.02	= 0.8
Reduced	3 × 60/28	= 6.4
Silica in slag		= 6.2 + 0.02 x

By similar calculations we find the slag to contain, as a whole:—

Silica	6.2 + 0.02 x
Alumina	3.4
Lime	0.50 x
Magnesia	0.04 x
Alkalies	0.4
Total weight	10.0 + 0.56 x

If the slag is to be 65 % of silica and alumina together, then

$$0.65\ (10.0 + 0.56x) = 9.6 + 0.2x$$

from which $x = 9$.

The above solution is perfectly general, and applies to all kinds of ore, flux, and fuel, and the production of any desired kind of slag.

(2) The gases will contain the fixed carbon of the charcoal (except that part which goes into the pig iron) in the state of CO, the carbonic acid driven off the flux, and the volatile matter from the charcoal. The latter may be assumed as composed of equal parts by volume of hydrogen, carbon monoxide, and carbon dioxide, which would correspond to weights of those gases in the proportion of 2:28:44. The gases passing off will therefore be, in parts by weight:

CO from fixed carbon ..	32.5 × 28/12	= 75.8	76.8
CO from volatile matter	2.7 × 28/74	= 1.0	
CO_2 from volatile matter	2.7 × 44/74	= 1.6	5.6
CO_2 from flux	9.0 × 0.44	= 4.0	
H_2 from volatile matter.	2.7 × 2/74	= 0.1	0.1
Total weight of gases			82.5

Percentage composition of gases by volume:—

		Per cent.
CO	76.8 ÷ 1.26 = 61.0	= 92.4
CO_2	5.6 ÷ 1.98 = 2.8	= 4.2
H_2	0.1 ÷ 0.09 = 2.2	= 3.4
	66.0	100.0

The volumes 61.0, 2.8, and 2.2 represent cubic meters of these gases per 100 kgs. of pig iron made; if multiplied by 16 they give the cubic feet per 100 lbs. of pig iron.

(3) The slag will contain, substituting $x \times 9$:—

	Per cent.
Silica	6.4 = 42.4
Alumina	3.4 = 22.5
Lime	4.5 = 29.8
Magnesia	0.4 = 2.65
Alkalies	0.4 = 2.65
	15.1 100.00

Combined Blast and Electrical Furnace.—The electrical reduction of iron ore differs radically from blast-furnace practice in one essential particular, viz., that since no air is blown in, any excess of carbon above that consumed in reduction must remain unused, accumulate, and eventually clog the furnace. The amount to be used as a minimum cannot, moreover, be calculated until we know how much CO_2 will be formed in reduction, and that is an unknown quantity unless arrangements are made so that none can be formed. The following modifications of working an electrical pig-iron furnace are possible, with the object in view of avoiding the accumulation of excess carbon in the crucible:—

(1) A deficit of carbon may be put into the charge, thus permitting unreduced iron oxide to escape in the slag, and preventing unused carbon from accumulating. This solution leads to the disadvantages of loss of iron, heavy corrosion of lining of furnace, and heavy consumption of electrode carbon. It may have the secondary result of preventing reduction of silica or taking up of carbon by the iron, and thus furnish a metal with high melting point and approaching steel in composition. Such slag would also remove some of the phosphorus in the charge, but practically no sulphur.

(2) A charge of ore and flux without fuel may be run through the furnace whenever an accumulation of carbon occurs, as is shown by the resistance of the furnace falling off and the furnace getting cold. This was the device adopted in the experiments of the Canadian commission at Sault Ste. Marie, but while permissible in experimental work, it would not do to thus periodically derange a furnace in regular running.

CHARGE SHEET—PER 100 OF PIG IRON PRODUCED.

Charges.	Pig Iron.	Slag.	Gases.
Ore: (148.0)			
Fe_2O_3 .. 133.2	Fe 93.0		O 40.2
SiO_2 .... 11.8	Si 3.0	SiO_2 .... 5.4	O 3.4
Al_2O_3 .... 3.0		Al_2O_3 ... 3.0	
Limestone: (9.0)			
CaO 4.5		CaO 4.5	
MgO 0.4		MgO 4.5	
SiO_2 ..... 0.2		SiO_2 .... 0.2	
CO_2 ..... 4.0			Co_2 ... 4.0
Charcoal: (40.6)	C 4.0		
Fx'd C .. 36.5			C 32.5
CO 1.0			CO ... 1.0
CO_2 ..... 1.6			CO_2 ... 1.6
H_2 ..... 0.1			H_2 .... 0.1
SiO_2 ..... 0.8		SiO_2 .... 0.8	
Al_2O_3 .... 0.4		Al_2O_3 ... 0.4	
$(NaK)_2O$. 0.4		$(NaK)_2O$ .0.4	
Totals.... 197.9	100.0	15.1	82.8

(3) The fuel may be calculated only for the production of CO in the furnace, and this condition approximated by leading off the gases from the hot part of the furnace and not allowing them to cool in contact with the ore. In this way reduction by CO is avoided, and the fixed carbon in the charge may be consumed almost entirely to CO without formation of CO_2. This would bring the furnace consumption of carbon nearer to a definite amount, and by avoiding reduction except by solid carbon tend to use up all the carbon charged, the amount of which would be calculated by this manner of working (as in the numerical example worked out for illustration).

(4) The best solution of this difficulty may be to provide tuyeres by which air can be sent into the crucible of the furnace, and thus burn any accumulation of carbon. A given quantity of air will always burn a given quantity of carbon, and therefore the cure would seem to lie in having a variable supply of air, which is increased whenever the falling resistance of the furnace indicates that carbon is beginning to accumulate, and diminished to a small minimum supply, only enough to keep the tuyeres open, when the furnace is in good electrical running order. It would represent a combined electrical and blast furnace, with the blast so regulated as to overcome the chief difficulty of the purely electrical furnace—the accumulation of unused carbon in the crucible.

It may be quite possible, by some such device as Mr. Taylor's large electrical furnace, to practically combine the blast furnace and the electrical furnace. The writer is

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quite confident that any practical method of introducing electrical heat into the crucible of a blast furnace will result in large economies in the furnace working. Only one-quarter of the heating power of the fuel is developed around the blast tuyeres, and yet if half of this could be replaced by electrically-generated heat, an economy of 50% could in all probability be reached upon the fuel bill. To put it into figures, it takes 1.2 tons of coke to make a ton of pig iron in the blast furnace, and about three-quarters of a ton is burnt by the blast, producing at the smelting zone about 25% of the calorific power of the coke. If electrical energy could be made to supply one-half of this, the furnace would make iron with half the previous coke supply, that is, with 0.6 ton of coke per ton of pig iron, and this with an expenditure of electrical energy equal to 12.5 per cent. of the calorific power of the coke, that is, equal to the calorific power of but 0.15 tons of coke.

The question of economy in this case will not be, then, the simple replacement of fuel heat energy by an equivalent amount of electrical heat energy, but the comparison of fuel heat energy with the cost of one-fourth its amount of electrical heat energy. This may be quite possible in many localities, and the combined furnace would work more regularly than a purely electrical furnace. The question awaits the coming of the electro-metallurgical engineer who can make practicable the requisite combination. A possible solution may be to use cheap electrical power to superheat the hot blast, and thus to make the blast itself the agent for carrying electrically developed heat into the furnace.

A NON-ATTENDANCE ELECTRIC PLANT.

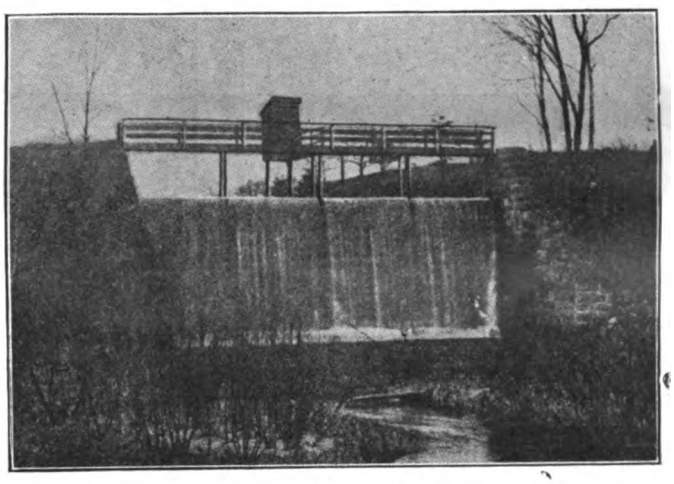
Electricity, both as a motive power and for illuminating purposes, could be far more extensively used in this country in regions remote from public generating stations than is the case to-day. We have in mind a well-known laboratory up North, situated in the open country, where electricity is used for all motive power, heating and lighting, and is generated by means of ordinary water-wheels and small turbines actuated by several small streams. Those responsible for this establishment have fitted up similarly economically planned plants at neighbouring mansions. This is a phase of electrical engineering that should be fostered.

One point that often proves a stumbling block is the question of management. That there need be no difficulty in this matter is shown by instances reported in the American *Electrical World* of a practically automatic hydro-electric installation of small capacity, which has been successfully worked for upwards of six years. It was set up by Mr. J. C. Buschmann, proprietor of the Bismarck Hotel, Westfield, Massachusetts, and who is also the owner of a tobacco warehouse and the owner of an estate. The plant, which only requires half an hour's attendance in the morning for cleaning and oiling, and half an hour at lighting-up time, provides all the lighting for hotel, warehouse and private residence. The installation is a direct-current one, and provides a service of about 225 volts. Mr. Buschmann has certain water-rights over a kind of artificial lake, fed by two small brooks.

The power house is placed at the base of an earth dam about 200 ft. in total length, with a spillway of stone masonry about 50 ft. wide. There are no other water-power developments on this water privilege. The dam gives a head of 22 ft. on the single water-wheel which the station contains, and at no time has it been necessary to use flash boards. The pond is employed in winter for ice cutting for the use of the hotel, but no difficulty has ever been experienced with the ice in relation to the continuous operation of the machinery.

A small gate-house is installed at a bulkhead at the top of the dam above the power station, controlling the flow of water through a steel-rivetted penstock 42 in. in diameter and $\frac{3}{8}$ in. thick. This penstock is 40 ft. long, and it delivers water to the wheel without change in direction. The power-station building is a brick structure of one storey, 32 ft. long and 20 ft. wide, with masonry foundations. The generating machinery consists of an 18 in. McCormick horizontal turbine, direct-connected on a horizontal shaft through a coupling with a 150-amp., 250-volt., compound-wound, direct-current generator. This unit is mounted in a masonry foundation, and the normal capacity of the turbine is 56 h.p., the speed being 300 r.p.m. The wheel-case is covered with an insulation resembling asbestos, to prevent condensation from the atmosphere, and the case is fitted with a $\frac{3}{4}$ in. pipe tap for drinking and washing purposes. A 14 ft. draft tube extends from the bottom of the turbine case to the tailrace of the plant, which leads ultimately into Westfield River. The tailrace is about 50 ft. long, and discharges into the spillway below the dam. It is of masonry, 8 ft. deep and 9 ft. wide.

The turbine is controlled automatically by a Lombard governor, which is direct-connected to the wheel, and adjusted to a point where it will respond to the turning on or off of one 16-c.p. incandescent lamp in the station. A special cone receptacle has been installed on the stem of the governor valve to collect oil and prevent dripping or spreading over the floor. There are three bearings on the generating unit, and each is equipped with a thermostat alarm, which rings a bell in the hotel office in case a bearing becomes overheated. Another gong is located in the station for the same purpose. When a bearing becomes overheated, the plant can be immediately shut down by an electric switch controlling the governor, the switch being located at the hotel. A battery of 12 cells of the liquid type is used for the thermostatic and shut-off connections.



The wiring in the station is all carried overhead through the generating-room to a switchboard consisting of a marble panel containing a voltmeter and ammeter, a field rheostat, a circuit-breaker, and a double-pole, single-throw knife switch, for cutting the generator in and off the line. The panel is 48 in. high × 36 in. wide, and from this the outgoing line is run to the hotel. The line consists of two parallel circuits of No. 4–0 conductors in multiple, or four wires, in all, carried on chestnut poles spaced 75 ft. apart, and varying in height from 25 ft. to 30 ft. Two galvanized-iron wires are installed on the pole line for the operation of the thermostat circuit, and there are also two similar wires installed for a private telephone line between the hotel and the station. The switchboard and wiring were installed by the Berkshire Electric Company, of Pittsfield, Mass., as were the bells and thermostats. The turbine room is lighted by four 16-c.p. incandescents. The average loss on the line is about 4 volts. The present connected load amounts to about 350 lamps of 16-c.p. Current is distributed from the hotel office as a centre, a 36-in. × 30 in. panel having been installed at this point. On it are mounted an ammeter and a voltmeter, which are duplicates of those at the generating station, together with appropriate enclosed fuses and knife switches from which branch lines run about the premises.

This plant has frequently run for 6 to 12 weeks at a time without stopping, and with only casual attention for a short while each day. The man who looks after it is employed about the premises of the hotel on non-technical work most of the time, and is not an engineer or electrician.

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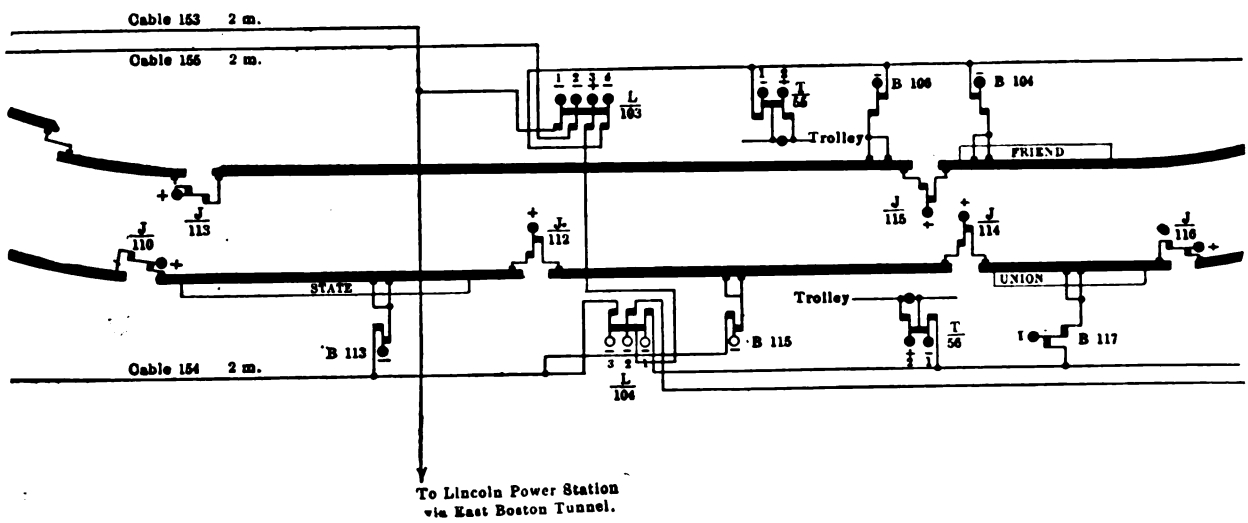
ELECTRICAL EQUIPMENT STREET SUBWAY IN BOSTON.

The Electrical equipment of the Washington Street subway in Boston presents some interesting features, which are described in the *Electrical Railway Journal*, from which we borrow a few details and diagrams.

Fig. 1 shows a short section of the feeder connections which supply current to the third rails.

The third rails are divided into sections which correspond with the signal blocks, and the easterly track is supplied with current independently of the westerly track, so that in case of breakdown the trouble will be minimised. The ends of the third rails at each section are connected by single pole knife jumper switches which are normally kept open. If one of the large cables supplying any third-rail section fails the jumper switches can be closed by hand so as to maintain a continuous feed from adjoining third-rail-sections. The feeders for the northern end consist of three



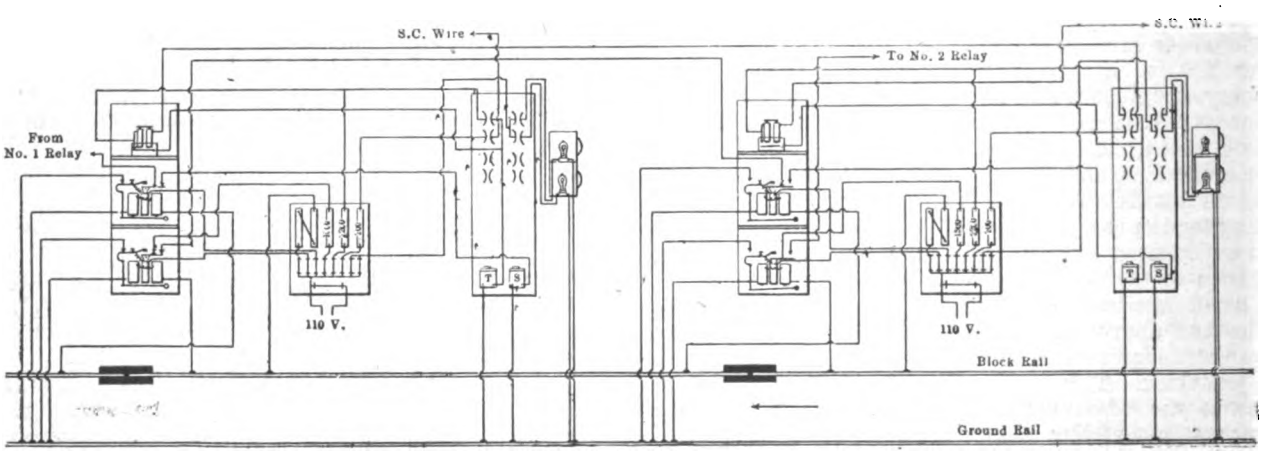
Washington Street Subway—Third Rail Feeder Connections and Sectionalizing Switches.

FIG. 1.

2,000,000 circ. mil underground cables brought to the tunnel from the company's Lincoln Wharf power station on Atlantic Avenue. These cables terminate on a bus in a switch box at the North elevated station. From this point connection is made with the tunnel distribution system through taps to the third rails. At the State Street station an additional 2,000,000 circ. mil cable from the Lincoln Wharf power station is brought into the tunnel for feeding the westerly track in each direction. Switch boxes are installed near State Street station, and these are provided with an emergency cross connection between the positive busbars in each box, so that if the cables on one side go out of service, the opposite lines can be connected up. Normally the tie line switch in one cable box is open, the switch in the other side of the tunnel being closed, so that only one change is needed to throw the two sets of feeders together. South of State Street three 2,000,000 circ. mil feeders are carried through to the vicinity of Essex Street, where a second pair of group switch boxes is installed, with tie line connections for emergency service. Beyond this point the third rail sections are served by two 2,000,000 circ. mil cables, which terminate in a box near the southerly end of the tunnel, where the switches are arranged to connect each side of the tunnel with a separate cable leading to Central power station, on Albany Street. A cross-over is installed south of Boylston Street, and to carry out the separation of north and south bound feeders, the cross-over is sectionalized, half being fed from the east side of the tunnel and half from the west side. There are no circuit breakers on any of the feeder lines supplying the third rails in the tunnel, these devices being installed only at the power stations.

Throughout the tunnel over each track is carried a No. 00 round trolley wire for use in case of emergency. This is supported by hangers and span wire construction with wall fastenings between stations, while at stations it is hung from the girders by wooden supporting blocks. The trolley wires are fed by taps from the same cables which supply the third-rail sections, but there are only five section breaks in each wire. At each section break a two-point switch box is installed, with connections for feeding around the break or for feeding in each direction independently. Normally each trolley section is fed from but one end. In addition to the section breaks in the tunnel, provision is made for the complete isolation of the tunnel trolley at each portal. All cables in the tunnel are triple braided rubber insulated; no lead-covered power cable was installed.

Plans of the tunnel feeder system have been prepared by the company to facilitate the operation of trains by trainmen in case of trouble. These drawings are arranged to show, in instruction book form, what sections of the third rail can be killed or made alive by given switches in any locality in the tunnel. In case a train becomes disabled so that it is necessary to cut out the third-rail section on which it has stopped while repairs are made it is easy to



Washington Street Subway—Wiring for Automatic Signals for One Block

FIG. 2.

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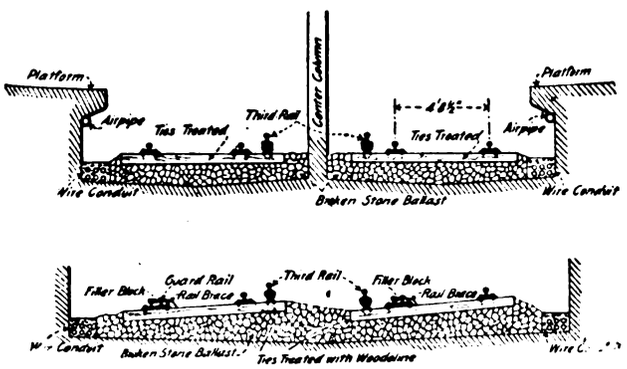
determine from the drawings just what switches to operate.

The tunnel is lighted by about 1,700 16-c.p. incandescent lamps, consuming 64 watts each, installed in series of five lamps each. No arc lamps are used in any part of the tunnel. All the wiring for the lighting distribution outside of the main vitrified clay conduits is run in iron conduit, the lights in different sections being controlled from fireproof distribution boxes. In general, the system of interstation illumination is similar to that adopted in the East Boston Tunnel. The station lights are installed about 12 ft. above the platform. A special feature is the use of a line of lamps 10 ft. apart and from 15 ft. to 20 ft. above



Washington Street Subway—Cross-Sections at Platform and on Curves.

FIG. 3.

the platform edge, to illuminate the edge of the platform. The edge itself is painted with a broad white band that makes it conspicuous. The total number of lamps per station averages about 150. Special care has been taken to keep the lamps out of the direct vision of passengers. Frosted bulbs are used generally in exposed locations, such as in lobbies and passageways. Throughout the tunnel "H K" wall outlets are used, the size and shape of the white porcelain being altered according to location. Illuminated transparencies for announcing train destinations are installed at all stations at right angles to the track, centrally above the platform.

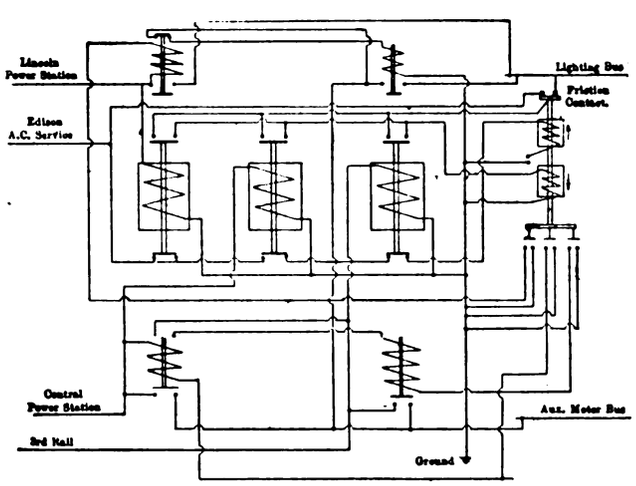
In each station are two switchboards, one being located at each end of the platform. Each of these boards controls half the station lamps. The switch for controlling the power supply to the section of third rail in front of the platform is located in the same chamber as the lighting control. At one of the boards in each station is located a double-throw single-pole automatic switch, which, in case of failure of the main lighting cable which runs through the tunnel, throws the lights for half the station on the third-rail. At the other switchboard of the station is located a single-pole double-throw hand switch which throws the other half of the station lamps on the third-rail feeders Snap switches are located in the switchboard booths at the ends of the platforms to control the individual lighting circuits.

In the tunnel between stations two staggered lines of char glass bulb lamps are installed. The lamps in each line are spaced 24 ft. apart. All track lights are provided with shields to protect motormen's eyes. At intervals of 500 ft. distribution boxes are installed on each side, each box controlling 50 lights arranged in 10 circuits. These circuits are taken off the central point of a double-throw single-pole switch, hand operated, through a busbar and fuse connection. The switch connects the lights of the section of the tunnel with the trolley wire when thrown upward, and with the main lighting cable when thrown downward.

Care has been taken to preserve continuous lighting of the tunnel under all circumstances. At State Street station a switchboard has been installed with automatic equipment for supplying the tunnel lights in normal and emergency conditions. South of State Street the lights on the northbound side of the tunnel are supplied by a No. 00 cable running to a point opposite Winter Street station. Beyond this point the balance of the lights on this side is supplied by a No. 0 cable in series with the first, and connected with it through a knife switch in a wall box, so that if trouble occurs on the cable north of the switch the lights on the No. 0 section can be supplied from the trolley or third rail. Similar cables are installed between State Street station and the South tunnel portal, on the southbound side of the tube. North of State Street station the tunnel lights are fed by a a No. 0 cable on each side. The auxiliary motors and heaters for ticket booths are furnished with current through a No. 0000 cable running south from State Street to Summer Street, where the cable is reduced in size to No. 00.

The scheme of automatic operation of the lighting and power supply at State Street station switchboard is shown in Fig. 4. All lighting cables are brought to a common bus, and all auxiliary power cables are similiarly concentrated at the centre of distribution and control. The sources and order of supply for lighting service are: Lincoln Wharf power station, Central power station, the tunnel third rail, and the service of the Edison Electric Illuminating Company of Boston. The order of supply for auxiliary power distributed from State Street station is, first, Central power station, and second, third-rail connection. The switchboard consists of a motor service panel, a lighting service panel, and an automatic control panel on which are mounted solenoid switches for automatically throwing the services from one source of power to another. These switches are arranged so that only one source of supply is connected at any one time. If the current from one source fails, the switches, which are of the General Electric contactor type, open and close by gravity, throwing the lighting or power cables instantly on the next source. The wiring is so arranged that no matter if the current supply fails on an alternative source, any source remaining will at once take up the load. If all the sources fail, the first source to have current restored takes up the load, and as the different sources come back into service, the emergency supplies are cut off until finally the normal supply is once more at work. Interlocks are provided to prevent the connection of the Edison service, which is 550-volt alternating current, with the auxiliary motors, which are all wound for direct current only. Under no circumstances do the Edison current and the railway company's current come on the circuits together. The Edison current is supplied through a step-down transformer located at State Street, the secondary line being grounded on one side.

The tunnel is equipped with 16 automatic block signals of the electro-pneumatic type, designed for the Boston Elevated



Washington Street Subway—Wiring Diagram of Automatic Lighting Connections

FIG. 4.

Railway. The longest block is about 1,500 ft., and the shortest block 600 ft. The compressed air supply is furnished by compressors located at Sullivan Square, Central power station, and the Guild Street shops. A 2-in. pipe line is carried through the tunnel for distribution of air at a pressure of about 90 lb. per sq. in., and at each end the pipe is connected with the line on the Atlantic Avenue elevated structure, to provide for emergency feed in case of trouble at any point in the tunnel.

The wiring of the signals for a complete block is shown on page 150. A modified Brown polarized relay is used.

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The design of the signal equipment was made under the immediate personal supervision of Paul Winsor, chief engineer of motive power and rolling stock, and W. C. Smith, inspector of signals. The indications to trainmen are given by red and green lamps mounted in a narrow case at the right and above the track. The contactor equipment occupies a space only 47 $\frac{7}{8}$ in. high by 14$\frac{1}{4}$ in. wide. At each signal is an automatic stop which is practically the same as that in use on the present elevated division in Boston.

AMERICAN NOTES.

[From Our Correspondent.]

NEW YORK.

An interesting new departure is being made by the Portland (Oregon) Railway Light and Power Company, who are putting in a 6,000-k.w. steam relay plant, which will use sawdust as fuel. It is estimated that a thousand cubic feet of sawdust, costing a trifle under two shillings, will evaporate 5,000 lbs. of water, and thus prove much cheaper than coal.

Electrical developments on a colossal scale are to enter into the scheme for the improvement of Chicago, which has been drawn up by Messrs. D. H. Burnham and E. H. Bennett, under the auspices of the Chicago Commercial Club. Electric railways and central generating stations for heat, light and power, loom largely in an ambitious—but by no means impracticable—scheme.

At no distant date the horse-drawn mail van will be superseded in New York City by electrically propelled vehicles. Already fourteen such vans have been supplied to the Post Office Department, and the experiment has, so far, proved a great success. Their total carrying capacity is 29,400 lbs.

The New York Central Railroad is contemplating a large extension of its electrical plant, and the electrification of many miles of track. The works are not likely, however, to be put in hand until early next year. On the other hand, the Chicago, Milwaukee and St. Paul Company has, for the time being, abandoned the Montana electrification scheme owing to insufficiency of the water power which it had been hoped to utilise.

Dr. F. S. Pearson, President of the Mexican Light and Power Company, states that his Company will in the near future possess the largest power plant in the world. Nearly £11,000,000 sterling are invested in the Company's undertakings, and next summer 100,000 h.p. will be available, the Company's storage reservoirs in the mountains being capable of storing, when completed, a hundred million cubic metres of water.

The electrical companies on this side are making a good showing this year. According to the *Electrical World*, the Westinghouse Company is now employing close on 7,500 workmen in its East Pittsburgh shops, and is doing a business at a rate which will approximate $25,000,000 a year. The company has a much larger capacity than it formerly had, and it is estimated that at the present time it can handle a business of close to $50,000,000 a year. The General Electric Company is also showing a very steady growth. An official of the company is quoted as saying that it is expected that orders for the current year will amount to at least $60,000,000, and it is estimated that business at the present time is running at the rate of between $52,000,000 and $53,000,000 a year. The business of the Western Electric Company continues to show improvement, and sales are running at the rate of $50,000,000 per annum.

Mr. C. D. Hoskins, talking at Brooklyn on electrical developments, foreshadowed the early abolition of the small central station. He instanced the fact that there were within his knowledge 3,200 central stations operating independently in communities of 2,000 people or less; while in one location which he had in mind there were 13 central stations within a radius of seven miles. These eventually must be coalesced in one system, and these larger systems spreading out would overlap, and some day there would be a few great networks covering the entire country. In this way service could be given not to half the population as at present, but to 80 per cent. of the people, including the farmers.

According to Mr. W. S. Hadaway, jun., in a paper read before the American Institute of Electrical Engineers, one watt-hour (= 3.41 B.T.U.) will raise the temperature of 1 sq. ft. of ordinary radiator surface 1.26° F., and 1,000 watt-hours (3,412 B.T.U.) will heat the surface approximately 126° F. above the room temperature; that is, for room heating from 85 to 110 watt-hours are practically the equivalent of steam at low-pressure condensed by 1 sq. ft. of radiator surface with the difference between the room and the radiator temperatures, as above stated. This, of course, takes no account of the heat capacity of the apparatus, which is practically eliminated by the imposed conditions of continuous running.

The New York, New Haven and Hartford Railroad Company are about to place on the main line two new goods steam locomotives, one with side rods and the other of the geared type. These are to be used experimentally against two electrically-driven locomotives in order to determine the relative economy of the different types for goods traffic.

The American Railway Association has formed a new committee to investigate and report upon the progress being made by roads which have adopted electricity as a motive power. The committee is composed of officers of roads which have electrified portions of their lines or contemplate doing so. Mr. George Gibbs, chief engineer of electric traction of the Long Island Railroad, is chairman of the committee. The railroads represented on the committee are the Illinois Central, Union Pacific, Southern Pacific, Erie, Delaware and Hudson, and New York, New Haven, and Hartford.

THE ATLANTIC CABLE OF 1858.

Mr. Charles Bright, the well-known authority on telegraphy, in the course of an extremely interesting letter addressed to the *Electrical World* of New York, on the subject of the Atlantic Cable of 1858, says he holds in his possession, among numerous other official documents, the agreement between John Watkins Brett, his father (Sir Charles Bright) and Cyrus W. Field, signed, in this order, as equal projectors of the first Atlantic cable. Field came over to England after he had secured the Newfoundland landing rights from F. N. Gisborne, but his ideas had all been preceded by Brett and Sir C. Bright over here. Moreover, nearly all the capital was subscribed for in the end on this side of the Atlantic.

It seems that it had been stated by a writer in the United States that after the transmission of the messages to and from the Queen, the signals over the cable became weaker and weaker, until August 31st, 1858, when they failed utterly, and C. F. Varley, the electrician of the company, after making a number of tests, reported that a fault of great magnitude existed at a distance of about 260 miles from Valentia. It was also stated that it had been thought that the injury to this cable may have been due to the employment of high-tension currents from induction coils in signalling, and that had only low-tension currents been employed, their utility for this purpose having been demonstrated by Latimer Clark, the injury to the cable might have been avoided. There was, however, no proof that the fatal faults in the cable were due to these high-tension currents, and it was not difficult to imagine that the inexperience in cable-making at that time, together with the more or less crude methods of paying out the cable on shipboard, may have been sufficient to account for the cause and development of the faults in question. The suggestion was also made that it probably was not until Varley's interposition of the condenser in the cable circuit, thereby obviating the disturbing effects of the earth currents, that recourse could be had to weaker signalling currents.

On this Mr. Bright points out that in the opinion of practically everybody, "Whitehouse, the electrician, was alone responsible for the gradual breaking down of the cable, by the use of a generating power of immense intensity in conjunction with the rest of his apparatus. The subsequent complete electrical (and, therefore, commercial) successes," adds Mr. Bright, "were mainly due to the introduction of Lord Kelvin's delicate receiving apparatus, first employed by my father on the first cable to India, of 1863-4—long before the second and third Atlantic cables of 1865-6—and subsequently on all the lines that followed."

TRADE CHANGES.

The Simplex Conduits Ltd., of Birmingham, London, and elsewhere, notify that from August 2nd, they have entered into an agreement with the British Prometheus Co., whereby they have been appointed sole selling agents for the well-known apparatus, both on the Prometheus "strip" system and on the new Silundum system, which was recently described in our columns. Special arrangements have been made in regard to facilitating delivery, and large stocks of standard types of electric kettles and other appliances, particularly electric irons, will be carried at our London showrooms and various provincial branches. Owing to the growth of the electric heating business, it has been decided to further extend this department, which will be under the managership of Mr. N. E. Beves, who has acted as London Manager for the British Prometheus Co., for some years past.

An amalgamation has taken place between the Heddernheimer Kupferwerk und Süddeutsche Kabelwerke, Artiengesellschaft, and the Abteilung Süddeutsche Kabelwerke, of Manheim.

Messrs. Davidson & Blackadder, of 50, Wellington Street, Glasgow, have been appointed agents for the St. Helens Cable and Rubber Co., Ltd., of Warrington, for the whole of Scotland. Mr. J. W. Logan will continue to represent the St. Helens Co. in the Scottish district as a member of Messrs. Davidson & Blackadders' staff.

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CONTENTS.

	PAGE
Notes	141
The Institution of Electrical Engineers	142
The Electrical Properties of Flame	142
Automatic Point Working on Electric Tramways	144
Electrical Conditioning Oven	145
Electric Furnace Reduction of Iron Ore	147
A Non-Attendance Electric Plant	149
Electrical Equipment Street Subway in Boston	150
American Notes	152
Trade Changes	152
Electricity in Textile Factories	153
Marine Engineering	154
Correspondence	154
Companies' Meetings and Reports	155
Simplification of Lighting Tariff	ix.
An Electrified Newspaper Office	517
Bottled Electricity	158
New Electric Heating Material	158
Portsmouth Bankruptcy Court	158
Cheap Power in Transvaal	160
Companies' Stock & Share List	160
Technical Problems, with Solutions by Practical Men	161
Lighting & General Notes	164
Traction Notes	165
New Catalogues and Price Lists	165
Fatal Accident at Manchester Electricity Works	166
Contracts Open	166
Results of Tenders	166
Patents	166
Traffic Returns	170
Classified Directory of Electrical Trades	171

ELECTRICITY IN TEXTILE FACTORIES.

Considering the magnitude, wealth, and general enterprise of the textile industry in this country, it is well worth the persevering attention of electrical engineers. When reading his paper on "The Electrical Operation of Textile Factories" (ELECTRICAL ENGINEER, p. 30), before the Institution of Mechanical Engineers, Mr. Herbert Wilson said that between 700,000 and 800,000 electrical horse-power was actually employed in the textile manufactories of the world, and that this was being increased at the rate of 80,000 H.P. per annum. But we must, unfortunately, add that by far the major part of this activity is manifested abroad, so our competitors are reaping many benefits, including economy of running and greater output. Our spinners appear to be fairly alive to the possibilities of electricity, and it only requires repetition of such papers as those read by Mr. Wilson and individual efforts of electrical engineers to induce many of them to make a change that can but prove beneficial to themselves and British commerce. No doubt the full benefit to be derived from electrification is felt when a new factory is being erected, or an old one refitted; but the conversion of old premises and existing machinery is by no means a difficult matter, and will bring immediate relief. The great flexibility of extensions, the ease with which sections of machinery can be stopped or run overtime without waste of power, and the greater steadiness of drive are points, as Mr. Wilson emphasised, that should commend electric power to the wideawake spinner and weaver. As regards profit and loss account, Mr. Wilson, taking a spinning factory as an example, finds that the increased output is on an average quite 5 per cent. We believe that Continental practice has obtained rather higher results. Much of the spinning work with us is piece work, and it is difficult to introduce any modification of prices paid; but even so, and allowing for an increase of cost of power, a margin

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of 0·35 per cent. extra profit is secured merely by increasing the output. Rightly enough, the reader of the paper declined to admit that there need be any increase in the cost of power. This is proved by a most instructive report published in *The Electron* on an electric power installation in a weaving shed at the jute spinning mills of Messrs. W. Blutchen & Sons, Shonebeck, near Vetschau. It appears that 30 looms were in question, and coal to the amount of £28 7s. a year was required to operate them. Messrs. Blutchen were so satisfied with the results to be gained in other ways, that they were prepared to increase coal consumption of £5 10s. to £33 17s., but actual work gave an economy of 2.2 lb. of coal per day loom, as compared with steam drive, in spite of the increased output. So this cry of the costliness of electricity may be boldly faced and denied. Mr. Wilson estimates that a Lancashire factory (able to obtain slack of a caloric value of 11,000 B.T.U., at 8s. per ton), and having a capacity of 1,500 I.H.P., can produce energy at about 0·2d per I.H.P.-hour, or 0.3d per kilowatt-hour, allowing for interest and depreciation. Probably central stations would require, and could obtain, rather more than this, and yet the manufacturer would stand to the good Another point to be borne in mind is that if due care is paid to installation and upkeep, the danger from breakdowns and accidents to persons would be greatly lessened. The motors installed at the Schönebeck weaving shed by the Siemens-Schuckert Werk are totally enclosed, thus affording safety, as well as protecting the machines from dust and mechanical injury. Mr. Wilson's main illustration is derived from two Lancashire mills where gauge-driving appertains. In the Schönebeck installation the individual drive is adopted. Actual tests showed, in this mill, that the 30 looms had an average consumption of 0·52 I.H.P., therefore the total required was 15·7 I.H.P.; but as, owing to a loom standing idle for changing a shuttle or to repair broken threads, the individual power required per loom is higher than 0·52 H.P., and so as individual motor-driving was adopted, motors of greater output had to be chosen. Then, again, in order to allow for future extension, the three-phase generator was one of 85 K.V.A. at 750 revolutions per minute, and 200 volts pressure. Reduction gear, combined with Siemens-Schuckert patent clutches were employed for driving the looms. After running some time, it was found that the output could be increased from 15 to 20 per cent., and this is weaving so that the Brtish estimate of 5 per cent. in spinning is, it will be seen, extremely conservative. As we have already said, there was an actual saving in coal consumption, and that, notwithstanding that the engine and generator worked at a lower efficiency on the diminished load. This little triumph in the economics of weaving should go far to prove to Lancashire and Yorkshire that electricity offers great attractions for all classes of textile manufacturers.

MARINE ENGINEERING.

With the enthusiasm born of full knowledge, Mr. Arthur J. Maginnis declared to his fellows at the Liverpool meeting of the Institution of Mechanical Engineers, that the direct electrical drive in marine engineering "is coming," and implied that this coming will be soon. This is a big thing to say, for it foreshadows a veritable revolution in the running of our great commercial and passenger ships. Many there will be, who will shake their heads over such a prophecy, but so did many others over the turbine, when that was a new-fangled notion. Mr. Maginnis put very neatly the advantages of the direct application of electricity to the shaft. As he said, "in the first instance, reversal of the propeller with full effective power is attained and readily effected. Secondly, the design of both the steam and electric plant can be so modified as to enable the naval architect to make better and more profitable arrangements for both passenger and cargo space. The application of the electric drive and form of motor have now been so improved as to reduce wear and tear to a minimum, and has also increased the efficiency, so that prompt and reliable starting, reversing, and stopping are ensured. Owing to the fact that the lower boiler pressure can be used by the steam-turbine generator, it is anticipated that the weights of the steam and electric plants together will not exceed that of the present system of reciprocating machinery, and it is also estimated that the first cost will average about the same. Of the advantages of this system, one which will commend itself to the navigating department, is that the long-looked-for apparatus to control the movements of the propellers direct from the bridge may be obtained. Another advantage is that electricity, like steam, is capable of being readily applied to all the other requirements of ship-board, such as steering, windlass, and winch work, combined with the further advantages of more economical distribution and giving a simple and agreeable artificial light throughout the vessel."

There is here a grand future opened up before electrical engineering, and one which, as soon as its pull import is understood, will be furthered by shipowners themselves.

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be inclued in that week's issue of the Journal.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

WATER POWER IN FRANCE.

Sir,—In your leading article last week you referred ot the activity displayed by French engineers in utilising water power. The extent to which this is done is even more striking than your remarks would lead one to suppose. Rather more than ten and a half millions sterling are invested in twenty-three companies, possessing power stations capable of generating rather over 320,000 h.p.; of this total only about 90,000 h.p. are generated by steam; even of this, a percentage is merely duplicate plant for use in the event of water power failing. The use of small streams for private installations is also very general.

Paris, August 2nd. Yours, etc., Houille Blanche.

Sir,—I enclose herewith a copy of a circular letter which I am sending round among the Electrical Manufacturers, and which may, I trust, interest you.

Yours, etc., F. B. O. Hawes, Secretary.

The National Electrical Manufacturers' Association (Incorporated), Balfour House, Finsbury Pavement, London, E.C., July 30th, 1909.

Re BRUSSELS EXHIBITION.

Dear Sirs,—You have doubtless received a prospectus, etc., from the Exhibition Branch of the Board of Trade regarding the above exhibition. I would draw your attention to the fact that the Board of Trade are giving special facilities to British exhibitors, which I may briefly set out as consisting of fixing the platforms for the stands, showcases, etc., unpacking and packing the goods, and various other minor matters for the assistance of exhibitors. It is estimated that they will pay £50 out of every £150 expended on British exhibits; in other words, that they will pay one-third of the expenses. The matter of exhibiting is, therefore, one which probably is worth your consideration.

Beyond the assistance which the Board of Trade can give, there are many details in which this Association can be of assistance to those who anticipate exhibiting, among others being the following:—

(1) It is very desirable that an exhibitor should have some information regarding the positions available for his exhibit beyond that which can be obtained

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from a plan, and this can only be furnished by someone who has seen the buildings, etc. It is, therefore, suggested that joint action should be taken on the part of the members of this Association who are proposing to exhibit, by arranging for someone to report to them on this point.

(2) In the case of firms who would be prepared to make a joint exhibit with others, this Association can arrange for such members to co-operate and obtain an arrangement of space, show-cases, etc., suitable for the exhibit.

(3) As regards either the sending out of a representative to report or arranging for joint exhibits, this Association would not make any profit, and would propose to share the actual costs among the exhibitors. It is thought that it will probably be wise for the exhibitors to appoint a representative to go over to Brussels and to act in conjunction with someone who can be appointed locally.

If you are interested in this matter I shall be glad if you will kindly let me hear from you at the earliest possible moment, so that I can make whatever arrangements are necessary and generally prepare the matter.

I may remind you that the exhibition commences in April next, and will remain open for a period of at least six months.

I may add that in addition to the above points, there are many others where joint action may cause a large saving to the exhibitors.

I am, Dear Sirs, yours faithfully,

F. B. O. HAWES, Secretary.

COMPANIES' MEETINGS AND REPORTS.

CROMPTON & CO.

The report shows that the net profit for the year ended March 31st is £10,051, compared with £31,320 for the previous year. The balance remaining, after providing for debenture interest, and other charges and including the amount brought in, is £7,828. Out of this, £1,500 is set aside for doubtful debts and contingencies, and the balance carried forward. For 1907-8 a dividend of 5 per cent. was paid.

SINGAPORE ELECTRIC TRAMWAYS.

The accounts for 1908 show an excess of revenue over expenditure of £24,294, against which has been charged debenture interest, depreciation and royalty, amounting to £28,335, showing a loss for the year of £4,040. The severe depression in trade in Singapore which set in towards the end of the year 1907 showed no abatement during 1908, and as a consequence the tramway revenue shows a decrease of $20,176, as compared with 1907. The demand for energy for lighting and power purposes shows a satisfactory increase—the receipts from this source in 1908 being 94 per cent. higher than in 1907. The new 200 kilowatt steam lighting set, referred to in the last report, has been erected, and is now taking the lighting load. The new bridge over the Singapore River is still not completed, and it will be some months before plate laying can commence on it, and so enable the company to link up section 6 and section 3 of the tramways. The delay in the construction of this bridge is greatly to be regretted, but the company is powerless to hasten matters.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY.

The Secretary has issued the following circular to the shareholders:—"I am instructed by the directors to inform you that the profits for the first six months of the current year, as shown by the cost sheets, amount to £47,759, which, after including the balance brought forward from last year and deducting interest on loans, debentures, etc., represents a net sum of £41,704. Out of this the directors have decided to pay, on the 31st instant, an interim dividend on the preference shares of 2½ per cent., absorbing £17,187. The balance—namely, £24,516—though subject to deductions for depreciation and a sum to be carried forward, would, in the ordinary state of business, permit the declaration of a small interim dividend on the ordinary shares. In view, however, of the critical position of the coal trade and the possible stoppage of and damage to other trades which may follow therefrom, the directors do not think it prudent to deal with the balance before the end of the company's financial year."

SOUTH AMERICAN LIGHT AND POWER.

The report of the South American Light and Power Company, Ltd., for the year ended 31st March last, to be presented to the meeting to be held on the 10th inst., states that the net profit for the year, after writing off a further sum of £550 against the cost of the dynamo, is £5,274, which, added to £147, the amount brought forward, makes the total sum available £5,422. The directors recommend the payment of a dividend of 4 per cent., and also the payment of interest at the rate of 4 per cent. per annum on the £15,951, further capital expenditure incurred during the year by the railway company, which interest amounts to £274. There will remain a balance of £627 to be carried forward. The above-mentioned capital expenditure will be satisfied by a cash payment of £461 and the allotment of 15,500 shares fully paid to the Bahia Blanca and North-Western Railway Company, Ltd., making the total amount of share capital issued £128,500. The 50 per cent. of the gross receipts payable to this company under their agreement with the Bahia Blanca and North-Western Railway Company for the past year amounted to £12,991, against £8,889 in the previous year, showing an increase of 46 per cent. The directors consider the increase in the business during the past year has again been very satisfactory. In accordance with the terms of the working agreement between this company and the Bahia Blanca and North-Western Railway, the latter having subscribed for £30,000 of the capital of the company were entitled to appoint a second director to the Board, and therefore on September 23rd, 1908, they appointed Mr. Frederick Oldershaw Smithers in the place of Mr. Charles Murray Wilkins, who had resigned.

KALGOORLIE POWER AND LIGHTING.

The statement of accounts of the Kalgoorlie (Western Australia) Electric Power and Lighting Company, for the year ended 1908, shows that the profit was £21,644, which has been appropriated as follows:—Debenture interest account, £2,156; dividends on preference shares, £9,000; dividend on ordinary shares, £1,250; dividend tax in Western Australia, £512; reserve for depreciation and renewals, £7,500; carried forward, £1,226. Including the amount brought forward from the 1907 accounts, the total balance to credit of profit and loss account is £6,556. Since the date to which the accounts have been made up, a dividend has been declared and paid at the rate of 6 per cent. per annum on the preference shares for the six months ended March 31st, 1909, and the directors have recommended that a dividend be paid at the rate of 3 per cent. per annum for the six months ended December 31st, 1908, on the ordinary shares, making 4 per cent. for the year. The trading for the year shows an increase in the amount of power sold, and although the profit is not so large as last year, the directors consider the results satisfactory, in view of the lower average price obtainable for power, the wood-getters' strike, and the increased cost of fuel.

ANGLO-AMERICAN TELEGRAPH COMPANY.

The report states that the total receipts from January 1st to June 30th, including £1,565 brought forward, amounted to £211,759. The traffic receipts show an increase of £14,503, as compared with the half-year ended June 30th, 1908. The working expenses amounted to £72,345, a decrease of £950. The directors have set apart £10,000 to the renewal fund, leaving a balance of £129,414. Quarterly interim dividends of 15s. per cent on the ordinary and £1 10s. per cent. on the preferred stocks were paid on May 1st, absorbing £52,500, and second quarterly interim dividends of 15s. per cent. and £1 10s. per cent., amounting to £52,500, will be paid on July 31st. A balance of £24,414 is carried forward. Presiding at the half-yearly meeting, Mr. F. A. BEVAN, the Chairman of the Company, said that regarding the statements that had been made respecting the reduced rates for messages, they could not give any better terms for Press cables, though for social messages perhaps they could, in conjunction with the Postmaster-General, make some reduction.

CHARING CROSS WEST END AND CITY ELECTRICITY SUPPLY.

The Charing Cross West End and City Electricity Supply Co., Ltd., has declared an interim dividend at the rate of 5 per cent. per annum on the Ordinary shares of the West End undertaking.

W. T. HENLEY'S TELEGRAPH WORKS CO., LTD.

The directors of W. T. Henley's Telegraph Works Co., Ltd., have declared an interim dividend on the preference shares at the rate of 4½ per cent. per annum, less income tax, and on the ordinary shares at the rate of 10 per cent. per annum, free of income tax, for the half-year ending June 30th last, both payable September 1st.

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CHILIAN ELECTRIC TRAMWAY AND LIGHT.

The report of the Chilian Electric Tramway and Light Co., Ltd., for 1908, states that the result of the company's operations for the year, after deducting interest and redemption of Debentures, London office, and other charges, shows a balance to credit of profit and loss account of £8,832, to which must be added the balance to the credit of this account, brought forward from the previous year, namely, £1,712, which makes a net balance to credit of £10,545. From this sum £8,000 has been transferred to renewals reserve account, leaving a balance of £2,545 to be carried forward to credit of profit and loss account for the year 1909. The Chilian currency has suffered still further depreciation in 1908, the rate of exchange being on an average about 9 1/16d. per peso, and at one time falling as low as 7 3/4d. This has, of course, adversely affected the profits earned. The year under review shows a further development in the tramway traffic. The company has carried 68,342,366 passengers, earning $5,696,868, as against 61,451,234 passengers, earning $5,011,363 in 1907. The receipts for light and power during 1908 amounted to $3,681,118 as against $2,658,254 in 1907, showing a satisfactory development in this department; although the increased demands for power for tramway operations, as also for the extension of the public lighting, made it necessary for the company to partially limit the supply to the increasing demand for private lighting and power installations. However, it is hoped shortly to be able to meet all demands that may be made upon the company's power and lighting plant, with the advent of hydraulic power—the installation of which is nearing completion. The works for the installation of water power are expected to be completed and the hydraulic power plant to be ready for operation at the closing months of the present year.

METROPOLITAN ELECTRIC SUPPLY.

The Directors of the Metropolitan Electric Supply Co., Ltd., have declared an interim dividend of 5 per cent. (2s. 6d. per share), less income-tax, on the Ordinary shares for the past half-year, payable 10th instant.

LANCASHIRE ELECTRIC POWER CO., LTD.

At the annual meeting of this Company and its affiliated company, the Lancashire Power Construction Company, the Chairman (Mr. H. F. Parshall) said that the reorganisation of the Company was not completed till the end of 1908, so that the new directorate had only been in existence six months. Matters were very much at a standstill until the financial position of the Company was put on a proper basis, but, since the reorganisation steady progress had been made, and more satisfactory contracts had been entered into. He was pleased to say that the Board of Trade had sanctioned the transfer from the local authorities to the Company of a considerable number of lighting orders. There orders were a valuable asset to the Company as the districts were on the trunk mains of the Company, and in consequence supplies of electricity could be given with comparatively small capital outlay. One of the most satisfactory developments was in connection with the supply of electric power to collieries. It was thought that the business of the Company would be almost confined to cotton mills, but a number of collieries were finding it to their advantage to take electricity from the Power Company, and it was anticipated that there would be considerable development in that direction. During the last six months the output had increased something like 30 per cent., while the total costs of production were actually less than those of the corresponding period of last year, the revenue increase being £1,500. This was especially satisfactory considering the great depression in trade in Lancashire during the last 12 or 15 months. This satisfactory increase was to be accounted for by the fact that the advantages of the Company's supply were becoming better understood by the Lancashire manufacturers. Various improvements were being carried out in the power station and economies effected in the cost of generation, and new connections were of a satisfactory nature. The policy of the Board had been, first, to reduce the loss on working, and, secondly, to expend money only when there was a certainty of such expenditure bringing additional revenue.

During the year a Local Government Board inquiry was held at Radcliffe, in which district their power station was situated. The attitude taken up by the Local Government Board was to discourage the development of the Radcliffe Urban District undertaking for the purposes of power generation, and a recommendation was made to the effect that the position of this Company should be taken into consideration by Radcliffe, which was practically the only authority with which the Company was not on the best of terms. The directors had many times met the Radcliffe authorities with a view to arriving at a better understanding, but their efforts had so far met with no encouragement. For this reason it had appeared to the directors advisable to apply to the Board of Trade for a provisional order to supply electricity in the Radcliffe district. There were most important customers in the district who were willing to deal with this Company, and it was hoped that this phase of the business would take a satisfactory turn.

UXBRIDGE AND DISTRICT ELECTRIC SUPPLY CO., LTD.

CREDITORS' AND CONTRIBUTORIES' MEETINGS.

At 33, Carey-street, on the 29th ult., meetings of creditors and contributories were held in the liquidation of the Uxbridge and District Electric Supply Company (Limited) under a winding-up order made on June 29th. Mr. H. E. Burgess, Assistant Official Receiver, presided. The statement of the company's affairs disclosed, as regarded creditors, loans on debenture bonds £52,579, and unsecured creditors £6,622 4s. 5d., against assets £74,949; and as regarded contributories a deficiency of £10,526 16s. 9d. The Assistant Official Receiver stated that the company was promoted in 1900, the original idea being merely to provide a local supply of electricity in the parish of Hillingdon. It was found, however, that the expenses of obtaining a provisional order would have to be incurred, and the scheme was altered so as to provide for extending a supply to several parishes, including Uxbridge. The provisional order was obtained in due course, and the company was able to start its work, a certain amount of capital being offered to the public for subscription. The capital of the promoting syndicate was £1,000, the intention being to get the provisional order into working and then to make over the concern to another company. This was found to be impracticable, and the capital of the company was therefore increased to £20,000, and eventually to £75,000, the scope of its memorandum being also extended. Ordinary shares representing £26,275 had been allotted, chiefly for cash, and the rest of the company's capital had been raised by debentures. A company known as the General Electric Company undertook to finance the concern on certain conditions, and had financed it to a considerable extent, but later on in the history of the company it had been thought desirable by the directors to transfer the debentures held by the General Electric Company to the Metropolitan Electric Supply Company (Limited), and at the present time there was some £43,000 due to the latter company. The transfer was effected by an agreement with the Metropolitan Company on May 8th, 1905, at which time the General Electric Company held debentures to the extent of £21,000. Under that agreement the Metropolitan Company, in consideration of the Uxbridge Company withdrawing its opposition to a Bill then being promoted by the Metropolitan Company, undertook to acquire the interest of the General Electric Company and of Callender's Cable and Construction Company (Limited), who also held debentures. The receipts for current supplied by the company in its first year amounted to £720, which had increased by 1908 to £5,644. After the deduction of the working expenses this showed a profit of £2,903, which sum, however, went in payment of the interest on the debentures. The failure of this company was attributed to want of working capital to enable it to carry out the extensions necessary to make it a paying concern. The assets of the company had already been subject to some considerable reduction for depreciation, and the figures given in the statement of affairs were thought to be substantially correct. Mr. J. Conacher was acting as special manager of the company, and it was stated that schemes for the future carrying on of the company's business were under consideration.

Both meetings passed resolutions in support of the Official Receiver as liquidator of the company, and nominated a committee of inspection.

PERTH (WESTERN AUSTRALIA) ELECTRIC TRAMWAYS CO.

The net profit of the Perth (Western Australia) Electric Tramways Co. for the past year amounted to £12,099, from which £6,000 has been devoted to a dividend on preference shares, and a 5 per cent. dividend on ordinary shares absorbs £5,000, leaving £1,099 to be carried forward. The year's gross profit amounted to £27,720.

CITY OF LONDON ELECTRIC LIGHTING.

The Directors of the City of London Electric Lighting Co., Ltd., have declared a dividend on account of the year 1909 on the Ordinary shares of 5s. per share, less income-tax.

CURTIS TURBINES.

The British Thomson-Houston Co., Ltd., Rugby, have issued a partial list of "Curtis" Steam Turbines, manufactured by them, which have been installed or are in the course of construction. Those of the vertical type range from 500 kw. 3-phase and direct current, to two 3,000 kw. sets, which are now in course of construction for the Bradford Corporation. Several sets of high pressure, mixed and exhaust type, horizontal turbines, are in commercial service. The total kilowatt capacity of "Curtis" Turbines up-to-date amounts, we are informed, to 1,378,970, representing a total selling price of 6½ millions sterling.

The new address of the North East Coast Institution of Engineers and Shipbuilders is Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

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Generally: As regards Flat Rates.

I am of opinion that flat rates as a rule are incorrect methods of charge, and I would not recommend an extension of such rates for this district. The only fair method of charging on the flat rate system is to group various classes of supply and give each class of supply a different flat rate according to load factor, which would result in no end of dissatisfaction amongst consumers.

Generally: as regards "Maximum Demand" System.

The "maximum demand" or "power required" system of charging is the correct one, the difficulty having been to get it simple and understandable by consumers. This proposed tariff, I think, meets this difficulty. The variation in "annual charge" as between large and small consumers differentiates between wholesale and retail supplies. The "annual charge" plus 1d. per unit automatically gives a low average price per unit to the desirable long hour consumer with high load factor, and likewise a high average to the short hour user with low load factor, who is much more costly to supply.

The annual payment in advance for large and medium consumers lessens the risk of bad debts to the Council, and further, in the case of small consumers, renders deposits unnecessary.

General: Saving in Duplicate Wiring.

A most important point to the consumer is that one set of wiring only is necessary in all premises, even where lighting, heating, and cooking are mixed up. This is a considerable saving to the consumer, and which the Council, in the past, have been endeavouring to effect by means of plug meters for heating, etc.

"Maximum Demand" or "Power Required" Indicators and Meters.

Under this proposed tariff, these indicators will only require to be read in the months of October, November, December, January and February.

The fact that this tariff saves meters, does not make much difference from our point of view, because meter rents are charged. Under the proposed tariff, meter rents, connection charges, inspection charges, etc., all remain as at present.

Definition of Power, Lighting and other uses of Electricity.

As to what may be termed "lighting," "power," "heating," "cooking" and other uses of electricity, the general manager's decision must be final.

Application of Tariff.

Any consumer wishing to avail himself of this optional lighting tariff must have the whole of his lighting on this system, but I recommend that any consumer, no matter the system he elects to be charged upon for lighting, can have the new "heating" and "cooking" and "other uses" rates, provided he puts in separate wiring for such uses, and uses, exclusively the Council's electricity for lighting. The cost of separate wiring will, in any case, be an inducement to the consumer to take the "Telephone System" of charging, right through.

ELECTRIC SMELTING PLANT FOR CANADA.

Inquiries are being made in Canada, especially in the provinces of Ontario and Quebec, for electric iron ore smelting plant, similar to the installations now working in Norway and Sweden. The iron ore in all three countries is of a similar nature.

PROTECTING LIGHT AND POWER CIRCUITS.

An improved apparatus for protecting electric light and power circuits, recently been patented by Mr. C. J. Bennett, of Woodside, Hildenborough, is attracting much attention. Mr. Bennett, who is a pupil of Mr. J. P. Strange, Assoc.M.Inst.E.E., of Messrs. Strange & Sons, Ltd., Tunbridge Wells, has had several good offers from manufacturers who wish to take up the patent.

A South African Institute of Electrical Engineers has been established, with headquarters at the Grand National Hotel, Johannesburg.

AN ELECTRIFIED NEWSPAPER OFFICE.

One of the most complete electrical installations of its kind in the world has been recently laid down at Springfield, Massachusetts, on the premises of the Phelps Publishing Company, printers of such popular magazines as "Good Housekeeping," "Current Events," "The American Agriculturalist," "New England Homestead," "Farm and Home," "Popular Fashions," the "Woman's Home Journal," and others.

Every machine in the Phelps Company's huge eight-storey building is driven by a motor by means of a steam-driven power plant of 585-k.w. There are one 440-h.p. Babcock & Wilcox and two 250-h.p. Atlas water-tube boilers in the plant, built for 200 lb. pressure and operated at a pressure of 150 lb. The boilers are equipped with Murphy automatic stokers, and coal is handled from the storage pocket by a 1-ton Sprague electric hoist running on a suspended beam having a minimum radius of 12 ft. The hoist runway forms a complete loop. The bucket used in the coal-handling system has a capacity of 300 lb., and provision is made for the removal of ashes from the ash pits by a runway connecting with a freight elevator leading to the street level. The motor operating the hoist is a direct-current, 240-volt machine. There are two Warren & Deane feed pumps for boiler service. The stokers are steam-driven, and a 500-h.p. National feed-water heater is in service, a smaller heater of the same type being available for domestic hot-water supply. A 12 in. main and a 10 in. main lead into the engine-room from the boiler-room, branches being taken off for the different generating units. An 8 in. auxiliary main is also run through the plant. The exhaust steam is carried to the feed-water heaters in a 12 in. line, there also being an 18 in. connection to the atmosphere for free exhaust.

The generating units comprise four direct-connected sets, three rated at 35-k.w., 100-k.w. and 150-k.w., consisting of Westinghouse three-wire, compound-wound, 240-volt, direct-current generators driven by American Ball horizontal, single-cylinder, high-speed, non-condensing engines. The largest unit (300-k.w.) is driven by a Hewes & Phillips compound engine. There are also in service a 40-k.w., 240/120-volt balancer set and a 75-k.w., 260-volt, compound-wound booster, direct-connected to a 105-h.p., 240-volt, direct-current motor. The first machine takes care of a positive or negative variation of 10 per cent. on the lighting load, which is supplied from the same generators that handle the motor requirements of the installation. The booster is installed for the purpose of supplying power to a number of 500-volt direct-current motors of the company which survived the fire, and it is connected in series with the 240-volt busbars so that both 500-volt and 240-volt service, as well as 120-volt lighting service are available in different portions of the plant. The switchboard is of black slate and was designed and built by the Trumbull Electric Manufacturing Company, of Plainville, Conn. It consists of nine three-wire direct-current feeder panels for lighting service; one three-wire balancer and bus circuit-breaker panel; four direct-current generator panels; two blank generator panels; six 240-volt, direct-current motor feeder panels; one ammeter panel; four 500-volt, direct-current motor feeder panels; one direct-current motor panel, and one direct-current booster panel. In case of an accident to the booster, two generators may be electrically connected together in series.

A differential relay is connected across the lighting busbars of the board and arranged to trip a circuit-breaker in one outside bus in case of a dangerous unbalancing of the voltage in the three-wire system. With the board are provided two voltmeters, one to indicate voltage on either side of the balancer, of any generator and of the booster, by means of suitable receptacles located on the machine panels, and the other being connected to indicate the potential across the 500-volt busbars through a receptacle on the booster panel, and the ground voltage to the 120-volt, 240-volt, and 500-volt busbars through receptacles on the ground-detector panel. Each motor feeder circuit contains an ammeter shunt with leads running to the ammeter panel, a plug switch being used to throw any circuit upon the proper instrument. When shunting a motor feeder circuit through the ammeter for a reading, the circuit-breaker attached to that circuit is opened, each circuit being provided with an automatic circuit-breaker manufactured by S. B. Condit, Jr., & Company, Boston. No fuses were used on the motor panels of the switchboard. The circuit-breaker located on the bus circuit panel

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between the motor and the lighting divisions of the switchboard is of 4,000-amp. capacity at 240 volts.

In general, the feeder conduits for motor and lamp circuits are of 1.5 in. pipe, and the building is divided into two equal parts with separate wells for the risers feeding each half of the establishment. One lamp and one motor distribution box are located between each floor in the shaft, and from these boxes short runs of distributing feeders are made to the floor levels, where the conduits are carried horizontally across and through the floor structure in such a way that the riser shaft boxes supply adjoining floors. That is, the lighting feeders from a riser box in the shaft between the fifth and sixth floors serve, for example, the ceiling of the fifth floor, while the motor feeders branching from the corresponding motor distribution box between the fifth and sixth floors run downward to a horizontal fanning out at the fifth floor. The building is divided into a large number of bays 20 ft. square, there being 70 bays per floor. Each bay is provided with an average of one motor and two lamp outlets, the former being in the floor and the latter in the ceiling. To enable the connections to be made with ease when they are wanted, there were left in the concrete construction of the ceilings and floors over 7,000 tin-sleeved wooden plugs 1¼ in. in diameter, three being allowed per bay for the running of flexible wires where needed.

Tungsten lamps with prismatic glass shades are used extensively on the different floors except where special conditions enabled other types of lamps to be employed. In general, each corridor landing is lighted by one 40-watt tungsten lamp, and in long corridors one such lamp is allowed to each 20 ft. bay. The general offices are lighted with 25 4-lamp tungsten fixtures, 60-watt units being used in each socket. Prismatic glass shades are hung 11 ft. above the floor, and the office area is about 400 sq. ft. In the mailing-room the company uses a Cooper Hewitt mercury-vapour lamp in each 20 ft. bay. In the composing-room each 20 ft. bay is equipped with a Cooper Hewitt new curved-tube lamp, operated in series with a 2-amp. 120-volt tungsten lamp, with prismatic glass bowl 11 ft. above the floor. The press-room is equipped in general after the manner of the main offices, the fixtures having gun-metal finish. In the photo-engraving department two sets of Cooper Hewitt lamps are used for photographic work, and there are eight 40-amp. arc lamps for printing negatives. There are eight dark rooms, each provided with a sliding-screen window of yellow or red glass, an ordinary 16-c.p. carbon-incandescent lamp being hung outside. The main press-room has 12 120-volt enclosed arc lamps of the portable type, and the press frames are wired on all landings for incandescent lamp connections. All the lighting panel boards are provided with terminals for the attachment of meters in case the company rents any floor or office section to other parties. A number of tenants are now served in this way. The variety of uses to which the motors are put (says the New York *Electrical World*, to which we are indebted for the foregoing details), and the sizes of motors required cover an extended range. It is the company's intention to gradually weed out the 500-volt motors as they become worn out and replace them with 240-volt machines. Ultimately the plant will be equipped for straight 240-volt and 120-volt service.

BOTTLED ELECTRICITY.

A Baptist clergyman, of Bayonne, New Jersey, who is described as a scientific student, who has contributed largely to technical magazines, announces, says the New York *Electrical World*, that he has discovered a method for the elimination of thunderstorms, and of storing on earth part of the electricity in the clouds. His plan is to construct a huge steel tower reaching to the clouds, down which silently and harmlessly would be conducted the immense quantities of electricity to be there stored. All that would be necessary, he says, would be three city blocks on which to build a solid foundation. "There are 10,000 million volts of electricity in every flash of lightning two miles long. Bottle up this immense energy in storage batteries and sell it, and in a year's time you could buy out Rockefeller. The clouds are charged with electricity, and the supply is inexhaustible. By the use of such a tower and proper storage facilities thunderstorms in cities would be eliminated. I predict that within the next few years every city in the United States will build one large steel tower in its territory, and will run its street cars and large power plants by only that energy drawn from the clouds."

NEW ELECTRIC HEATING MATERIAL.

"The comparatively low efficiency of the radiant heat electric radiator and the cheerlessness of the ordinary black electric radiator have long been realised," says Mr. Andrew Stewart, A.M.I.E.E., in the current issue of *The Engineering Review*. "The coal or gas fire has generally been favoured on account of its superiority in this respect, and while the latter has the disadvantage from a feminine point of view, that it cannot be poked, its cleanliness has led to its ousting the coal fire in very many cases.

"As a means of heating a room the electric radiator has so far only been a partial success; it is either cheerful and inefficient as in the case of a luminous radiator, or cheerless and efficient as in the case of a non-luminous radiator, and between the two there is not much to choose.

"For cooking purposes electricity occupies a distinctly more favourable position; its efficiency is unquestioned, as much as 97% of the energy supplied to an electric kettle or similar vessel reaching the contents, and in this respect it has no rival at all, even if such appliances did not have the collateral advantages of cleanliness, portability, and freedom from the risk of fire.

"Many efforts have been made to produce a more or less refractory material which would, while giving all the advantages of existing electric heaters, prove an efficient radiator, and give the much desired cheerful glow. Calorit will at once occur to some of our readers as one example of the attempts which have been made in this direction. For the benefit of many of our readers we should explain that this material consisted of small particles of graphitic material through which the electric current passed, causing these particles to glow like pieces of red hot coal. Unfortunately this material slowly oxidised when heated, and soon lost its conducting power, so that frequent renewal became necessary.

"The electric furnace, which has in modern times solved so many difficult problems in metallurgy, physics, and chemistry, has now produced a material which is beginning to be known commercially as silundum, which can be heated in the atmosphere to a temperature of 3,000° F. without entering into combination with oxygen, nor apparently losing any of the electrical or physical properties which are so valuable. It appears impossible to melt it; it is, therefore, truly refractory, and it will withstand the attacks of acid and is unaffected electrically by water.

"The material is produced in rods, bars, sheets or other suitable shape, and is used for electric stoves, radiators, grills, toasters, and cooking purposes generally, for the work can be done over a bright red or even incandescent material, just like a bright coal or coke fire.

"For cooking such a material cannot approach the resistance methods now so common, because of the great heat dispersion into the surrounding atmosphere; but for many purposes, where a glow combined with a high temperature is desirable, the new material will prove invaluable. No reliable information as to the composition of silundum is yet available, but the foregoing information is sufficient to indicate that the new material will prove of very great value for many purposes."

PORTSMOUTH BANKRUPTCY COURT.

In the case of William Thomas Harris, an electrical engineer, trading as W. T. Harris & Sons, at 460 and 464, Commercial-road, Portsmouth, and 47, Emanuel-street, the liabilities were expected to rank at £678 4s. 3d., and there was a surplus over the liabilities of £166 5s. 3d. The debtor attributed his failure to heavy expenses connected with his business and bad debts, and pointed to a large difference between the cost of the machinery and plant and its realisable value. He had been a chief torpedo instructor in the Navy, and began business for himself in 1899. Replying to the Official Receiver, he said that since he took over a garage at Emanuel-street his financial position became involved, and that undertaking was largely responsible for his present position. The Official Receiver had been advised that the value of the stock-in-trade, machinery, etc., was about £960, but if there was realisation by forced sale the amount obtained would be about £550. The examination was closed.

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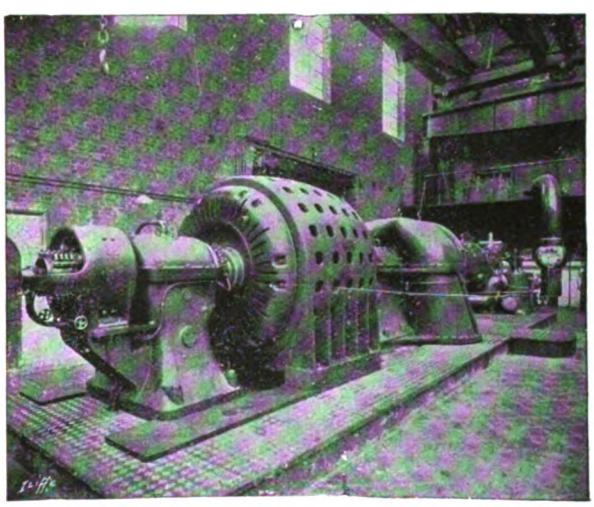
ALPHABETICAL INDEX TO ADVERTISEMENTS.

	PAGE
Abbott and Co.	—
Adams Manufacturing Co.	—
Aerators Limited	15
Allen, W. H., and Son	16
Ammon, A. F.	12
Andrews, R. W., and Co.	—
Auto Controller and Switch Co.	13
Babcock and Wilcox	2
Bailey, W. H., and Co.	—
Bastian Meter Company	16
Bates, C. G.	—
Bellis and Morcom, Ltd.	20
"Bewarht"	15
Bill, S., and Co.	—
Birkbeck Bank	19
Boddy, G. M., and Co.	—
Braulik, G.	—
British Insulated and Helsby Cables, Ltd.	6
British Mica Company	12
British Thomson-Houston Company	—
British Westinghouse Electric and Mfg. Co.	—
Brockie-Pell Arc Lamp Company	—
Brook, E.	—
Browett, Lindley, and Co.	5
Callender's Cable & Construction Co.	19
Capell Fan Company	1
Churton, T. H., and Co.	12
Concordia Electric Wire Co.	1
Cort, A., and Co.	—
Croft and Perkins	—
Crossley Bros.	17
Cryselco Limited	—
Derby and Co.	—
Dick, Kerr, and Co.	6
Diesel Engine Company	—
Dore, J., and Co.	9
D. P. Battery Co.	—
Dorman and Smith	2
Edison and Swan Company	—
Electrical Standardising, Testing, and Training Institution	13
Electric and Ordnance Accessories Co	—
Electric Construction Co.	—
Electrical Engineer Institute	—
Electrical Trades Supply Limited.	12
Electromotors Limited	—
Everett, Edgcumbe, and Co.	—
Everitt and Co.	12
Evershed and Vignoles	12
Ferranti, Limited	17
Fischers Ball and Bearing Co.	12
Flexible Metallic Tubing Company	1
Foster Arc Lamp and Engineering Co.	—
General Electric Company	8
Gibbs, J., and Son	1
Gilkes, G., and Co.	—
Griffiths Bros.	1
Grimshaw Bros.	—
Hardy Patent Pick Co., Ltd.	—
Harris, A. E., and Co.	—
Hart Accumulator Company	—
Harvey, G. A., and Co.	—
Heathman and Co.	19
Heenan and Froude	—
Hendry, J.	19
Henley's Telegraph Works Company	—
Home and Rowland	12
Hooper's Telegraph & Indiarubber Works	15
Hudson, J., and Co.'s Successors	—
India Rubber Company	4
Johnson and Phillips, Ltd.	—
Kaye, J., and Sons	—
Keys, W. H.	—
Key Engineering Co., Ltd.	14
Lancashire Dynamo and Motor Co.	—
Ledward and Beckett	—
Liverpool Electric Cable Co.	—
London Electric Firm Co.	19
London Electric Wire Co.	2
Lorrain, J. G.	19
Lundberg, A. P., and Sons	3
Lunken Valve Co.	12
Macintyre, J., and Co., Ltd.	1
Major and Co.	15
Marryat and Place	—
Matthews and Yates	1
Mayer, H. G., and Co.	1
McClure and Whitfield	3
McGeoch, W., and Co.	17
Merryweather and Sons	12
Metallic Seamless Tube Company	9
Millar's Karri and Jarrah Co.	3
Mitcham Electric Fan Company	—
Morris-Hawkins, Ltd.	—
Moseley, D., and Sons	9
Mosses and Mitchell	19
Nalder Bros. and Thompson	16
New Brotherton Tube Company	16
Pass, C., and Son, Ltd.	19
Petter, J. B., and Sons, Ltd.	—
Phœnix Fire Office	13
Price, Powell, and Co.	—
Railway Passengers' Assurance Company	3
Reason Manufacturing Company	—
Reyrolle, A., and Co.	14
St. Helens Cable and Rubber Company	—
Sandycroft Foundry Co.	—
Schaffer and Budenberg	1
Siemens Bros., Dynamo Works, Ltd.	—
Simplex Conduits, Limited	—
Sloan Electrical Co.	—
Small Power Dynamo & Motor Co.	—
Smith, Geo.	—
Spencer Chapman and Messel	—
Stearn Electric Lamp Co., Ltd.	20
Süddeutsche Kabelwerke, A.G.	—
Sun Electrical Company	—
Switchgear Co., Ltd.	1
Taylor and Co.	—
Thermit, Limited	—
Tilbury Contracting and Dredging Co., Ltd.	15
Tormo Manufacturing Co.	—
Townshends, Limited	—
Traun, Dr. Heinr.	19
Tucker, J. H., and Co.	—
Tudor Accumulator Company	—
Turnbull, A., and Co.	—
Union Electric Co., Ltd.	5
United Electric Car Company	—
United States Metallic Packing Co.	3
Verey and Co.	3
Victoria Electrical Works	—
Vlasto, Clark, and Watson	—
Webb and Son	—
Western Electric Company	2
Weston Electrical Instrument Co.	—
White, J. G., and Co.	1
Wilkinson, G.	—
Willans and Robinson	—
Willcox, W. H., and Co., Ltd.	18
Wilson, L. E., and Co.	—
Winter, F.	—
Youngs	20

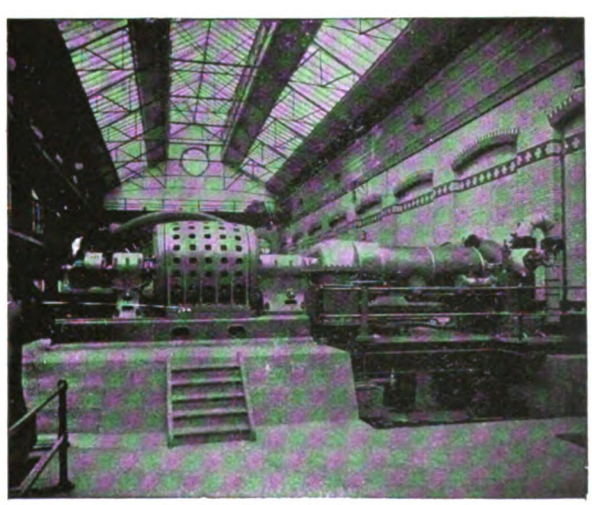
Willans & Robinson,

LIMITED.

STEAM TURBINES.



3,000-kwt. Willans-Parsons Turbine.



1,500-kwt. Willans-Parsons Turbine.

VICTORIA WORKS, RUGBY.

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CHEAP POWER IN TRANSVAAL.

In view of our last week's leading article on the Victoria Falls and Transvaal Power Co., Ltd., the following report of proceedings before the July meeting of the Power Commission, which appears in the *Transvaal Leader*, will be of interest :—

Sir Thomas Price presided, and evidence was given by Mr. Sidney Bilborough, coal-testing expert, and member of the local Institute of Mechanical Engineers. Questioned at length on the cost and method of producing electricity, he said that it would be a good station that would produce a unit of power from a gallon of water.

Cheap power, he further declared, was of the first importance to the Transvaal, and as a result of its adoption he would expect that the coal consumption would not be diminished. It would place the inland colonies in an advantageous position as compared with the coast colonies, and this would, he thought, conduce to the good of South Africa as a whole. An iron industry would be of great value, and he would place it in importance to the country next to the gold industry. He referred to the report of a Canadian Commission, and said that the electric smelting of ores was possible where power was produced at 0·03 of a penny per kilowatt-hour. This figure was about one-twentieth of the lowest cost of production in South Africa. Better results from Transvaal coal could be obtained by washing. He thought the Government would be the proper body to conduct on a large scale tests for the manufacture of coke for the special purposes of an iron industry. The potentialities of the Middelburg and Carolina districts were quite unknown as regards the production of sulphate of ammonia, for instance.

By Mr. Kotze : If special facilities were given to one power company there should be some method of control to secure purchasing in the open market. He did not agree that the cost of power produced from coal could be brought down as low as a farthing. To do so plant would have to be cheaper and the station have to be at the pit's mouth, which, in turn, would mean a long transmission line. At present the cost from suction gas producers was very much lower than was possible from a power company ; including all costs, it might be as low as a farthing. The life of the coal industry would be difficult to estimate, but it was estimated that one colliery could supply 40,000 tons a day for a thousand years.

By Mr. Balfour : A coal combine should be fought just as strongly as a power combine. The Government might insist on buying in the open market, but it was a drastic assumption that all the collieries combined.

Mr. Balfour said he hardly thought it was a drastic assumption, as 53 per cent. of the collieries were already together in one association.

Witness, proceeding, said small coal was being increasingly used locally. It was not so suitable for export ; in fact, it might be difficult to export it, and the tendency was to export large coal.

By Mr. Michael Dodd : He did not know whether power companies would use two tons of coal per ton crushed where gold mines used three. Improved boiler plants on gold mines would, to a certain extent, save something in the amount of coal used per ton crushed. He had not studied the question of coal export, and was not aware that not a single ton had been exported in the last couple of months.

Mr. William Pott, representing the Henderson's Transvaal Estates, etc., stated that his company held land all over the colony—750,000 acres. A large portion of it was mineralised, and some lay in the areas to be served by the schemes now before the Commission. He thought the attitude taken up by the Randfontein group and the East Rand group was reasonable. The prospective saving of 10d. a ton at Randfontein would hardly be made if the freight on coal was reduced to cost price.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last price. £
Alliance Electrical Co., 5 p.c. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
— — Ord., 1,125,000	1 ..	¼-¾
Aron Electr'ty Meter, 6 p.c. Cum. Pref. Sh's, 1-125,000	1 ..	½-⅝
Ordinary, Nos. 1-125,000	1 ..	¼-½
British Aluminium Co., Ordinary, 2,001-40,000	5 ..	¼-¼
—— 7 p.c. Cum. Pref., 1-40,000	5 ..	1¼-1⅝
—— "A" 6 p.c. Cum. Pref., 1-20,000	5 ..	3-3⅛
—— 4 p.c. Funding Certificates, 1-20,000	5 ..	2⅛-3⅛
—— 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	82-87
— — 5½ p.c. Loch Leven Deb. (Reg.), Red., 1-3,000	100 ..	94-99
British Insulated and Helsby Cables, Ord. 1-100,000	5 ..	7⅛-7¼
—— 6 p.c. Cum. Pref., 1-100,000	5 ..	6⅛-6⅜
— — 4½ p.c. Mortgage Debentures	100 ..	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	91-96
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 275,001-475,000	3 ..	3 16-7 16
— 4 p.c. Mortgage Debenture Stock	100 ..	38-42
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	0-¼
—— Non. Cum., 6 p.c., Pref.	2 ..	0-¼
—— 4½ p.c. 1st Debenture Stock	100 ..	43-48
— — 4½ p.c. 2nd Debenture Stock	100 ..	27-31
Callender's Cable, Debentures	100 ..	105-107
—— Ordinary	5 ..	10-10⅛
—— 5 p.c. Pref.	5 ..	5⅛-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7 16-9 16
Crompton and Co., Nos. 1-85,000	3 ..	¼-1
—— 5 p.c. 1st Mort. Reg. Debs., Nos. 1-900 of £100, and 901-1,100 of £50, Red.	— ..	91-94
Dick, Kerr, and Co., Ordinary, 1,260,000	1 ..	1 1 16-1⅛
—— 6 p.c. Cum. Pref., 1-305,000	1 ..	1 3 32-1 7 32
—— 4½ p.c. Debenture Stock, Red.	100 ..	99-102xd
Edison and Swan Unted, "A" Shares, 1-99,261	3 ..	¼-⅜
—— "A" Shares, 01-017,139	5 ..	1⅛-2¼
— — 5 p.c. Debentures	100 ..	68-73
—— 4 p.c. Deb. Stock, Red.	100 ..	93-96
Electric Construction, Nos. 1 to 112,100	2 ..	7 16-⅜
— 7 p.c. Cumulative Pref.	2 ..	1 7 16-1 11 16
—— 4 p.c. Perp. 1st Mort. Deb.	100 ..	63-67
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	71-77
General Electric Company (1900) 5 p.c. Cum. Pref.	10 ..	7⅛-8
— — 4 p.c. 1st Mort. Deb. Stock	100 ..	85-88
W. T. Henley's Telegraph Works, Ordinary	5 ..	12-12½
—— 4½ p.c. Preference	5 ..	5⅛-5⅜
— — 4½ p.c. Debentures	100 ..	105½-107½
India Rubber, Gutta Percha, and Telegraph Works	10 ..	14½-15½
— — 4 p.c. Debentures	100 ..	99-101
National Electric Construction Co., 1-170,000	1 ..	⅛-¼
Telegraph Construction and Maintenance	12 ..	34½-36
— — 4 p.c. Bonds	100 ..	99½-101½
White, J. G., and Co., 6 p.c. Cum. Pref., 1-15,000	10 ..	9-10

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	5⅛-5⅜
Bournemouth and Poole, Ordinary	10 ..	9⅞-10⅛
— — 4½ p.c. Cum. Pref., 7,501-15,000	10 ..	9⅞-10⅛
—— 6 p.c. Cum. Sec. nd Pref., 15,001-22,500	10 ..	10⅛-10⅜
—— 4½ p.c. Debenture Stock, Red.	100 ..	99-103 xd
Bromley (Kent) Electric Light and Power Co.	5 ..	4⅛-5
—— 4½ p.c. 1st Debenture Stock, Red.	100 ..	93-96
Brompton and Kensington, Ordinary	5 ..	8-8⅛
— — 7 p.c. Preference	5 ..	8-8⅛
Calcutta Electric Supply Corp., Ord., Nos. 1-100,000	5 ..	5⅛-6⅛
Cambridge Electric Supply Company, £10 Ord.	8 ..	12⅞-13⅛
Canadian General Electric Co., Common Shares	$100 ..	123-127
—— 7 p.c. Cum. Pref. Stock	$100 ..	116-118
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100 ..	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5 ..	3⅞-4⅛
—— 4½ p.c. Cum.. Pref., 1-80,000	5 ..	4⅛-5
—— 4 p.c. Debenture Stock, Red.	100 ..	96-99 xd
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5 ..	3⅞-4⅛
Chelsea Electricity Supply	5 ..	3⅞-4
—— 4½ p.c. Debentrues	100 ..	100-103 xd
City of London, Ordinary	10 ..	10⅛-11
—— 6 p.c. Cumulative Pref.	10 ..	12-12⅛
—— 5 p.c. Debenture Stock	100 ..	121-124
—— 4½ p.c. 2nd Deb. Stk., Red.	100 ..	99-102 xd
Cordoba Light and Power Co., 1st Mt. Stl. 5 p.c. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	2⅞-3⅛
—— 5 p.c. Preference, 1-50,000	5 ..	3⅛-3⅜
County of London Elec. Supply, Ordinary	10 ..	8⅛-8⅜
—— 6 p.c. Cum. Pref.	10 ..	10⅞-11⅛
—— 4½ p.c. Debentures Prov. Certs. Al pd., Rd.	100 ..	103-106
—— 4½ p.c. 2nd Debentures Prov. Certs.	100 ..	100-103
Edmundson's Electricity Corporation, Ord., 1-80,000	5 ..	3 16-5 16
—— 6 p.c. Cum. Pref.	5 ..	⅛-¼
—— 4½ p.c. First Mort. Deb.	100 ..	59-62
Electrical Development Co. of Ontario, 5 p.c. 1st Mort. 30-year Gold Bonds, 10,751-15,750	— ..	84½-86½ p.c.
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100 ..	85½-88½ xd
Folkestone Electric Supply, Ord., Nos. 1-10,000	5 ..	4⅛-5
—— 5 p.c. Cum. Pref., Nos. 1-10,000	5 ..	5-5⅛
—— 4½ p.c. First Deb. Stock, Red.	100 ..	98-101
Hove Electric Lighting, Ord., 1-13,000	5 ..	7⅛-7
Indian Electric Supply and Traction Co., 6 p.c. Construction Deb. Stock, Red.	5 ..	1⅛-2
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100 ..	74-79
Kalgoorlie Electric Power and Lighting, 6 p.c. Cum. Pref., 1-150,000	1 ..	25/32-¾
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000.	5 ..	6⅛-7
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100 ..	98-101

(*Continued on page 169.*)

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

"If thou hast knowledge, let others light their candle at it."

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should be *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

Question No. 1,192.—Describe a suitable but cheap arrangement for absorbing 700 kw. at 2,200 volts three-phase. A cooling tank 30 ft. by 7 ft. by 4 ft., with a good circulation of clean water, is available for the purpose.

Answer to No. 1,192 (*awarded* 10*s.*).—It is assumed that the tank mentioned is iron. Consequently the star should be disconnected from earth to avoid leakage currents.

1. A non-inductive load can be obtained most cheaply by three iron plates of the size shown in Fig. 1,, screwed to wooden cross-pieces, and having one hole ½ in. diameter on each side, as shown at A A, to which to bolt the cable lugs. Fig. 2 shows the tank with the plates in position. Four 10 in. planks are fixed as shown, and the plates are threaded on, being suspended by the wooden cross-piece. The plates should be at least 2 ft. 6 in. from the sides of the tank. To vary the load the plates can be slid along the planks. This can be accomplished by means of a long pole if desired, and this would be quite safe at the voltage stated if the pole were kept dry and the man ordinarily careful. A more elaborate arrangement with cords and pulleys is shown dotted. This is the cheapest possible arrangement, as the plates are practically the only expense. The planks could, of course, be

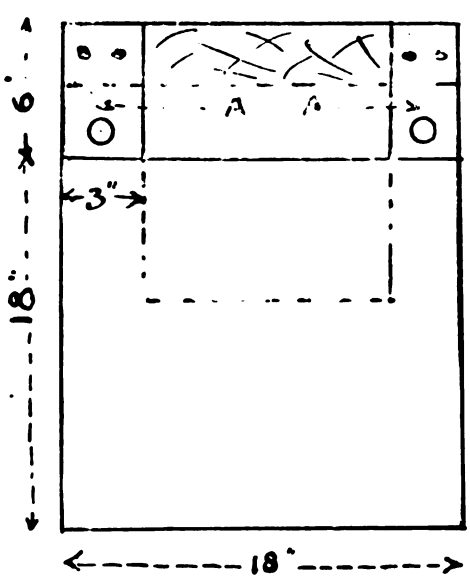

FIG. 1.

borrowed temporarily. The current density on the plate allows of an overload of 50 per cent., and even then comes within the limit of one ampere per square inch, as given by Messrs. R. K. Morcom and D. K. Morris in their paper read before the Institution of Electrical Engineers, and published in the ELECTRICAL ENGINEER of March 27 and April 3, 1908. The distance between the plates will depend largely upon the quality of the water, as the specific resistance of the tap water in different towns varies over a very wide range. Also the temperature of the water will make a very large difference. These details can be found best by experiment on the particular site of the test. It is very probable that if the water is kept nearly cold (say, 80° F.) the plates will have to be brought comparatively close together to obtain the correct full load, and allowing a maximum distance of 4 ft. between them should leave ample margin for obtaining any load desired. A more elaborate apparatus can, of course, be arranged by either putting the plates on rollers or substituting a round iron bar for the cross-piece of timber on the plate and bending the ends of the vertical strips round this. Either would facilitate the moving of the plates along the planks.

2. The question would not seem to imply a desire for an inductive load. If, however, this were desired, the diagram of connections would be as shown in Fig. 3, and three choking coils would be required. Seven plates would also be required, as to connect the choking coils to the tank itself would damage it if the load were kept on for any length of time. In this case the plates could be arranged as shown in Fig. 3. The size of choking coils can be worked out for the desired power factor from the details given in the above-mentioned paper, which deals very

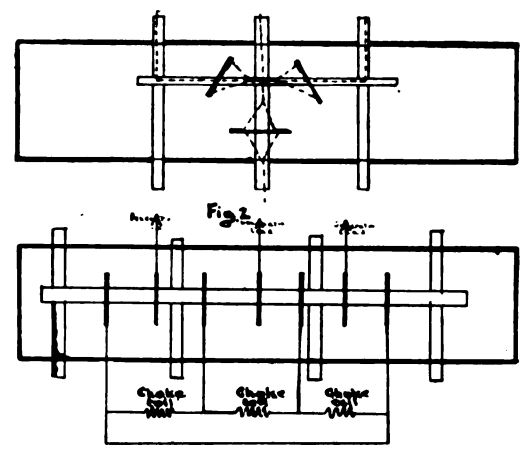

FIG. 3.

fully with the subject. For the two middle plates connected to the choking coils it would be necessary to have a wooden baffle arrangement, consisting of a box about 18 in. high, without top or bottom, which could be raised or lowered to cover part of the plate. These two plates also should be cut as shown dotted in Fig. 1. By this means the power factor could be varied by raising or lowering the baffles and removing or bringing closer the two outside plates; the non-inductive load, of course, being varied by moving the other three plates nearer together or farther apart.—B.

Answer to No. 1,192 (*awarded* 5*s.*).—For the artificial loading of a high tension generator such as the present one, water resistances are the cheapest and most satisfactory apparatus by which to dissipate the required energy. Not only is a high resistance of heavy current-carrying capacity readily obtained by the use of water as the resistor, but difficulties owing to the heating of the resistance element are easily overcome by keeping the water in constant circulation. The provision of a metallic resistance dissipating 500–1,000 kw. at 1,000–2,000 V is a costly proceeding, and the form of the finished resistance is not nearly so convenient as that of a water load. Unless the capital outlay be unduly heavy, the life of the metal resistance strips is very short. Besides, the great advantages of low capital cost and compactness liquid resistances are regulable far more easily and closely than metallic resistors. Having decided to employ a water load, however, the greatest care must be exercised in the choice of a suitable water, since the specific resistance varies enormously with the impurities present. *Pure* water is an insulator, but the highest recorded specific resistance obtained for distilled water is 25 · 10⁶ Ohms. per cubic centimetre; while to obtain a water pure enough to give a specific resistance of only 1,100,000 Ohms. per c.c. demands extraordinary care. Ordinary distilled water varies in specific resistance from 300,000 to 600,000 Ohms. per c.c.; while the condensed steam from an engine, the nearest approach to distilled water that is commercially obtainable in bulk in works, has a specific resistance varying from 50,000 to 100,000 Ohms. per c.c., the latter figure not being difficult to realise. With such variations in the electrical properties of water supposed to be pure and hence standard, it is easy to appreciate the importance of carefully testing any proposed water supply before adopting it for use as an artificial load. The data in Table I. give the characteristic properties of certain waters (as quoted by Morcom and Morris). The relative importance of a given amount of impurity is greater the more dilute the solution to which it is added. For example, the addition of 1 part in 10^8 of NaCl to water originally having a specific resistance of 300,000 Ohms. per c.c. halves the latter value.

TABLE I.—(MORCOM & MORRIS).

Source.	Degree of Hardness.	Mineral Matter in Solution. (parts in 100,000).	Spec. Res. at Ohms. cc.	Spec. Res. at 60° F. Ohms. ft.³	Factor for 70° F. rise.
Distilled (*see* letterpress)	—	—	600000	20000	—
Condensed from engine	—	About 2	66000	2170	—
Birmingham tap water	3·2	6·2	13200	435	50
50% ditto + 50% B'ham Canal	—	—	965	32	—
Birmingham Canal	52	143	435	14	50
Blackburn water	—	—	17000	560	—
Glasgow water	—	—	17500	580	—
West London water	—	—	2800	92	—
Rugby water	—	—	2400	79	—
Victoria St. water (New River)	—	—	250	8¼	—

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This fact is also well illustrated by Fig. 1, which shows that the relationship between the specific resistance and the percentage of impurities present is of hyperbolic nature. The curve is not a rectangular hyperbole as might be expected from theoretical considerations, but can be fitted very closely by a hyperbolic equation involving a higher index than unity. Thus I find that the approximate equation to the experimental curve plotted is $PR^{1\cdot26} = 423{,}100$, the curve represented by this equation being plotted for comparison.

Again, the effect of temperature on the specific resistance of water is very marked, and is, as with most liquids, negative, so that to avoid overloading the generator the water supply must be sufficient to restrict the temperature rise, to say, 70° F. as a maximum limit. The specific resistance will then be about half its value at 60° F., and is mainly a temperature effect, though in some cases it is exaggerated by the water, circulation being reduced (to raise the temperature), so permitting the formation of a more concentrated solution of metallic salts from the electrodes. The law connecting resistance and temperature in the case of water is *not linear* (partly, but not wholly, due to the effect of metallic salts as above), and the percentage fall of resistance with rising temperature is not the same between 20° and 40° C., say, as between 40° and 60°. The fall also depends

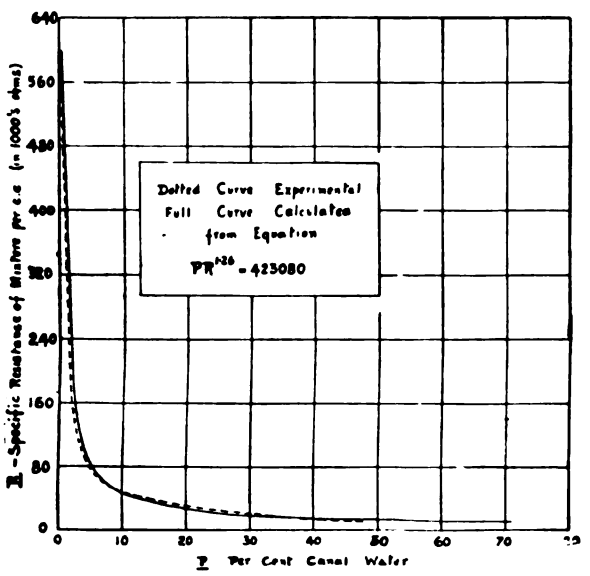

FIG. 1.

on the initial purity of the solution. As 60° F. starting temperature and 70° F. rise during the test are standard conditions, the above 50% drop in resistance is a useful factor to memorise.

Referring, first, to the best type of tank construction and, later, to the size required to dissipate various amounts of energy: Wooden tanks present many advantages, the chief of which is initial cheapness. Where a large amount of testing has to be done, a large permanent metal or brick tank may be justified; but in ordinary cases cheapness is vital, and a very reliable and durable wooden tank can be cheaply built. A natural or artificial pond is convenient in many cases, but is not often available, and less readily gives light loads than do the wooden tanks below. The usual two objections to wooden tanks are leakage and charring, or even firing. These may be respectively avoided by (*a*) using double wall construction as below, thoroughly tarring the wood and caulking all joints; and (*b*) by allowing only a moderate voltage drop per foot of electrolyte. For high voltage work a long, narrow tank is the best shape to employ (for wooden construction), since, with a large mass of water concentrated into a tank of more or less equal dimensions in every direction, it is impossible to obtain a high resistance between electrodes. Where metal tanks are used a central neutral electrode, surrounded by the various phase electrodes, is the usual construction, a long, narrow shape of tank being then impossible unless the metal be insulated from the water (otherwise the bulk of the current would flow *viâ* the metal). Wooden tanks are less dangerous to operate than might be supposed, for though the tank cannot be earthed like metal tanks, yet the overflow water provides a moderate good earth path. Metal tanks are undoubtedly safer in this respect, and may possibly soon be insisted upon by Home Office regulations. The type of construction in Fig. 2 is excellent for H.T. work. One such tank is required per phase, and the size of tank shown is suitable for 200 to 300 kw. at pressures up to 6,000 volts, if it be desired to build a tank sufficient for present requirements only (233 kw. at 2,200 volts), the dimensions might be reduced

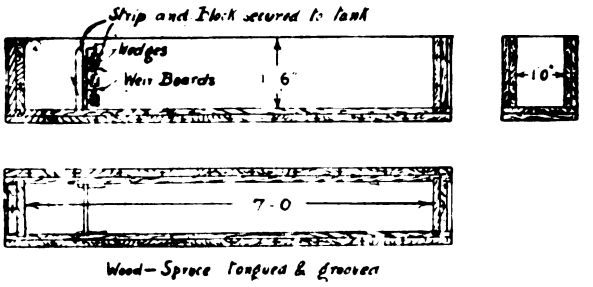

FIG. 2.

to 4′ to 5′ long by 1′ × 1′ section. The timber used is spruce, and the two walls are built up at right angles. No screws must come within ¾″ to 1′ of the inner face of the tank, and the wood is thoroughly tarred and all joints caulked. An adjustable weir, as shown, forms the best means of varying the load, additional control being obtained by sliding the moveable electrodes together or apart as required. Lifting electrodes in and out of the water does not much affect the load when long tanks are used (except when the area of immersed electrode is very small). In metal tanks, however, where the electrodes are of necessity much closer, the extent of their variation gives a powerful control on the load. The use of diaphragms or baffle plates between the electrodes increase the effective resistance by distorting the lines of current flow, as well as by reducing the area at one point of the path. The use of a central pierced baffle plate, whose opening had $\frac{1}{3\cdot5}$ the area of the effective tank section, reduced the current in the ratio 100 : 26·5, *i.e.*, 1 : 0·265. Where baffles are used, they must not stop water circulation unduly, complicate the tank arrangements, or introduce too steep a potential gradient where used (in the latter case, the danger of wood charring will be increased). The inlet pipe should be of rubber for the last 20 ft., as not only are shorts to earth so avoided, but also by leaving no metal in the tank to corrode, and cause charring and firing of the wood, the life of the tank is extended indefinitely. For a similar reason a plain hole outlet discharging into rubber hose is employed. The satisfactory behaviour and life of the tank in service depends wholly on close adherence to the above simple precautions. The electrodes may be of cast iron rod or plate, and should be proportioned so that the current density is not greater than 1 amp. per sq. inch (½ amp. being as after allowance). Above these densities, troubles by excessive bubbling and consequent variations of load, and rapid wasting of the iron (probably by formation of hydronide) set in to a serious extent. The current per phase being 106 amp. per phase in this case, on full load the immersed area of each electrode of each phase should be from 100 to 200 sq. inches (at full load). Assuming 150 sq. in., and taking the immersed depth to be 12″, the width of plate must be 6″ to 7″. The electrodes, whether single plate or 2 or more rods, should be placed symmetrically across the width of the tank. Concentration of the electrodes to one side or other of a narrow tank may raise the effective resistance of the latter by as much as 50%, consequent on the distortion of the lines of current flow. Though this gives an alternative means of varying the current flow, it must be used with caution, since the liability to char the wood is much increased, when the sides form a path between the electrodes almost as short as the shortest available. A safer means of regulation is the screening of the electrodes by insulating shrouding, and in cylindrical metal tanks this shrouding may very conveniently be given the form of an earthenware pipe surrounding the electrode: a considerable increase in net resistance then results. The maximum safe volts drop per foot of such a wooden tank as that of Fig. 2 is about 600 volts if freedom from charring is to be ensured.

The tank capacity required to dissipate a given amount of energy varies greatly with the construction employed, but the manufactor is the efficiency of the circulation provided. Practice in this respect is not yet standardised, as is shown by Table II., giving data of several tanks in present satisfactory service. This table shows that the long, narrow tank is the most efficient form to employ as regards space occupied, while the open pond or large tank is the least efficient. Where the distance between electrodes is variable, the minimum safe gap between them varies from ¾″ to 2″ per 100 volts P.D., the lower allowance being for higher voltages where the total distance is much greater.

TABLE II.—COEFFICIENTS OF DESIGN OF TEST TANKS.

Type.	K.W.	Volts.	Dimensions.	Volume c. ft.	Distance between electrodes at full P.D.	Variation of load possible	k.w. dissipated per c. ft. of tank at full load.	Voltage gradient between electrodes at full load.
Cylindrical Metal Tank..	4000	6500 3 ph.	6′ dia. × 4′	113	7 in.	40–4000 k.w	35.5	6450
Long Wood Tank ..	950	7500 3 ph.	3 of (6′ × 1′ × 6″)	9	5 ft.	40–950 k.w.	105	870
Open Pond	100	1000 1 ph.	15′ × 10′ × 10′	1500	15 ft.	—	0·067	668
Cylindrical Metal Tank..	5500	11000 3 ph.	15′ dia. × 10′	1768	20 in.	—	3·11	3810
Long Wood Tank ..	100	6000 1 ph.	6′ × 1′ × 1′–6″	9	6 ft.	—	33·3	1000
Brick Tank	25	500 1 ph.	6′–9″ × 2′ 6″ × 2′	31·75	6 ft.	—	0·79	83

[Note the much steeper potential gradient in metal than in wooden tanks: permissible because of the absence of the charring danger, and necessary to prevent the current from flowing mainly *viâ* the tank itself.]

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With regard to the amount of water to be passed through the tank per hour per kw. dissipated: If the permissible temperature rise be 70° F. and x lbs. of water be allowed per kw. per hour, then $\frac{1,000}{746} \times \frac{33,000}{778} \times 60 = x \times 70$ B.Th.U., whence the gallons per hour = 4·9 per kw., so that, allowing for cooling by radiation from the tank and so on, 5 galls. per kw. hour is a safe allowance for continuous operation. Where a good supply of town water or fairly clean canal or river water is available, no difficulty will arise as to the cooling of the water heated during the trial, but if a limited supply of condensed water from the engine has to be used, or if a special solution adjusted to correct conductivity has to be employed, the rapid cooling of a limited bulk of water for re-use has to be allowed for. For the latter reason the use of any materials in solution in the water other than those naturally existent therein is to be deprecated. Assuming 25 lbs. steam per kw. hour, the water available from the engine condenser will be 2.5 gallons per kw. hour, as against 5 gallons needed on the above basis, hence the note regarding the re-use of water; if the condensed steam from more than one engine be available, this difficulty may not exist. As a rule it will be convenient to dilute condensed engine steam with, say, 30% canal water (*see* Fig. 1) to obtain a water of 1,000-2,000 Ohms. per c.c. resistivity, this being convenient for most tests: canal water is 500 Ohms. per c.c. on the average.

The use of water-cooled iron resistances run at very high current densities and very short life, and the use of chokers for producing a more or less inductive load are not referred to here by reason of lack of space. For particulars of these, refer to *Journal I.E.E.*, vol. xli., pp. 137-165.—"WREN."

Answer to No. 1,192 (*awarded* 5/-).—For exhausting a load of 700 kw. at 2,200 volts, a tank of the dimensions given by "X" viz., 30 ft. × 7 ft. × 4 ft. is rather on the large side, but it will, nevertheless, be quite suitable. The writer has conducted a few tests on large H.C. machines, and quotes one instance of a two-phase 3,000 kw. 2,100 volt Alternator in which case four tanks each 10 ft. × 3 ft. 6 in. × 3 ft. were used. With these tanks full load was maintained throughout the steam consumption run of 12 hours and 20 % for two hours. The arrangement of plates was similar to that shown on Fig. 1, but was, of course, arranged in four tanks instead of one. For this arrangement nine plates will be required, each like Fig. 2, and made out of sheet iron or steel (Fig. 2). The three H.T. plates will not require the wooden top bar quite so long as the others, since it is fixed, and therefore will not require any overhang for handling when regulating the load. The H.T. plate support should be nailed to the top of the tank, and the support, plate, terminals and cable to same painted red to denote danger. On looking at Fig. 1, it will be noticed that two earthed plates are shown between each H.T. plate. This arrangement allows of a very much more satisfactory varying of the load.

To explain. Suppose only one plate were between the two H.T. plates, then if the load on phase two has to be altered it is done by moving one of the single plates that would be in the positions occupied by the plates 2 and 3 or 4 and 5. Now it can be easily seen that in moving these plates the load on phase one or three will be altered, depending on which plate was moved. Therefore, for every alteration of the load on phase two it will be necessary to readjust the load on either phase one or three. Take the case of two plates as shown. The load on phase two is adjusted by moving either plates 3 or 4, and this does not affect phases one or three, since we have not moved plates 2 and 5. The thick black line shows how the earthed neutral plates should be connected together. Care must be taken in doing this to allow sufficient slack in the cable to permit the plates being moved their full extent. The water arrangement is very simple. If permissible, drill two 3 in. holes in the side of the tank to act as outlets, and fix two 8 in. elbows as shown. If it is not permitted to drill the tank, it will be necessary to fix up two syphons at these points, but this will not be so satisfactory as the former method. It will not be as easy to adjust, and the overflow water will not be taken from the best spot (*i.e.*, the surface), but will be drawn from below, and thereby will allow the scum to collect which would otherwise be drawn off. Care must be taken that the water inlets and outlets are at the same points as the earthed

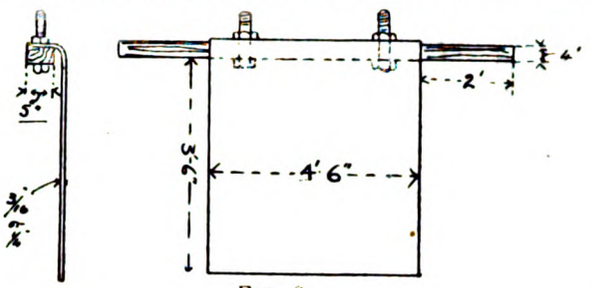

FIG. 2.

plates. For the inlet all that is necessary is a couple of hose pipes over the end of the tank, which must be put deep enough into the tank, the water to enter the bottom of the tank and flow upwards.

From personal experience, I find that clean water is of very little use when used for tank loads similar to the one described above, except in cases where the pressure exceeds 4,000 volts; then, of course, clean water is essential. In the test quoted previously, town water was tried at first, with the result that we could not obtain more than 50 amperes through the tanks. Although the plates were within 2 in. of one another and full voltage across them. Water was then pumped from the canal which ran alongside the power station, and the result was in every way satisfactory. If "X" has no canal water available, I would suggest that he fills a large tank or old barrels with a solution of salt and water, and allow it to syphon into the test tank along with the clean water, which can then be regulated to suit.

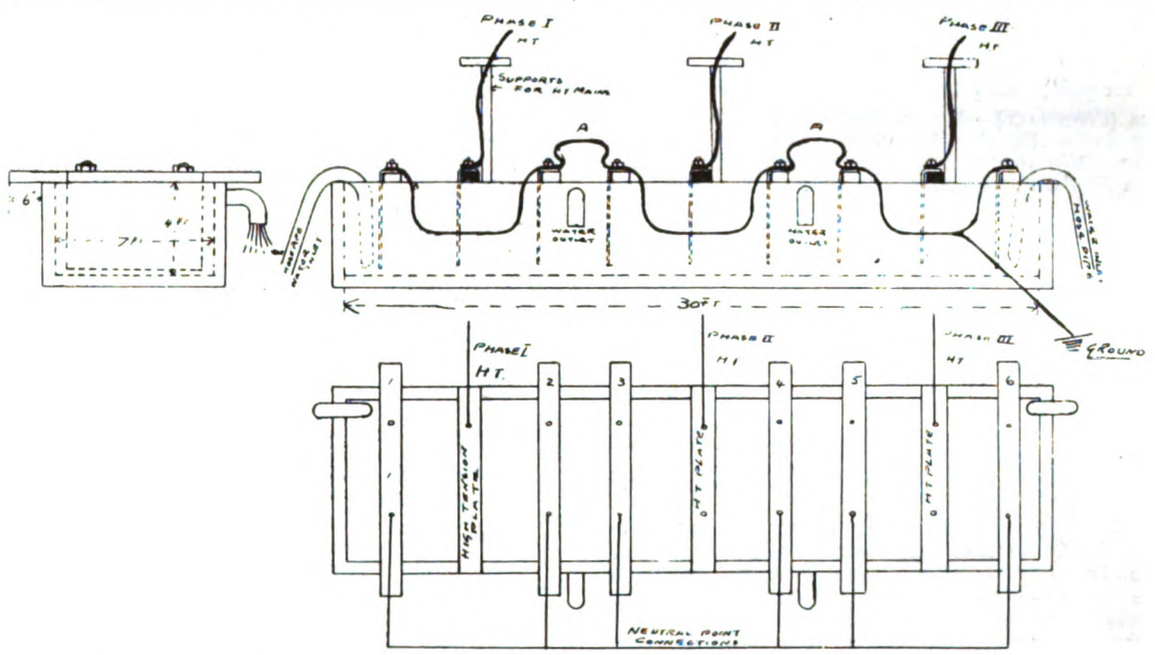

FIG. 1.

It is advisable to insulate the tank from ground, and for this voltage a few 6 in. cubes of hard wood arranged between planks, as shown on Fig. 3, will be quite satisfactory. I should

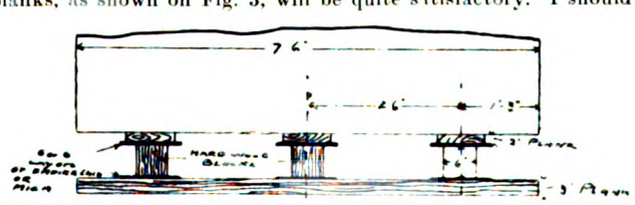

FIG. 3.

place these in 7 equidistant positions under the tank to prevent any tendency for the tank bottom to drop out. If "X" has any good porcelain insulators to take the place of the wood blocks, then so much the better.

With regard to costs, I may say that I had some plates made similar to the ones described, but 1 foot narrower, for 8s. each, so that 10s. ought to cover the cost of the large size required. The hose-piping and cable "X" will, no doubt, have at hand so that adding a few shillings for the wood blocks and empere cloth, the total cost should come out at about £6.

With regard to the actual operation, I would advise that the top of the tank be greased, so as to allow the plates to slide easily.—R. N. N.

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BUSINESS NOTES.

LIGHTING AND GENERAL.

CORDOBA.—The Cordoba Government has fixed the definite capital of the Cordoba Electric Light and Power Company as being £476,683 9s. 10d.

LA PLATA.—The Government has ordered a contract to be drawn up in connection with the concession granted to Mr. A. Limousin for an electric light station in La Plata.

BUENOS AIRES.—The Directors of the United River Plate Telephone Company have, at the request of the public, resolved to construct a line from Buenos Aires to Mar del Plata.

CORDOBA.—The Compañia de Electricidad de Cordoba, which has recently been formed, has purchased the hydraulic station of Molet & Co., which was utilised as a Carbide factory. This will enable the Company to considerably increase its output.

SANTA FE.—The Santa Fe Government has given $40,000 gold to the Santa Fe Municipality for new machinery for their electric light station.

OXFORD.—The Directors of the Oxford Electric Supply Co. have declared an interim dividend at the rate of 5 per cent. per annum on the ordinary shares for the half-year ended June 30th.

KLONDYK GOLDFIELDS.—Lloyd's has taken up an insurance contract in connection with the Klondyk Goldfields for the insurance of about £130,000 worth of electrical machinery and improved mining equipment. An Atlantic liner will transport the plant, which will be transhipped into a specially chartered British steamer after crossing Central America by the Isthmus of Tehuantepec. The insurances include marine perils and land risks until the machinery, which will be landed at Skagway, arrives at the mining city of Dawson.

GLOUCESTER.—The Gloucester Corporation have given notice to the Gloucester Rural District Council of their intention to apply for a Provisional Order to authorise them to supply electricity for public and private use outside of the city limits.

ST. IVES (CORNWALL).—Messrs. Foote and Milne (London) have given notice that they intend to apply to the Board of Trade before December 31st next for a Provisional Order to supply electricity within the Council's area.

HULL.—The Hull City Accountant (Mr. Wm. H. Smith) presented the annual accounts of the Hull Corporation Electric Lighting undertaking. From the summary it appears that the revenue account shows a total of £49,501 8s. 6d., the sales of current amounting to £29,330 2s. 3d., motor power £17,826 16s. 3d., and public lamps £623 15s. The total expenditure is £26,958 1s. 5d., leaving a gross balance of £22,543 7s. 1d. Deducting interest, sinking fund charges, etc., the net balance for the year is £1,165 8s. 5d.

GLOUCESTER.—At the Electricity Committee meeting it was reported that the supply during June was 105,254 units, as compared to 88,759 units at the same period last year, largely, no doubt, owing to the holding of the Royal Show. The cost of coal had dropped from 0.55d. to 0.33d. per unit.

FULHAM.—As the result of experiments the Borough Council proposes to abolish 48 arc lamp posts in Fulham Palace-road, and to substitute 144 metallic filament lamps to be fixed on the tramway poles. The work is estimated to cost £507, but there will be not only better lighting, but a saving of £259 a year, besides the removal of nearly fifty obstructing pillars on the footways. It is also proposed to take out 913 carbon lamps in the town hall, and put in metallic filament lamps. It is estimated that there will be a saving of £233 in the cost of lighting the town hall, or more than the total cost of the conversion of the system.

MIDDLESBOROUGH.—The local Government Board have sanctioned further borrowing powers, amounting to £18,922, for the extension of mains and house services and public lighting.—Mr. Taylor, the engineer, reported that for the June quarter the returns showed a revenue of £3,011—an increase of £380, or 14.5 per cent., compared with the June quarter of last year. Of the increase, £160 was due to the shipyards, which were idle last year. Apart from that, there was an increase of £220.

TROLLHATTEN FALLS (SWEDEN).—An electric iron ore smelting installation is being erected at Trollhatten Falls. It will consist of three furnaces, each of a capacity of 7,500 tons of pig iron per annum.

MAIDSTONE.—The accounts of the electric lighting undertaking for the year ended March 31st, 1909, show an income of £13,307 13s. 2d. and an expenditure of £7,363 14s. 11d., the gross profit transferred being £5,943 18s. 3d. The income was made up principally as follows:—Sale of electricity to private consumers, £7,279 5s. 1d.; public lamps, £2,578 10s.; light railways, £3,034 11s. These three items made a total of £12,892 6s. 1d., reduced to £12,757 1s. 7d. by allowances to consumers and bad debts. By meter rents £205 3s. was received and by sale of lamps and sundry work done for Corporation departments £236 6s. 2d. On the expenditure side the principal items were:—Generation of electricity, £4,197 8s. 11d.; distribution of electricity, £208 5s.; public lamps, £931 5s. 9d.; rates and taxes, £277 2s. 2d.; management expenses, £1,083 0s. 10d.; miscellaneous, £381 16s. 7d. The net revenue account showed on the income side the amount of gross profit transferred, £5,943 18s. 3d., and the expenditure was as follows:—Interest on bank overdraft, £430 7s. 7d.; interest on loans, including accrued proportion to date and income tax, £1814 3s. 5d.; repayment of loans, including accrued proportion to date, £2,626 9s.; net profit transferred, £1,072 18s. 3d. The profit appropriation account showed a total of £3,527 17s. 7d., made up of the net profit on the year and a balance of £2,454 19s. 4d. brought forward. The capital account showed a total expenditure of £78,779 6s. 10d., as compared with £71,112 0s. 11d. to March 31st, 1908.

WALSALL.—Extension of the electricity supply undertaking is to be undertaken at a cost of £35,000.

SEGHILL.—The Urban District Council propose adopting a scheme for the supply of electricity, for lighting and power purposes, within their area.

FRINTON.—The Frinton-on-Sea Electric Light and Power Co., Ltd., have added to their power station in St. Mary's-road, and installed an additional 150-h.p. vertical driving engine, driven by suction gas derived from the plant adjacent. It was supplied by Messrs. Hindley and Sons, of Bouston, Dorset. Additional cables have also been laid to enable the Company to split Frinton up into three districts. The building operations have been carried out by Mr. T. W. Wash, of Frinton-on-Sea, and the installation by the Electrical Company of London.

LEAMINGTON.—The Midland Electric Light and Power Co. have commissioned the "D.P." Battery Co., Ltd., of Bakewell, to instal a storage battery and maintain it for ten years.

BASLE (SWITZERLAND).—340,000 francs has been voted for the extension of the town electrical works.

ST. GALLEN (SWITZERLAND).—The Cantonal authorities will spend 2,600,000 francs in erecting a central electrical station for the supply of the Canton.

TORONTO.—The Ontario Government's Hydro-Electric Power Commission has accepted tenders for the erection of the transformer stations at Niagara and Dundas, both to be completed by December 1st, 1909. The Commission is calling for tenders for all the local transformer stations, and the Government anticipates closing the contracts for them before the end of the month. A rumour is rife that Mr. William Mackenzie is likely to acquire a controlling interest in the Toronto Electric Light Co. He is offering for the stock fifty-five dollars in cash and a hundred dollars' stock in one of his railway ventures. *The Standard of Empire* local correspondent says: "If Messrs. Mackenzie and Mann secure the Lighting Company they will have within their hands the making of one of the strongest electric combines in the world. They already control the Toronto and Niagara Power Co. and the Electrical Development Co., which develop electric energy at Niagara Falls and transmit it to this city. They manage the Toronto Railway Co., which is the Electrical Development Co.'s chief customer. In the Electric Light Co. they will possess the local distributing agency for the entire city.

EPSOM.—The income from public lighting during the quarter ending June 30th was £534, as against £527 for the corresponding period last year, and the income from private lighting £494, as compared with £409. The receipts for the quarter totalled £1,048 18s. 8d., as compared with £958 7s. 8d. for the corresponding period last year. There was a surplus for the quarter ended June of £464 13s. 4d., as compared with £408 12s. for the corresponding quarter.

A considerable economy will be effected in the units unaccounted for, there having been during the quarter a reduction of not less than 2,328, as compared with the corresponding quarter the previous year. A year ago the number of units unaccounted for was 9·38 per cent. of the units generated; now it was 4·37 per cent.

EPSOM.—Mr. H. R. Hooper, Local Government Board Inspector, in closing his inquiry into the application of the Urban District Council to borrow £1,500 for electric lighting purposes, said: "Open your suspense account from the 1st of April, 1909, with the £1,500 obtained, and then you would be clear and cleaned up, and your position will be more simple. Don't spend more money than you can possibly help, you have spent too much, that is the trouble." He pointed out that capital had been invested to the extent of £40,000, and there was practically a deficit of £10,000.

HULL.—It was decided to offer Hessle Council £200 for taking over their Provisional order for the electric lighting of Hessle. Eight arc lamps are to be bought for lighting Victoria-square.

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WALTON-ON-NAZE.—The Bill confirming a Provisional Order for electric lighting passed the examiners, and was sent for second reading in the House of Commons. It has gone through the House of Lords.

ILFORD.—The electricity undertaking has made a small profit as a result of the past year's working. At the commencement of the year there was a deficit approaching £400, and this has been wiped off, and an additional sum of £637 paid in respect to loans, without any reduction in the reserve fund, which stands at £6,398, while the repayments of loans up to date represent the large sum of £25,000.

DUBLIN.—Mr. P. C. Cowan, Chief Engineering Inspector of the Local Government Board for Ireland, concluded his inquiry into the application for a loan of £3,800 for the electric installation at the Richmond Asylum.

BARKING.—The Urban District Council will apply to the Local Government Board for sanction to borrow £2,500 on electric lighting account, made up as follows:—Excess expenditure to March 31st, 1909, on loan account, £745; new plant, £750; transformers, £250; mains extensions, £250; house services, £200; public lighting extensions, £200; meters, £105. A sub-committee, consisting of Messrs. R. H. Carter, Reidie, Smith, and Young, was appointed to inquire into and report upon the working and efficiency of the boilers at the electricity works.

ECCLES.—The accounts for the year ending March 31st show an expenditure of £5,237 12s. 7d., and an income of £8,737 17s. The sale of 267,585 units to general consumers brought in £3,750, of 685,774 units for tramway traction £3,580, and of 96,000 units for public lighting £971.

DOVER.—As regards Private Arc Lighting, the electrical engineer suggests that a fixed charge should be made to cover the capital charges as follows:—two lamps, £2 10s. (cost per lamp); six lamps, £1 12s. 6d. (cost per lamp), and in addition, the charge for the current consumed to be at the rate of 2½d. per unit.

DARLINGTON.—According to Mr. J. W. Armitage, the borough accountant, the Darlington electric lighting undertaking has a capital of £70,041, and a revenue of £11,457, which yielded a gross profit equal to 10·4 per cent. on the capital employed. The works have now been in operation a little over eight years, and in each of the eight complete years there has been a profit after paying all loan charges. The present year, however, is the first that the department has felt in a position to transfer any of its surplus profit in aid of rates (a sum of £2,000 has been voted for the coming year). One-fifth of the debt has been paid off, and, in addition to the provision for redemption of the debt, there are reserves for depreciation, etc., amounting to £7,066, which is equivalent to redeeming almost one-third of the capital expenditure within eight years. Further, a sum of £1,040 has been expended out of profits on capital works.

ST. PANCRAS.—The gross income for the year amounts to £75,358 14s. 9d., a decrease of £2,243 12s. 11d. as compared with the previous year, and an increase of £1,187 4s. 9d. in comparison with two years ago. After meeting all working expenses and the repayment of loans and payment of interest charges, a net profit remains of £6,925 18s. 10d. The net profit compares with £9,454 7s. 3d. for the previous year, and £6,495 0s. 4d. at March 31st, 1907. The latter year, however had borne the cost of the Westlake action, amounting to £3,585 The above net profit of £6,925 18s. 10d. to which the sum of £200 18s. 4d., the difference in the provision made for outstanding charges, has been added, makes the balance standing to credit in the net revenue account £7,126 17s. 2d.

TRACTION.

EDINBURGH.—The inquiry under the Private Legislation Procedure (Scotland) Bill into the Colinton Tramways Order was continued in Edinburgh, Sir J. Dewar, M.P., presiding. In the Order the promoters sought powers to carry an electric tramway from the terminus of the Edinburgh system, past the site of the new cavalry barracks at Redford to Colinton, and there was an agreement with the War Office for the contractors for the building of the barracks to have the use of the track. It was opposed by the city of Edinburgh and the County Council of Mid-Lothian, but the preamble was found proved, subject to the adjustment of some clauses.

FIFESHIRE.—A scheme has been prepared for the amalgamation of the various interests hitherto existing in the county of Fife for the supply of electric power. These negotiations have resulted in the formation of a company, entitled the Fife Tramway, Light, and Power Company, which will carry out the various schemes of electrical development in the district. A tramway is to be constructed from Dunfermline, covering a route of 9½ miles, and in connexion with this it is proposed to link up in the near future with the new naval base of Rosyth.

VANCOUVER, B. C.—It is officially announced that the British Columbia Electric Railway Co. will start work at once on extensions to its lines east of Vancouver, aggregating nearly 15 miles in length. The programme outlined includes the construction of an initial line in Burnaby, about six miles in length. The company has awarded a contract to Boyd, Short & Craig for preparing the right-of-way for the line on Hastings-street, east from Campbell-avenue, to the eastern boundary of Hastings townsite. This extension calls for about seven miles of new track.

LONDON.—At the last meeting of the L.C.C. before the autumn recess, the Highways Committee brought up their scheme for new tramways, for which Parliamentary authority is to be sought in the 1910 session. About 24 miles of single track are to be provided. With the exception of a short distance from Putney Bridge to Wandsworth and Brixton-road to Herne-hill Station, the undertaking relates to North London. The estimated capital cost of construction and equipment of the tramways is £417,080, to which must be added in respect of cars, car-sheds and sub-stations £144,920, making a total estimated cost of £562,000, and the estimated cost of the street widenings is £294,910 gross, or £279,860 net, making a total of £856,910 gross, or £841,860 net.

BRIGHTON.—The adoption of the Report of the Lighting Committee, recommending the Council to fix the charge for electricity supplied to the Tramways Department for traction purposes during the current financial year at 1.4d. per unit, was moved by Councillor German, and carried.

LONDON, E.—At a meeting of the East London Railway Co., Lord Claud Hamilton referred to the prospects of the electrification of the line. He had often, he said, referred to the great difficulties which existed in regard to the electrification of their line. There had been delay in the completion of the South London section of the Brighton Railway. It was difficult to say with certainty when that line would be opened, and until it was opened and in regular working it was impossible for the directors of the East London Railway to form an opinion as to the comparative cost of the installation and working of the over-head and third-rail systems. Until this was known he was afraid they could not move any further in the way of electrification.

BACUP.—The Bacup Electric Tramways has now been opened. This completes the electrification of the Rossendale Valley tramways, the contracts for the Bacup line amounting to £36,000, and for the Rawtenstall sections £145,000. A mayoral banquet followed. Rawtenstall Corporation will work the Bacup tramways for 30 years, taking the profits, and then handing the line over free as a going concern to the Bacup Corporation.

LPEZIA (Italy).—Mr. A. J. Ogston, British Vice-Consul, has supplied particulars of electric discharging apparatus now in process of erection at that port:—The installation consists of four pieces of apparatus on the pier for lifting and transporting coal, and two electric cranes on the north wharf with grain-discharging apparatus. The coal-discharging apparatus will be fitted to take coal or ore from the holds of ships or barges by means of automatic buckets, raise it, transport it horizontally, and discharge it. The apparatus will be capable of unloading on to the wharf or into wagons not less than 2,000 tons of coal or ore in a day of 10 hours' effective work. The normal lifting power of each grain-discharging crane will be 1,500 kilos. (about 3,300 lbs.). Each discharging apparatus will be able to handle 36 tons an hour. Mr. Ogston adds that the use of this apparatus will probably serve to abolish the long delays at present suffered, owing to lack of accommodation, by boats discharging at Spezia.

ILKESTON.—The receipts of the tramways and electricity department for the week ending July 28th were £135, as compared with £155 for the same period last year. The receipts for the past 17 weeks were £2,285, as compared with £2,477 last year.

NEW CATALOGUES AND PRICE LISTS.

Messrs. Burgoyne, Burbidges & Co. have just issued their new price list of chemicals and reagents. It is a well got-up pamphlet, handy for reference.

The latest circular of the Sun Electrical Co., Ltd., refers to new patterns of iron-clad distribution switches and fuse gears and pressed brass sucating sockets. It is fully illustrated.

From Messrs. Siemens Brother Dynamo Works, Ltd., of Tyssen Street, Dalston, N., we have received their latest Catalogue of carbon filament lamps. This list is very complete, and illustrates many types of lamps as stocked by the firm. Prices have, we notice, been reduced throughout. The reductions in prices of radiator lamps, of lamp lacquers and obscuring varnishes will be particularly welcome. We understand that Messrs. Siemens Brothers are willing to send quantities of this list, printed with the name and address of the electrical contractor, free on receipt of application. The same branch also sends us a copy of their latest "Tantalum" arc list 29-B, illustrating numerous new designs of the patent wireless cluster fittings. These should be of particular interest to shopkeepers.

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FATAL ACCIDENT AT MANCHESTER ELECTRICITY WORKS.

The Manchester Coroner, on the 26th ult., held an inquest on John Davies, aged 35, of Peel-street, Pendleton, who was electrocuted at the Stuart-street generating station of the Manchester Corporation the previous Thursday.

It was stated that Davies had been employed at the station for four years as a slinger. On Thursday he and a man named Wall were moving two transformers from one end of the high tension department to the other. Davies used a plank, and for some reason or other got inside the guard rail near the electrical apparatus. Suddenly there was a flash, and Wall saw his companion falling to the ground. Artificial respiration was tried for some time, but without avail, for the man was dead when a doctor arrived.

Wall told the Coroner that Davies got inside the guard rail to remove each transformer.

The Coroner: Why did he do so when he knew it was dangerous?—I can only suggest he did so because he thought it would be the easiest way to get his plank underneath the transformer for the purpose of prising it. It was possible for him to prise the other end of the transformer.

The Coroner: Was there any necessity at all for him getting inside the guard rail?—I could not say there was. Davies was a practical man, and it was left to him. I was only his assistant.

Mr. H. C. Lamb, the acting resident engineer, who described the work at the station, said there was a protecting rail, and the men knew it was dangerous to get underneath it.

The Coroner: When the "studs" are alive are instructions given to the men not to go inside the guard rail?—No one is supposed to go inside there at any time.

The Coroner: Would not a more efficient barrier than a handrail be better?—There is at present just as much protection as it is usual to put in such places.

Mr. Pearce, chief electrical engineer to the Manchester Corporation, said there was no more modern system of electrical equipment or protection to it than that in Manchester.

Mr. Brocklehurst (who appeared for the Corporation): It has been suggested there might be a glass screen or perforated screen put in front of the spark gaps. What do you think to that?

Mr. Pearce said that a flash would blow a glass screen into "smithereens." By putting a rail three or four feet away they had put reasonable and ample protection. The workmen did not pass to and from the high-tension department. It is in a special area set apart, in the words of the Home Office, for the location of high-tension apparatus. They had an instance some time ago of a porcelain guard being blown the whole length of the engine-room. If there was to be any protection it should be mechanical.

The Coroner: Can you account for this accident at all?

Mr. Pearce: I cannot offer any reasonable explanation. I can only assume that in turning round the man's hand came into contact with the live stud.

Mr. Brocklehurst, on behalf of the Corporation, expressed sympathy with the relatives of Davies, and said the Corporation would do what they could in the way of compensation to relieve the burden.

The Coroner said it was perfectly clear Davies had neglected the instructions given and that he was carrying out the work in a dangerous manner. He was doing what he ought not to have done and what his own common sense ought to have told him was the wrong thing to do.

The jury returned a verdict of accidental death.

CONTRACTS OPEN.

STOCKPORT.—Corporation Tramways Committee. Sale of 120 tons old tramway rails, points, crossings, etc. August 12. Borough Surveyor.

MADRID.—Public Works Department. Construction and exploitation of electric tramway between Monachil-bridge and Gabia Grande. Dep., 3,589 pesetas. August 26. Ministerio di Fomento, Direccion de Obras Publicas.

CONSTANTINOPLE. — Constantinople Horse Tramway Co. Doubling of line from Galata to Beschiktasch.

BERNE.—Electric Mountain Railway. Est., £26,000. F. Leder.

WESTPHALIA.—Narrow gauge railway from Coesfold *via* Senden to Ascheberg. Buergermeister, Muenster i.W.

WIESBADEN.—Provincial Government. Tramway from Quierschied to Eppelborn. Est., £50,000.

MANNHIM.—Municipality Suburban line to Schriesheim. Est., £97,000. Rathaus.

OFFENBACH-A.-M.—Municipality. Tramways, etc. Est., £755,000.

SALFORD.—Corporation.—Sale of a 120 kw. direct coupled steam dynamo. August 9. Borough Electrical Engineer, Frederick-road, Pendleton.

SHEFFIELD.—City Education Committee.—Electric lighting of Training College Hall. August 10. Spec., Gibbs & Flockton, 15, St. James-row.

CHATELLERAULT.—Ammunition factory cables and copper and bronze wire, electric apparatus, dynamo brushes, lead pipes, iron and steel construction material. August 11. Manufacture nationale d'armes.

BACHMUT.—Russia.—Provincial Government of Jekaterinoslaw.—Public electric lighting. September 13. Gorods-Kaja Uprawa.

BRUSSELS.—Roads and Bridges Department.—Electric equipment of new sub-station at Ostend. October 8. Spec. No. 103, 4d. Plans, 3s. 10d. 15, Rue des Augustins.

SYDNEY.—Branching metallic multiple magneto switchboard, at the Petersham Telephone Exchange. Dep., 5 per cent. on amount of tender up to £1,000, and 2½ per cent. on the amount over that sum. November 10. Spec., No. 268 (L), Captain Muirhead Collins, C.M.G., 72, Victoria-street, Westminster, S.W.

BRUSSELS.—Ixelles Municipality.—Installation and working for 15 to 30 years of electric light and power supply. Sécrétaire Communal Ixell.

ENNISCORTHY.—District Asylum.—Lighting. Spec., £1. Clerk.

CONSTANTINOPLE.—Admiralty.—Electrical apparatus for the navy. Part. Ministere de la Marine.

RESULTS OF TENDERS.

NANKING.—The Eastern Trading Co., Ltd., in competition with 26 firms, has been successful in obtaining the concession to light the city of Nanking with electricity, from the Viceroy, Tuan Fang. All the machinery is to be British, and will be supplied by, among others, Messrs. Babcock & Wilcox, Ltd., and Messrs. Belliss & Morcom, Ltd.

MAIDSTONE.—The Electricity Committee recommended that a tender for the supply of 2,000 "Osram" lamps at 2s. 10½d. each be accepted. The acceptance of the tender of the Western Electric Co. for the supply of feeder cable to Mill-street was also recommended. The following was a list of tenders received: The Union Electric Co., £317 11s.; the Western Electric Co., £397; Callender Cable Co., £108 18s. 2d.; Henleys, Ltd., £412; Johnson & Phillips, Ltd., £412; the B.I.W. Co., £412 10s. 6d.; W. T. Glover & Co., £414 17s.; the Electrical Co., £424 10s. 9d. The recommendations of the committee were confirmed, Alderman Vaughan stating, in reply to Mr. Betts, that application was made to the various firms named to quote prices for the feeder cable, and that the reason why the lowest tender was not accepted was the engineer's preference for the sample submitted by the Western Electric Co.

PONTE NOSSA—CLUSONE (ITALY).—The Italian Government has granted to the Commune of Clusone and to Signor P. Fogaccia a concession for the construction and exploiting an electric railway between Ponte Nossa and Clusone.

DOVER.—Fuel. The Vice-Chairman of the Electricity Committee stated that he and the electrical engineer had considered these tenders after testing the various samples obtained, and they recommended that the following be accepted:—South Kirby, Featherstone and Hemsworth Collieries, Ltd., Pontefract, pea slack, 11s. 7½d. per ton; Ynisarwed Collieries, Ltd., Swansea, small Welsh, 12s. 11d. per ton. This was agreed to.

PATENTS.

Automatic Switches of Electric Transformers.

13185—1908. L. SUNDERLAND and G. C. PILLINGER, 39, Victoria Street, London, S.W. This is an improved device for operating automatic switches used with electric transformers. The invention provides means for automatically switching off the primary current of transformers when there is no load on the secondary, thus obviating the "no load" losses; and reversely. Means are also provided for switching the primary current on again automatically the moment any load is thrown on the secondary.

Electromagnetic Switch.

13327—1908. R. F. VENNER, R. C. GRIESBACH, and D. K. MORRIS, Westminster, London. The object is to provide the main switch arm of automatic switches with a supplemental spring or gravity switch arm which makes contact with it to allow the current to pass through the coils of the operating magnet or solenoid for closing the switch. The supplemental switch arm is maintained in contact with the main switch arm, and the current allowed to pass through the operating coil for just the period necessary to effectually close the switch.

Rotors of Dynamo Electric Machines.

13501—1908. THE LANCASHIRE DYNAMO & MOTOR CO., and R. S. MCLEOD, Manchester. The object is to improve the mode of attachment of the end rings used to connect together the conductors of short circuited rotors employed in induction motors. The end rings are made with a central concentric opening considerably larger in diameter than the rotor shaft. A number of slots are formed in the outer portion of each ring so as to leave a number of deep radially disposed teeth of uniform width corresponding in number with the rotor bars which have to be connected together. Each of these teeth is twisted near the root, so that the plane of the tooth is at right angles to the plane of the ring. These teeth fit into saw cuts on the conductor bars of the rotor. The edges of the teeth abut together, and serve to space the rings apart by a distance equal to the width of the teeth. The teeth of the rings thus assembled form radially disposed plane surfaces of considerable length.

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Magnetic Brakes for Railway Vehicles.

13781.—1908. O. H. Baldwin, 2, Norfolk Street, Strand, London. One of the poles of the electro-magnetic track brake shoe is provided with a depending flange which enters the groove in the rail when the brake is applied. In this way the total width of the two poles may be made g eater than the width of the tread of the rail, so as to permit of a greater space being provided between the two poles without reducing the area of the polar surfaces which come in contact with the rail.

Electric Meters.

13788.—1908. The British Thomson Houston Co., Ltd., and A. G. Martin, Cannon Street, E.C. This is an improved in the type of meters in which a conductor in the form of an inverted cup immersed in mercury and placed within a magnetic field rotates under the action of current passed through the conductor. The walls of the field gap are roughened by mixing Frerch chalk or other pulverised material with the lacquer used for insulating the walls. This treatment increases the sensitiveness and accuracy of the meter.

Switches for supplying Electric Power.

14773.—1908. G. Cooper and F. C. Sharp, Moseley, near Birmingham. The switches are so arranged that while they can be put in action by a key in the usual manner, the contact will be broken unless a pre-determined amount of power passes through the circuit. The object is to protect suppliers from having power taken for lighting purposes through the power meter by a consumer.

Recording Current Leakage in Circuits.

17161.—1908. Ashington Coal Co., and T. McKie, Newcastle-on-Tyne. Each circuit is provided with means for returning any leakage current to the generator by a wire, water pipes or armouring of cable. This current flows through a solenoid attached to the main switch in the circuit and actuates a drop weight which when released falls on a trigger and throws the switch open. The leakage current also actuates a tell-tale on each leakage return. The leakage is also indicated at the power station, whereby the attendant can note the circuit in which the leakage occurs.

Direct Current Dynamo Electric Machinery.

21938.—1908. A. H. Midgley and C. A. Vandervell, Warple Way, Acton, W. The armature is wound in such a way that the voltage power in a dynamo and the speed of rotation in a motor can be varied by moving the brushes round the commutator relative to the field without any sparking taking place at the brushes. Chord winding is used for the armature in which the angle subtended by each coil is a third of the angle of the circumference of the armature divided by the number of pairs of poles in order to produce sparkless commutation.

Direct Current Dynamo Electric Machinery.

21936.—1908. A. H. Midgley and C. A. Vandervell, Warple Way, Acton, W. The central armature and an annular armature are mounted upon a shaft. Between the armatures is an annular space in which are arranged the field magnets. By this means the single magnet system suffices for the drum and the ring armatures.

Electric Planing Machine.

23908.—1908. Vickers, Son & Maxim, and A. D. Williamson, Sheffield. The machine has a combined reversing and starting switch controlled by a master switch that receives its movement from the reciprocating table of the planing machine. The combined reversing and starting switch has an oscillatory contact arm which, under the influence of spring pressure, assumes an intermediate position for short circuiting the armature through the starting resistance, and moves from its intermediate position in alternately opposite directions for controlling the series field windings and the direction of current in the armature.

Armature Windings.

3831.—1909. N. W. Storer, Pittsburg, U.S.A. A resistance conductor is provided between the armature winding and commutator segments of the dynamo. The conductor has portions of reduced cross sectional area provided with a copper coating applied by an electro-plating process, by which means the current carrying capacity is greatly increased.

Electric Ignition Gear.

6105.—1909. J. G. Hay, Blackhall Castle, Banchory, N.B. A casing provided with one or more contacts that can be connected up in the ignition circuits is so arranged that when the cover of the box and the driver's licence ticket are removed the circuits are broken. By this means unauthorised persons are prevented from using the vehicle, and, further, the driver is compelled always to carry his licence.

Electric Motor Generator Sets.

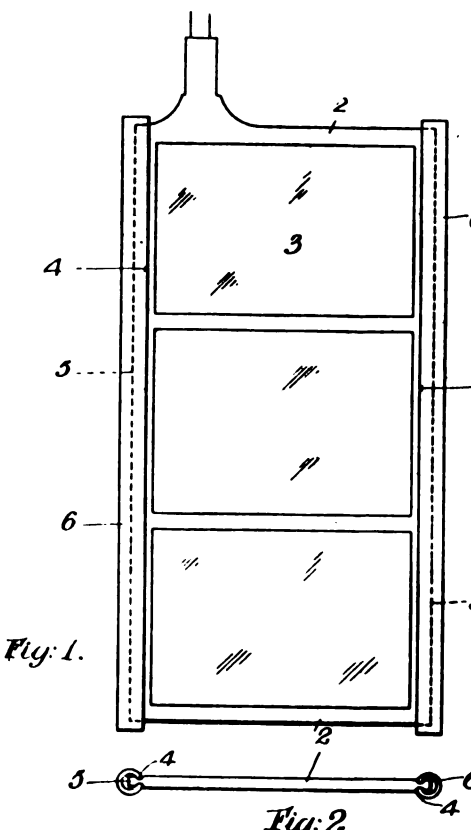
5119.—1909. General Electric Co., Schenectady, U.S.A. The armatures of the motor and generator are connected in series across a constant potential supply circuit. The generator has one set of brushes short circuiting the armature on a line displaced 90° from the line of field magnetism, and a second set of brushes through which the armature is connected in circuit displaced 90° from the first set, and a load circuit of variable resistance connected across the generator armature.

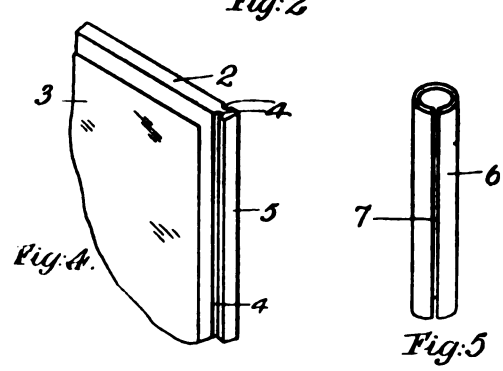
Single Phase Alternating Electric Current Meters.

28271.—1908. H. Aron Elektricitatszahlerfabrik, Charlottenburg. The series coil of the meter is wound with two divided windings, the one taking the current for motive power, and the other, which has only one-third of the number of windings of the first-named winding, taking the current for lighting. Under these conditions, as the velocity ratio of the meter counting mechanism is such that it will record triple the amount of energy passing through the meter, the latter will indicate correctly, with one counting mecha ism, the amount of current consumed for both motive power and lighting.

Accumulators.

15388.—1908. Van Radenz & Co. and M. Metz, Coventry. The principal object is to improve the method of separating and insulating the plates or electrodes. Figs. 1, 2 and 3 are front, plan and edge views of a battery plate with the present invention applied, and Figs. 4 and 5 are enlarged detailed views of the edge of the plate and of one form of strip. The frame 2 on one or both sides of the plate 3 is formed with grooves 4 parallel to near its vertical edges 5. The insulating and acid resisting material is applied to the plates in the form of tubes 6 of vulcanite. These tubes are split longitudinally at 7, Fig. 5, the width of the split being slightly less than the width of the grooves





4 in the plate so as to make a snug sliding fit. The tubes are fitted to the edges of the plate by sliding them on in a longitudinal direction, the edges of the material of the tube at the split 7 engaging the grooves 4 on each side of the plates, as will be readily understood from Fig. 2. By making the width of the splits in the tubes 6 slightly less than that of the grooves 4, the inherent elasticity of the material of the tubes is found sufficient to retain the latter firmly in position on the plates without the aid of other fixing means. The diameter of the tubes 6 is, as shown in Fig. 2, greater than the thickness of the plates 3, so that when two plates fitted with the present invention are placed parallel to and against each other the tubes of insulating material on the edges of same prevent contact taking place between the plates. An important feature

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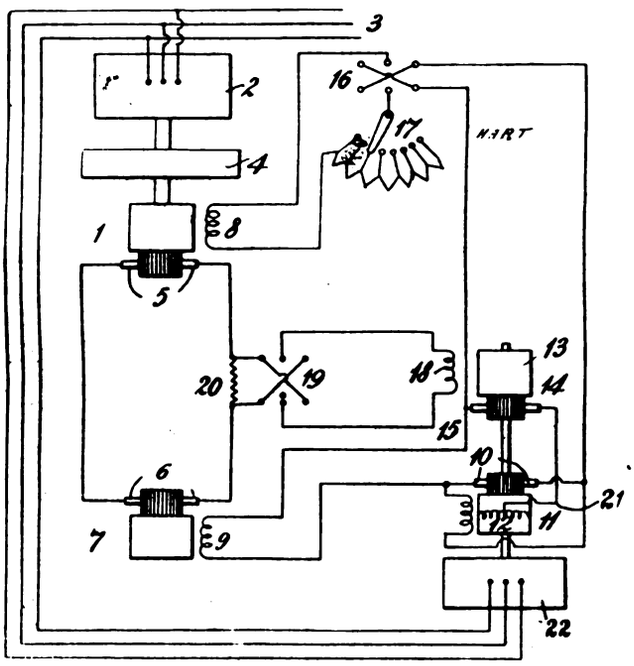
of the present invention is that the tubes of insulating material also at the same time serve to support and hold the plates 3 rigid, and is particularly advantageous in the case of large thin plates which easily bend and buckle owing to their being unable to properly support their own weight. Although the tubes 6 are shown as applied only to the vertical edges 5 of the plates, they may if necessary be applied to the upper and lower edges.

Control of Electric Motors.

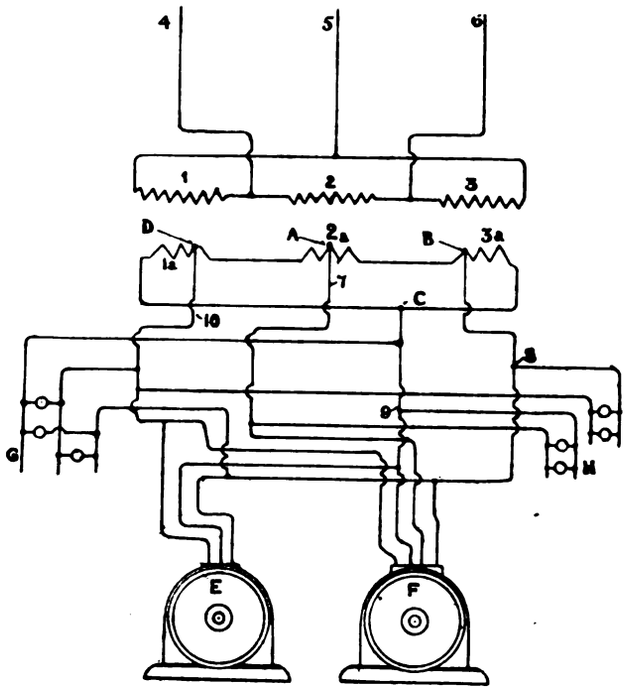
13520.—1908. M. HARTENHEIM, Hale, Cheshire. In control systems for electric motors, and in particular those systems in which the speed and direction of rotation of the motor are controlled by varying the field of the generator, it is desirable to reduce the excitation of the generator and to increase the excitation of the motor when the load on the motor is increased so as to prevent an abnormal increase in the power given out by the generator. The diagram shows an improved control system. The inventor's specification describes several modifications. A direct current generator is indicated at 1 as driven by a three-phase induction motor 2, connected to a supply circuit 3, and provided with a fly-wheel 4. The brushes 5 of the generator 1 are connected to the brushes 6 of a direct current motor 7 operating the intermittent load. The field winding 8 of the generator 1 and the field winding 9 of the motor 7 are connected in series across the brushes 10 of a three-wire exciter 11, driven by a motor 22, the third terminal 21 of the exciter 11 being connected in series with the armature 13 of an additional exciter 14 to the junction 15 of the field windings 8 and 9. A reversing switch 16 and a rheostat 17 are also connected in series with the field winding 8. The field winding 18 of the additional exciter 14 is connected through a reversing switch 19 to the terminals of a resistance 20 connected in one of the conductors connecting



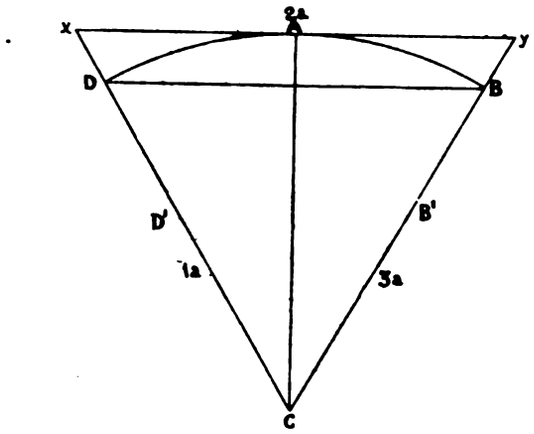
the brushes 5 and 6 of the generator 1 and the motor 7 respectively. The operation of the system is as follows:—The voltage generated by the additional exciter 14 connected in the third wire of the three-wire exciter 11 causes an increase in the current traversing the field winding 9 of the motor and a decrease in the current traversing the field winding 8 of the generator which is proportional to the load on the motor 7, since the excitation of this additional exciter is derived from the terminals of the resistance 20. The reversing switch 16 enables a reversal of the direction of rotation of the motor 7 to be effected, the rheostat 17 providing a manual adjustment for the excitation of the generator 1. The reversing switch 19 is provided so as to enable the voltage generated by the additional exciter 14 to always cause an increase in the current traversing the field winding 9 irrespective of the direction of rotation of the motor 7. The reversing switch 19 can evidently be arranged to be operated by the movement of the lever operating the reversing switch 16. The third terminal of the three-wire exciter 11 may be connected either to the middle point of the armature winding of the exciter as shown, or may be connected to an auxiliary set of brushes located in the neutral plane of the machine.

Transformation of Electric Currents.

15522.—1908. H. TAYLOR, Burnley. The object is to meet a problem which frequently arises in the distribution of electric energy by means of polyphase currents. It frequently happens that two-phase and three-phase apparatus are found together upon the same system, as for example where two previously independent systems of distribution are consolidated, or where an installation of three-phase apparatus is changed from a three-phase to a two-phase system of supply or the reverse. In such cases, according to practice as hitherto followed, one of two courses must be taken: Either there must be two sets of distribution wires, one for three-phase and the other for two-phase currents, or else the one general set of distribution wires for one system, and a special transformer at every point where there is apparatus adapted for the other system, to form a special secondary distribution system. The inventor deriver both two-phase and three-phase currents from a single set of four distribution wires, from which either two-phase or three-phase currents may be tapped as desired; and, further, according to the most improved form of carrying out the invention, the phases in each system are evenly balanced, and the drawing of current of one kind from the system cannot unbalance it with respect to currents of the other kind. Fig. 1 is a diagram of a scheme of the system of connections, and Fig. 2 is a vector diagram illustrating the phase relations geometrically. The inventor claims:—1. A composite polyphase system of distribution comprising a set of three inductive coils such as 1^a, 2^a and 3^a electrically energised with three-phase electro-motive forces, and a set of four taps for distributing leads, such as A B C and D connected thereto with mutual electro-motive forces between the taps B C and D forming



—FIG-1—



—FIG-2—

a three-phase system, the electro-motive forces between which will be equal and at equal phase angles of 120 degrees, and the four leads taken together forming a two-phase system having phase relations between the pairs of 90° degrees. 2. A composite polyphase system of distribution, comprising a set of three inductive coils, such as 1^a, 2^a and 3^a, connected in delta, which are electrically energized with three-phase electro-motive forces, and a set of four taps for distributing leads, such as A B C and D, the lead A being in the centre of any of the three coils, say the coil 2^a, and the point C at the junction of the other two coils 1^a and 3^a, and the points B and D at intermediate points between the ends of the coils 3^a and 1^a respectively, at equal distances electrically speaking from the point A.

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Name.	Amount paid. £	Last price. £
London Electric Ordinary	3 ..	1¼-2¼
—— 6 p.c. Pref.	5 ..	5¼-5¾
—— 4 p.c. st Mortgage Debenture Stock, Red.	100 ..	93-97
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100 ..	76-80
Metropolitan Ordinary, 100,001-300,000	5 ..	4 5/16-4 7/16
—— 4½ p.c. First Mortgage Debenture Stock	100 ..	105-108 xd
—— 4½ p.c. Cum. Pref.	5 ..	4¾-5¼
—— 3½ p.c. Mortgage Debenture, Red.	100 ..	83¼-86¼
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,000 ($500) M 1-4,400 ($1,000)	— ..	82-84 p.c.
($500), 4,001-14,000 ($1,000)	— ..	88-89½
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	94-97
Newcastle-upon-Tyne Electric Supply, Ord., 1-87,500	5 ..	4¾-5¼
—— do. 87,501-137,500 (issued at £1 prem.). All paid (Prov. Certs.)	5 ..	4¾-5¼
—— do., 5 p.c. Pref., 1-87,500 (Prov. Certs.)	2 ..	4¼-5¼
—— 5 p.c. Pref., 87,501-137,500 (Prov. Certs.)	4 ..	4¼-5¼
Notting Hill Electric Lighting	10 ..	11¼-12¼
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6-6½
—— 4 p.c. Debenture Stock	100 ..	94-97
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1 ..	1¼-1 7/16
—— 6 p.c. Non-Cum. Pref., 1-100,000	1 ..	1 1/32-1 5/32
—— 5 p.c. Debenture Stock, Red.	100 ..	102-105 xd
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5 ..	5¾-6
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5 ..	5¾-6
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100 ..	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	.. —	104-106 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	9 /16-13/16
South London, Ordinary	4 ..	2¼-3¼
South Metropolitan Electric Light and Power, Ord.	1 ..	5/16-9/16
—— 7 p.c. Cum. Pref.	1 ..	1 3/16-1 5/16
—— 4½ p.c. 1st Mort. Deb.	100 ..	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	8¾-9¼
—— 7 p.c. Pref.	5 ..	7¼-7¾
—— 3½ p.c. Deb.	100 ..	84-88
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	¼-1
—— 5 p.c. Cumulative Preference, 50,001-80,000	5 ..	1¼-2¼
—— 4½ p.c. First Mort. Debenture Stock, Red.	100 ..	79-83
Westminster, Ordinary	5 ..	8¾-9¼
—— 4½ p.c. Cum. Pref., 110,101-138,251	5 ..	4¾-5¼

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 10 p.c. Non-Cum. 2nd Pref., 260,008-280,007	5 ..	9¼-9¾
—— Permanent 6 p.c. Debenture Stock, 1888	100 ..	91-92
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	101-103
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	¼-¾
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1 ..	9 /16-11/16
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100 ..	87-91
Blackpool and Fleetwood Tramroad	10 ..	13¼-13¾
Bombay Elec. Supply and Trams. Co., 6 p.c. Cum. Pref.	10 ..	9¼-10
—— 4½ p.c. Deb. Stock, Red.	100 ..	93¼-95½
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	6¼-6¾
—— 5 p.c. Cum. Pref., Nos. 1-75,000	5 ..	5-5¼
—— 4½ p.c. Deb. Stk., Red., Prov. Certs., all pd.	100 ..	100¼-104¼
British Columbia Electric Railway Co., Ord. Def.	100 ..	143-147
—— Ord. Pref.	100 ..	122-126
—— 5 p.c. Cum. Perpetual Pref. Stock	100 ..	107-110
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	102-104
—— 4½ p.c. Vancouver Power Deb.	100 ..	101-104
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10 ..	¼-¾
—— 6 p.c. Cm. Pf., 30,001-60,000	10 ..	2¼-2¾
—— 5 p.c. Perpetual Debenture Stock	100 ..	86-90
—— 4½ p.c. 2nd Deb. Stock	100 ..	6-70
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	81-86
Buenos Ayres Gd. Nat. Trams. Co., 5½ p.c. Pref. Deb. Bonds, Red., 1-1,500	100 ..	102-107
—— 6 p.c. Deb. Bonds, Red., 1-2,275	100 ..	103-106
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	99-101
Calcutta Tramways, Ord., No. 1-137,610	5 ..	4¼-4¾
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5 ..	4¾-5
—— 4½ p.c. 1st Deb. Stock, Red.	100 ..	97-100
Cape Electric Tramways, Nos. 1-480,000	1 ..	5 1/16-5 3/16
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5 ..	4¾-5¼
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	97-101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5 ..	5¼-5¾
—— 4 p.c. Deb. Stock, Red. (1985)	100 ..	98-101 xd
Colombo Electric Tramways and Lighting, 5 p.c. 1st Mortgage Debenture Stock, Red.	100 ..	98-101
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 p.c. Cum. Pref.	10 ..	12¼-13¾
—— 4 p.c. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13-14
—— 6 p.c. Pref., Nos. within 1-60,000	10 ..	12¼-13¼
—— 3½ p.c. Mort. Debs., 1-3,000 Red.	100 ..	90-95
Hastings & Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	75-80
Havana Electric Railway Consolidated Mort. 5 p.c. 50-year Coupon Bonds of 1952, 1-6,957	$1,000 ..	91-94
Imperial Tramways, Ordinary	all ..	18-19
—— 6 p.c. Cum. Pref.	all ..	14-14½
—— 4½ p.c. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 p.c. Cum. Pref., Nos. 30,001-60,000	5 ..	¾-1¼ xd
—— 4 p.c. 1st Mt. Db. Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/32-3/32
—— 5 p.c. " A " Deb. Stock	100 ..	90-93
—— 6 p.c. " B " Deb. Stock	100 ..	64-68
Kidderminster & District Lighting & Traction, Pref.	5	9 15/16-10 3/16
Lancashire United Tramways, Limited, 5 p.c Prior Lien Deb Stock, Red	100 ..	88¼-90¾
—— £296,500 2nd Mort Deb Stock	— ..	—
—— £83,330 Deferred Deb Stock (all fully paid)	— ..	—
Lisbon Elec Trams, Limited, Ord, Nos 1-594,188	1 ..	15/16-1 1/16
—— 6 p.c. Cum Pref, Nos. 1-425,553	1 ..	15/16-1 3/16
—— 5 p.c. Mort. Deb., 1-5,000, Red.	100 ..	96-100

Name.	Amount paid. £	Last price. £
London United Trys (1901) 5 p.c. Cum. Pref.	10 ..	2-2¼
—— 4 p.c. 1st Mt. Db. Stock, Red.	100 ..	68-71
Madras Elec. Trams. (1904) 5 p.c. Deb. Stk., Red.	100 ..	93-96
Manila Elec. R.R. & Ltg. Corp., 5 p.c. 1st Lien & Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000 .	95-97
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5 ..	4¼-5
—— 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	86-91
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	1/32-5/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1 ..	23/32-27/32
—— 4½ p.c. Deb. Stock, Red.	100 ..	95-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 p.c. Gold Bonds	.. —	92¼-94¼
Milwaukee Electric Rail and Light, 5 p.c. 30-yr. Con. Mort. Bonds (1926) 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ p.c. Sterling Deb., 601-2,000 (1922)	100 ..	102-104
New General Traction, 6 p.c. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	¼-¾
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100 ..	100¼-103¼
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	¼-¾
—— 5 p.c. Cum. Pref., 300,001-545,000	1 ..	¼-¾
—— 4½ p.c. Debenture Stock	100 ..	86-89
Provincial Tramways Co., Ordinary, 1-24,912	10 ..	4-4¼
—— 6 p.c. Cum. Pref., 1-10,000	10 ..	9¼-10¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5 ..	5¼-5¾
—— 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	99-101
Sao Paulo Tramway, Light, and Power Co.	$100 ..	149-152
—— 5 p.c. 1st Mort Deb., Red. (1929) 1-12,000	$500 ..	97-99 p.c.
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	¼-¾
—— 4 p.c. Deb. Stock, Red. (1940)	100 ..	70-74
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red., 1-1,600	100 ..	82-86
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5 ..	¼-¾
—— 6 p.c. Cum. Pref., 1-46,261	5 ..	1¼-2¼
—— 4½ p.c. 1st Deb. Stock, Red.	100 ..	82-86

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100 ..	61-63
—— 4 p.c. Pref.	100 ..	83-85
—— " " deferred	100 ..	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	99-101
City and South London, Consolidated Ordinary	100 ..	31¼-32¼
—— 4 p.c. Debenture Stock	100 ..	99-101
—— 5 p.c. Pref. Stock '91	100 ..	110-112
—— " " " '96	100 ..	106-109
—— " " " '01	100 ..	102-105
—— " " " '03	100 ..	94-97
Liverpool Overhead, 5 p.c. Pref.	10 ..	10-10¼
—— Ordinary, 1-50,000	10 ..	3¾-4¼
—— 4 p.c. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 p.c. Profit-Sharing Secured Notes	— ..	102¼-103¼

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10 ..	2¾-3¼
—— 5 p.c. Debs., Red., within 1-1,060	100 ..	92-95
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000 ..	97-99
Anglo-American Telegraph Co., Ordinary	100 ..	58¼-60¼
—— 6 p.c. Preferred Ordinary	100 ..	102¼-103¼
—— Deferred Ordinary	100 ..	17¼-17¾
Anglo-Portuguese Telephone Co., 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	103-105
Chili Telephone Co., 1-44,000	5 ..	8¼-8¾
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100 ..	89-91
Cuba Submarine Telegraph Co., Ordinary, 1 16,000	10 ..	8¼-8¾
—— 10 p.c. Preference, 1-6,000	10 ..	17-18
Direct Spanish Telegraph Co., Ordinary	5 ..	2¾-3¼
—— 10 p.c. Cum. Preference	5 ..	8¼-8¾
—— 4½ p.c. Debs., 1 600	50 ..	99-101
Direct United States Cable Co.	20 ..	12¼-13¼
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100 ..	99-101
Eastern and South African, 4 p.c. Mort. Debs., within 1-3,000 (1909)	100 ..	100-102
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	25 ..	103¼-105¼
Eastern Extension, Australasia and China, 1-300,000	10 ..	11¼-12
—— 4 p.c. Mort. Deb. Stock, Perp.	100 ..	104-105
Eastern Telegraph Co., Ordinary Stock	100 ..	125-128
—— 3½ p.c. Preference Stock	100 ..	—
—— 4 p.c. Mortgage Debenture Stock	100 ..	104¼-106¼
Great Northern Telegraph Co. (of Copenhagen)	10 ..	26-27
Halifax and Bermudas Cable Co., 4½ p.c. 1st Mort. Debs., within 1-1,200, Red.	100 ..	99-101
Indo-European Telegraph Co.	25 ..	51¼-53¼
Marconi's Wireless Telegraph Co., Nos. 256,128-384,190	1 ..	11/16-13/16
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	¼-¾
—— 5 p.c. Preference, 1-86,492	1 ..	13/16-15/16
National Telephone, Preferred	100 ..	109-110¼
—— Deferred Stock	100 ..	125¼-127¼
—— 6 p.c. Cum. First Pref.	10 ..	10¼-11
—— 6 p.c. Cum. Second Pref.	10 ..	10¼-11
—— 5 p.c. Non. Cum. Third Pref.	5 ..	5¼-5¾
—— 3½ p.c. Deb. Stock, Red.	100 ..	97-99
—— 4 p.c. Deb. Stock, Red.	100 ..	99-101
Oriental Telephone and Electric Company	1 ..	1 5/16-1 7/16
—— 6 p.c. Cum. Pref.	1 ..	1 1/16-1 3/16
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100 ..	99-101
United River Plate Tele. Co., Ordinary, 1-100,000	— ..	7¼-7¾
—— 5 p.c. Cum. Pref., 1-40,000	5 ..	5¼-5¾
—— 4½ p.c. Debenture Stock, Red.	100 ..	102¼-104¼
Telephone Co. of Egypt, 4½ p.c. Deb. Stock, Red.	100 ..	99-101
West African Telegraph Co.	10 ..	12¾-13¼
West Coast of America, 1-30,000 and 53,001-53,008	2½ ..	1¼-1¾
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	99-101
West India and Panama Telegraph Co., Ordinary	10 ..	¼-⅝
—— 6 p.c. Cum. 1st Preference	10 ..	8-8½
—— 6 p.c. Cum. 2nd Preference	10 ..	—
—— 5 p.c. Debs., Red., 1-800	100 ..	101-103
Western Telegraph Co., 1-207,935	10 ..	13¾-14
—— 4 p.c. Debenture Stock, Red.	100 ..	90-92

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1909.	1908.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	July 21	1,894	1,990	— 96	— 207	27¼	27¼	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5·93
Ayr Corporation	„ 24	875	891	— 15	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	„ 24	3,065	2,870	— 195	+ 425	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	„ 25	1,062	1,077	— 15	— 457	23·53	23·53	—	—	—	—	—	—	—	—
Birmingham Corporation	„ 17	6,300	6,365	— 65	—	56·792	—	—	—	—	—	—	—	—	—
Blackburn Corporation	„ 21	1,149	1,280	— 130	— 628	23·8	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	„ 22	1,796	1,971	— 175	+ 627	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Aug. 8	2,304	2,329	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	July 18	2,435	2,432	+ 3	— 531	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	„ 21	1,681	1,723	— 42	— 23	20¼	20¼	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	„ 17	4,937	4,770	+ 168	+ 1,371	98¼	98¼	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	„ 25	1,028	1,065	— 37	+ 768	—	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	„ 23	5,973	5,383	+ 590	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	„ 24	1,185	1,270	— 85	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	„ 25	278	280	— 2	— 13	10	10	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	July 24	5,427	8,020	— 2,593	— 6, 7.	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	„ 24	3,080	3,235	+ 745	+ 2,000	—	—	—	—	—	—	—	—	—	—
City and South London Railway	„ 25	2,986	2,734	+ 252	+ 637	—	—	—	—	—	—	—	—	—	—
Colchester Corporation	„ 14	200	219	— 19	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	„ 22	580	514	+ 66	— 20	—	—	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	„ 16	1,455	—	—	—	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	„ 16	259	271	— 12	— 159	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	„ 17	235	226	+ 9	— 346	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	„ 23	159	162	— 3	+ 6	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	„ 16	5,681	5,434	+ 247	— 86	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	„ 21	1,239	1,304	— 65	— 458	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	„ 24	1,167	866	+ 301	+ 2,616	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	„ 17	15,961	17,286	— 325	— 2,745	185½	179	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	„ 21	301	298	+ 3	+ 583	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	„ 21	3,065	2,870	+ 195	+ 425	—	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	„ 17	1,626	1,550	+ 76	+ 564	28½	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	„ 24	2,516	2,441	+ 74	+ 403	26	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	„ 17	496	448	+ 48	+ 656	10	10¼	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	„ 21	141	146	— 5	— 173	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	„ 14	269	265	+ 4	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	„ 21	1,341	1,471	— 130	+ 110	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	„ 17	6,867	6,759	+ 108	+ 301	96½	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	„ 17	2,161	2,291	— 129	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	„ 17	10,999	11,048	— 49	— 3,0,7	104	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	„ 25	1,410	1,487	— 77	— 43	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	„ 17	36,003	35,012	+ 991	+ 19,389	118½	120½	Mar. 31	1,274,660	279,166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	„ 17	216	258	— 42	— 743	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	„ 10	184	219	— 35	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	„ 17	15,218	15,419	— 281	— 625	181	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	„ 24	10,846	9,093	+ 1,753	+ 3,285	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	„ 25	16,333	15,975	+ 358	+ 1,010	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	„ 21	133	158	— 25	— 108	2½	2½	Mar. 31	7,362	2,060,712	204,710	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	„ 2	3,804	3,840	— 36	— 1,425	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	„ 17	637	669	— 32	— 291	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	July 22	668	678	— 10	+ 54	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	July 19	4,603	4,947	— 344	— 2,192	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	„ 18	5,718	5,528	+ 190	— 1,112	68½	66½	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	„ 14	1,102	1,116	— 13	— 472	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	„ 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,084	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	July 7	127	162	— 35	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	„ 22	389	378	+ 11	—	5·16	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	„ 24	983	1,018	— 35	+ 740	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	„ 15	2,365	2,158	+ 206	+ 2,161	14·7	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	„ 21	867	825	+ 42	— 776	20½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train miles. *b* Half-year's figures.

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CLASSIFIED DIRECTORY OF ELECTRICAL TRADES.

Accumulators.

Brockie-Pell Arc Lamp Co., Wimbledon, S.W.
D.P. Battery Co., Lumford Mills, Bakewell, Derbyshire, and 11, Victoria-st., Westminster.
Hart Accumulator Company, Marshgate-lane Stratford.
Johnson and Phillips, Old Charlton, Kent.
Tudor Accumulator Co., Ltd., 119, Victoria-street, S.W.
Wilson, L. E., and Co., Imperial Buildings, 20, Cross-street, Manchester.

Accumulator Acid Manufacturers.

Berk, F. W., and Co., Limited, 1, Fenchurch-avenue, London, E.C.
Spencer Chapman and Messel, 36, Mark-lane, London, E.C.

Acid Proof Paints.

Griffiths Bros., Mack's-road, Bermondsey, S.E.

Arc Lamp Hoists.

Abbott and Co., Newark-on-Trent.
London Electric Firm, George-street, Croydon.
Reason Manufacturing Co., Lewes-rd., Brighton.
Youngs, Ryland-street Works, Birmingham.

Arc Lamps.

Braulik, G., 217 and 218, Upper Thames-street, E.C.
British Thomson-Houston Company, Rugby.
Edison and Swan United Electric Light Co., 36 and 37, Queen-street, Cheapside, E.C.
Electric & Ordnance Accessories Co., Stellite Works, Cheston-road, Aston, Birmingham.
Foster Arc Lamp and Engineering Co., Wimbledon, S.W.
General Electric Co., 71, Queen Victoria-st.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Old Charlton, Kent.
Reason Manufactg. Co., Lewes-rd., Brighton.
Union Electric Co., Park-street, Southwark, London, S.E.

Auto-Transformers.

Brockie-Pell Arc Lamp Co., Wimbledon, S.W.
Foster Arc Lamp and Engineering Co., Wimbledon, S.W.
Johnson and Phillips, Old Charlton, Kent.

Ball Bearings.

Fischers Ball and Bearing Co., Hinckley-st., Birmingham.
Tormo Manufacturing Co., 67-68, Bunhill-row, London, E.C.

Batteries (Primary) and Accessories.

General Electric Co., 71, Queen Victoria-st.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson & Phillips, Old Charlton.

Belting.

Cort, A., & Co., Bullace Works, 303½, Camberwell-road, London, S.E.
Hendry, J., 252, Main-st., Bridgeton, Glasgo'.
Webb & Son, Combs Tannery, Stowmarket.
Willcox & Co., 36, Southwark-street, S.E.

Bitumen Refiners.

Keys, W. H., Hall End Works, West Brom.

Boilermakers.

Babcock & Wilcox, 30, Farringdon-st., E.C.
Heenan & Froude, Worcester Engineering Works, Worcester.

Boiler Mountings.

Bailey, W. H., & Co., Salford, Manchester.
Turnbull, A., & Co., Bishopbriggs, Glasgow.

Cable and Wire-Covering Machinery.

Bridge, D., & Co., Castleton, Manchester.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson & Phillips, Old Charlton, Kent.

Carbons (Arc Light).

Electric & Ordnance Accessories Co., Stellite Works, Cheston-road, Aston, Birmingham.
General Electric Company, 71, Queen Victoria-street, E.C.
India Rubber, etc., Co., Silvertown, Essex.
Johnson & Phillips, Old Charlton, Kent.
Mayer, H. G., & Co., 67, Aldersgate-street, London, E.C.
Sloan Electrical Co., 15, Fore-st. Avenue, E.C.

Cable and Wire Makers.

British Insulated and Helsby Cables, Limited, Prescot.
Callender's Cable and Construction Co., Hamilton House, Victoria-embank't, E.C.
General Electric Co., 71, Queen Victoria-st., E.C.
Henley's, W. T., Telegraph Works Company, Blomfield-street, London-wall, E.C.
Hooper's Telegraph & Indiarubber Works, 31, Lombard-st., E.C., & Millwall Docks.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson & Phillips, Old Charlton, Kent.
London Electric Wire Co., Playhouse-yd., E.C.
Liverpool Electric Cable Co., Vauxhall-road, Liverpool.
St. Helens Cable & Rubber Co., Warrington.
Western Electric Company, Norfolk House, Victoria Embankment.

Casings and Cleats.

Electrical Trades' Supply Limited, Britannia Works, Great Charles-street, Birmingham.
General Electric Co., 71, Queen Victoria-street, E.C.
Simplex Conduits, Limited, Garrison-lane, Birmingham.

Casting Plant.

Aerators Limited, "Prana" Sparklet Works, Upper Edmonton, London, N.

Chemicals.

Spencer Chapman & Messel, 36, Mark-lane, London, E.C.

Circuit Breakers and Time Lags.

The Switchgear Co., (J. G. Statter & Co.), Birmingham.

Condensing Plant.

Allen, W. H., Son, & Co., Queen's Engineering Works, Bedford.
Belliss & Morcom, Ledsam-street Works, Birmingham.
Ledward & Beckett, 11, Tothill-street, S.W.
Willans & Robinson, Victoria Works, Rugby.

Conduits.

Flexible Metallic Tubing Co., Ponders End, Middlesex, & 112, Queen Victoria street.
General Electric Co., 71, Queen Victoria-st.
Metallic Seamless Tube Co., Wiggin-street, Birmingham.
New Brotherton Tube Co., Commercial-road, Wolverhampton.
Simplex Conduits, Garrison-lane, B'ham.
Sun Electrical Co., 118-120, Caring Cross-road, W.C.

Coppersmiths.

Andrews, R. W., & Co., 148-150, Pentonville-road, London, N.
Dore, J., & Co., High-st., Bromley-by-Bow.
Harvey, G. A., & Co., Lewisham, London, S.E.

Cycles and Cycling Accessories.

Tormo Manufacturing Co., 67 & 68, Bunhill-row, London, E.C.

Dynamo and Motor Repairs.

Home & Rowland, Charlton, Kent.

Dynamo Oil.

Willcox & Co., Southwark-street, S.E.

Dynamos, Transformers, Motors, etc.

Allen, W. H., Son, & Co., Queen's Engineerings Work, Bedford.
British Thomson-Houston Co., Rugby.
British Westinghouse Electric & Mfg. Co., Westinghouse Building, Norfolk-st., W.C.
Brook, E., Colne-road, Huddersfield.
Dick, Kerr, & Co., Abchurch-yard, E.C.
Electric & Ordnance Accessories Co., Stellite Works, Cheston-rd., Aston, Birmingham.
Electric Construction Co., Dashwood House, 9, New Broad-street, London, E.C.
Electromotors Ltd., Openshaw, Manchester.
Ferranti Limited, Hollinwood, Lancs.
General Electric Co., 71, Queen Victoria-st.
India Rubber, etc., Company, Silvertown.
Johnson & Phillips, Old Charlton, Kent.
Lancashire Dynamo & Motor Co.
McClure & Whitfield, Stockport.
Morris-Hawkins, 9½, Union-court, Old Broad-street, London, E.C.
Sandycroft Foundry Co., Chester.
Small Power Dynamo & Motor Company, Openshaw, Manchester.
Union Electric Company, Park-st., Southwark, London, S.E.

Ebonite and Vulcanite.

Cort, A., & Co., Bullace Works, 303½ Camberwell-road, London, S.E.
Mosses & Mitchell, 69, Chiswell-street, E.C.
Traun, Dr. Heinr., & Son, 8, Redeross-street, London, E.C.

Electric Cooking Apparatus.

British Thomson-Houston Company, Rugby.
General Electric Co., 71, Queen Victoria-st.

Electrical Appliances.

British Thomson-Houston Company, Rugby.
Reyrolle, A., & Co., Hebburn-on-Tyne.
The Switchgear Co. (J. G. Statter & Co.), Birmingham.

Electrical Fittings.

Barton & Sons, Green-lane, Walsall.
Bill, S., & Co., 54, Guest-street, Birmingham.
Dorman & Smith, Ordsal Station Electrical Works, Salford.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Flexible Metallic Tubing Co., Ponders End, & 112, Queen Victoria-st., London, E.C.
General Electric Co., 71, Queen Victoria-st.
Lundberg, A. P., & Sons, Pioneer Electrical Works, 477 to 487, Liverpool-road, N.
McGeoch, Wm., & Co., 28, West Campbell-street, Glasgow.
Metallic Seamless Tube Company, Wiggin-street, Birmingham.
New Brotherton Tube Co., Commercial-road, Wolverhampton.
Reason Mfg. Co., Lewes-road, Brighton.
Reyrolle, A., & Co., Hebburn-on-Tyne.
Siemens Bros. Dynamo Works, York-mansions, S.W.
Simplex Conduits, Limited, Garrison-lane, Birmingham.
Sun Electrical Co., 118 & 120, Charing Cross-road, London, W.C.
The Switchgear Co., (J. G. Statter & Co.), Birmingham.
Tucker, J. H., & Co., King's-road, Hay Mills, Birmingham.

Electric Heaters.

Electric Ordnance & Accessories Co., Stellite Works, Cheston-rd., Aston, Birmingham.
McGeoch, Wm., & Co., 28, West Campbell-street, Glasgow.

Electric Light Contractors.

British Thomson-Houston Company, Rugby.
Dick, Kerr, & Co., Abchurch-yard, E.C.
Electric Construction Co., Dashwood House, 9, New Broad-street, London, E.C.
Ferranti Limited, Hollinwood, Lancs.
Hooper's Telegraph & Indiarubber Works, 31, Lombard-st., E.C., & Millwall Docks.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson & Phillips, Old Charlton, Kent.
Marryat & Place, 28, Hatton-garden, E.C.
White, J. G., & Co., 9, Cloak-lane, E.C.

Electric Locomotives.

British Thomson-Houston Company, Rugby.
British Westinghouse Electric & Mfg. Co., Westinghouse Building, Norfolk-st., W.C.
Dick, Kerr & Co., Abchurch-yard, E.C.

Electric Motor Starters.

Reyrolle, A., & Co., Hebburn-on-Tyne.
The Switchgear Co. (J. G. Statter & Co.), Birmingham.
Vlasto, Clark, & Watson, London-road, bridge, Stockton Heath, near Warrington.

Elevating, Conveying Plant, Cranes, etc.

General Electric Co., 71, Queen Victoria-st.
Youngs, Ryland-street Works, Birmingham.

Engines.

Allen, W. H., Son, & Co., Queen's Engineering Works, Bedford.
Belliss & Morcom, Ledsam-street Works, Birmingham.
Browett, Lindley, & Co., Patricroft, Manchester.
Crossley Bros., Limited, Openshaw.
Dick, Kerr, & Co., Abchurch-yard, E.C.
Diesel Engine Co., 179, Queen Victoria-st., London, E.C.
Petter, J. B., & Sons, 73, Queen Victoria-street, London, E.C.
Willans & Robinson, Rugby.

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Classified Directory of Electrical Trades *(continued)*:

Engine Accessories, Tanks, etc.

Babcock & Wilcox, 30, Farringdon-st., E.C.
Croft & Perkins, Ltd., Bradford.
Dore, J., & Co., High-st., Bromley-by-Bow.
Harvey, G. A., & Co., Lewisham, London, S.E.
Willcox & Co., 36, Southwark-street, S.E.

Engineers' Stores.

Willcox & Co., 36, Southwark-street, S.E.
Youngs, Ryland-st. Works, Birmingham.

Feed-Water Heaters.

Wilkinson, Geo., Beech Mount, Harrogate.

Flexible Couplings.

Croft & Perkins, Ltd., Bradford.

Galvanisers.

Harvey, G. A., & Co., Lewisham, London, S.E

Incandescent Lamps.

British Thomson-Houston Company, Rugby.
Cryselco Ltd., Kempston Works, Bedford.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
General Electric Co., 71, Queen Victoria-st.
Henley's, W. T., Telegraph Works Company, Blomfield-street, London-wall, E.C.
Siemens Bros., Dynamo Works, Caxton House, S.W.
Stearn Electric Lamp Co., 47, Victoria-st., S.W.

Indiarubber Goods.

India Rubber, etc., Co., 106, Cannon-st., E.C.
Moseley, D., & Sons, Chapel Fields Works, Ardwick, Manchester.
Willcox & Co., 36, Southwark-street, S.E.

Insulating Varnish.

Ammon, A. F., 52, Chapel-street, Blackfriars, Manchester.
Major & Co., Sculcoates, Hull.

Insulators and Insulating Materials.

Cort, A., & Co, Bullace Works, 303½, Camberwell-road, London, S.E.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Everitt & Co., 40, Chapel-street, Liverpool.
General Electric Co., 71, Queen Victoria-st.
Griffiths Bros., Mack's-rd., Bermondsey, S.E.
Hooper's Telegraph & Indiarubber Works, 31, Lombard-street, E.C., & Millwall Docks.
Johnson & Phillips, Old Charlton, Kent.
Keys, W. H., Hall End Works, West Bromwich
Macintyre, J. & Co., Washington China Works, Burslem.
Mosses & Mitchell, 69, Chiswell-street, E.C.
Price, Powell, & Co., Bristol.
Traun, Dr. Heinr., & Son, 8, Redcross-street, London, E.C.

Iron-Clad Electrical Accessories.

Reyrolle, A., & Co., Hebburn-on-Tyne.
The Switchgear Co. (J. G. Statter & Co.), Birmingham.
Tucker, J. H., & Co., King's-road, Hay Mills, Birmingham.

Jointing—Manganesite.

Everitt & Co., 40, Chapel-street, Liverpool.

Ladders and Steps.

Heathman, J. H., & Co., Parson's Green, S.W.

Lamp Columns for Arc Lighting.

General Electric Co., 71, Queen Victoria-street, E.C.
Johnson & Phillips, Old Charlton, Kent.

Lampholder Makers.

Dorman & Smith, Ordsal Station Electrical.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C. Works, Salford.
General Electric Co., 71, Queen Victoria-st.

Lead-Covered Cables.

British Insulated & Helsby Cables, Limited, Prescot.
Callender's Cable & Construction Co., Hamilton House, Victoria Embank't., E.C.
Henley's, W. T., Telegraph Works Company, Blomfield-street, London-wall, E.C.
Johnson & Phillips, Old Charlton, Kent.
London Electric Wire Co., Anchor Works, Playhouse-yard, E.C.
St. Helens Cable & Rubber Co., Warrington.
Telegraph Mfg. Co., Helsby, Warrington.
Western Electric Company, Norfolk House, Victoria Embankment.

Lifting Tackle.

Youngs, Ryland-street Works, Birmingham.

Manganese Oxide.

Everitt & Co., 40, Chapel-street, Liverpool.

Measuring Instruments—Electrical.

British Thomson-Houston Company, Rugby.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Electrical Instrument Manufacturers, Ltd., Freezywater, Waltham Cross, N.
Everett, Edgcumbe & Co., 87, Victoria-street.
Evershed & Vignoles, Acton-lane, Chiswick, London, S.W.
Ferranti Limited, Hollinwood, Lancs., E.C.
General Electric Co., 71, Queen Victoria-st.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson & Phillips, Old Charlton, Kent.
Nalder Bros. & Thompson, 34, Queen-st., E.C.
Schaffer & Budenberg, Whitworth-street, London-road, Manchester.
Western Electrical Instrument Co., Audrey House, Ely-place, Holborn, London, E.C.

Mechanical Stokers and Conveyors.

Babcock & Wilcox, 30, Farringdon-st., E.C.

Metal Perforators—Speciality, Lead.

Harvey, G. A., & Co., Lewisham, London, S.E.

Meters.

Bastian Meter Co., Bartholomew Works, Kentish Town, N.W.
British Thomson-Houston Company, Rugby.
Reason Mfg. Co., Lewes-rd., Brighton.

Motors—Electric.

Allen, W. H., Son & Co., Queen's Engineering Works, Bedford.
British Thomson-Houston Company, Rugby.
Brook, E., Colne-road, Huddersfield.
Churton, T. H., & Co., Atlas Works, Leeds.
Dick, Kerr & Co., Abchurch-yard, E.C.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Electric Construction Co., Dashwood House, 9, New Broad-street, London, E.C.
Electromotors Ltd., Openshaw, Manchester.
Fuller Electrical & Manfg. Co., Norfolk House, Laurence Pountney-hill, London.
General Electric Co., 71, Queen Victoria-st.
Johnson & Phillips, Old Charlton, Kent.
Lancashire Dynamo & Motor Co.
Marryat & Place, 28, Hatton-garden, E.C.
Morris-Hawkins, 9½, Union-court, Old Broad-street, London, E.C.
Union Electric Co., Park-street, Southwark, London, S.E.

Mica.

British Mica Company, Lebanon-rd. Works, Wandsworth, S.W.
Taylor & Co., 40, Hatton-garden, E.C.

Oilcans and Economisers.

Kaye, J., & Sons, Leeds.

Packings—Asbestos and Metallic.

Hooper's Telegraph & Indiarubber Works, 31, Lombard-street, E.C., & Millwall Docks.
United States Metallic Packing Co., Soho Works, Bradford.
Willcox & Co., 36, Southwark-street, S.E.

Platinum Utensils.

Derby & Co., 44, Clerkenwell-road, E.C.

Printers and Lithographers.

Nicholls & Clarkson, 124, Shacklewell-lane, London, N.E.

Projectors.

Johnson & Phillips, Old Charlton, Kent.

Rheostats.

British Thomson-Houston Company, Rugby.
Ferranti Limited, Hollinwood, Lancs.
Schniewindt, C., Neuenrade, Westfalen.

Silk and Lace Shades.

Taylor & Co., 40, Hatton-garden, E.C.

Ships' Electric Fittings.

Dorman & Smith, Ordsal Electrical Works, Salford.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
McGeoch, Wm., & Co., 28, West Campbell-street, Glasgow.

Soldering Fluxes.

Auto Controller & Switch Co. (Fluxite), 70, Vienna-road, Bermondsey, London.
Grimshaw Bros. & Co., Canal Chemical Works, Clayton, Manchester.

Stampings and Metal Perforators.

Harris, A. E., & Co., 95, Camden-street, Birmingham.
Harvey, G. A., & Co., Lewisham, London, S.E.

Sulphate of Copper.

Spencer, Chapman & Messel, 36, Mark-lane, London, E.C.

Switches, Cut-Outs, etc.

Bray, Markham, & Reiss, Blackhorse-lane, Walthamstow.
British Thomson-Houston Company, Rugby.
Dick, Kerr, & Co., Abchurch-yard, E.C.
Dorman & Smith, Ordsal Station Electrical Works, Salford.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Electric Construction Co., Dashwood House, 9, New Broad Street, London, E.C.
Ferranti Limited, Hollinwood, Lancs.
General Electric Co., 71, Queen Victoria-st.
Johnson & Phillips, Old Charlton, Kent.
Lundberg, A. P., & Sons, Pioneer Electrical Works, 477 to 487, Liverpool-road, N.
McGeoch, Wm., & Co., 28, West Campbell-street, Glasgow.
Nalder Bros. & Thompson, 34, Queen-st., E.C.
Reason Mfg. Co., Lewes-road, Brighton.
Reyrolle, A., & Co., Hebburn-on-Tyne.
Sun Electrical Co., 118 & 120, Charing Cross-road, London, W.C.
The Switchgear Co. (J. G. Statter & Co.), Birmingham.
Tucker, J. H., & Co., King's-road, Hay Mills, Birmingham.

Tachometers.

Lunken Valve Co., 35, Great Dover-st., S.E.

Telephones.

General Electric Co., 71, Queen Victoria-st.
Western Electric Co., Bridge Chambers, 171, Queen Victoria-street, E.C.

Tools.

Hardy Patent Pick Co., Mining Tool Works, Heeley, Sheffield.
Youngs, Ryland-street Works, Birmingham.

Tramway Equipments.

British Thomson-Houston Company, Rugby.
British Westinghouse Electric & Mfg. Co., Westinghouse Building, Norfolk-st., W.C.
Dick, Kerr, & Co., Abchurch-yard, Cannon-street, E.C.
Ferranti Limited, Hollinwood, Lancs.
White, J. G., & Co., 9, Cloak-lane, E.C.

Turbines.

British Thomson-Houston Company, Rugby.
Gilbert Gilkes & Co., Kendal.
Willans & Robinson, Victoria Works, Rugby.

Ventilating Fans.

British Thomson-Houston Company, Rugby.
Capell Fan Co., 15, Mosley-st., Newcastle-on-Tyne.
Edison & Swan United Electric Light Co., 36 & 37, Queen-street, Cheapside, E.C.
Gibbs, J., & Son, 72, Duke-street, Liverpool.
Harvey, G. A., & Co., Lewisham, London, S.E.
Matthews & Yates, Cyclone Works, Swinton, Manchester.
Mitcham Electric Fan Co., 6, Broad-street-place, E.C.

Vulcanised Fibre.

Ammon, A. F., 52, Chapel-street, Blackfriars, Manchester.

Washers—Lock.

Ammon, A. F., 52, Chapel-street, Blackfriars, Manchester.

Zinc and Wire Workers.

Harvey, G. A., & Co., Lewisham, London, S.E.

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THE
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NOTES.

ELECTRIC DRIVE ON SHIPS.

Mr. A. J. Maginnis's paper on "Improvements in Ship Propulsion," part of which we published in our last issue, is calling forth a good deal of lively discussion. It seems to be generally admitted that the turbine has made the four-crank triple expansion engine obsolete; but, of course, few are willing to admit that this is the final word. That there is still room for improvement is obvious. It is curious, however, to see how many are suspicious of electricity, and look round in other directions for the desired ideal. Probably one of the strangest suggestions is that the propulsion should be by means of the emission of explosive gases. The argument is that it is the pitch over its diameter that causes the propeller to exert a direct thrust on the shafting, and that the "lead going" side necessarily causes retardation. Now, if we had discharges of explosive gas mixtures through nozzles the line of force would be equal and horizontal, the retardation would cease, and the space taken up by machinery on board greatly reduced. Apart from the mechanical difficulties, the other drawbacks would seem to be too apparent to induce anyone to persevere in this direction. Electricity would be far more amenable to man's needs on ships. Not that we desire to unduly minimise the very real difficulties that confront the marine electrician.

DIFFICULTIES ON SHIP-BOARD.

Some of these difficulties will require careful consideration, but they can all be overcome if boldly faced. A Liverpool critic points out that a serious obstacle arises from the liability of electrical insulation to break down under the influence of dampness. No doubt a breakdown such as is here suggested would be more than serious; would, indeed, under many conditions, quickly become disastrous. But hard as are the problems of effective insulation, they are by no means insuperable. We may take the comparatively and extremely humble example of trading laundries, where electricity is used not only for lighting, but as motive power, and as a means of heating irons and other appliances. In these cases constant annoyance was caused owing to the steam-laden atmosphere attacking the insulation. A little ingenuity has overcome the trouble. In marine engineering the problem is more intricate, though it is only a question of degree. Undoubtedly the designing of a suitable main motor is a formidable task. However, the prize is so enormous that it should prove a sufficient incentive to set our keenest wits to work on the problem, the chief features of which are: constant running without liability to overheating; reversibility by controllers of large size; large initial torque, and yet capable of being run dead slow and at varying speeds for long periods without the windings and resistances becoming too hot; means to overcome difficulties arising from fluctuations of voltage due to starting the main motors from a generator, and the variations of amperage due to drop of voltage at starting, and in manœuvring a ship on leaving or entering a port. Other points there are which assuredly cannot be settled in a day or in the course of a paper or two. As for the alarm as to a possible shortage of sea-going expert electricians, that may be set aside, for the demand will soon create the supply, as it has done in providing us with the competent steam-using engineers of to-day. For some time to come we must devote our attention to promote discussion, to experimentation, and to enlisting the interest and goodwill of shipowners.

ELECTRIC DRIVE IN SPINNING MILLS.

The *Manchester Guardian* represents the somewhat stolid conservatism of the large mass of British manufacturers in its criticism of Mr. Wilson's paper on "Electrical Operations in Textile Factories." It is argued that if electricity is generated at the mill, the whole plant has to be run, and that little is gained over the mechanical drive except that rather less line shafting is run idly. That in itself is a decided gain. We are told that the electrical drive is not particularly remarkable for its steadiness, and that complaint has arisen at the Bannerman and other Manchester mills deriving their power from the Corporation Central Station. As a matter of fact, what has arisen is that a speed recorder was specially set up so as to check irregularity and arrive at definite results. Mr. S. L. Pearson, chief engineer at the Manchester Corporation Electricity Works, is, indeed, able to report that the mill managers are perfectly satisfied with the electrical drive. It was, perhaps, inevitable, though somewhat unfortunate, that Mr. Wilson should dwell on the advantages that electricity can confer in reorganising old mills. It would, of course, have been better had comparison been confined to newly-erected and equipped mills. It is quite true that enormous improvements have been made in mechanical arrangements in mills. As regards Mr. Wilson's claim of an increase of 5% on output, and 2½% increase of price for better quality, this is altogether too modest, as we showed last week by reference to the Shonebeck weaving results. Engineers of central stations generating electricity for lighting and traction, as well as general power, will inevitably meet with occasional set-backs, though careful watching and a little experience will soon put matters right.

HIGH VOLTAGE ON RAILWAYS.

While our railway authorities are pondering over the relative merits of the overhead and third rail systems, the Americans have carried out the use of extremely high voltage for inter-urban traffic far beyond the experimental stage. There are now four lines operating the 1,200-volt direct current system, and apparently with excellent results. Seven more lines are to adopt the system. It is found in practise to be moderate as regards capital cost; certainly not more expensive as to upkeep than 1 600-volt system, while it permits of extension being made with ease and rapidity, and the task of running cars offers no difficulties, whether motors of 50, 75, or 150 h.p. are used. No wonder that when Mr. C. D. Eveleth discussed this matter before the Street Railway Association of the State of New York he found his brethren in sympathy with the new movement. It is regarded in the States as a distinct step towards securing better economy and efficiency, and, therefore, the departure should be closely watched by our men.

WIRELESS TELEGRAPHY PROGRESS.

Mr. Winston Churchill, as President of the Board of Trade, has stated that the Government are considering the advisability of rendering the carrying of a wireless telegraph installation compulsory for all ocean-going passenger steamers. In this the Government would not be in advance of public opinion. Indeed, it appears likely that the commercial world will force on an international movement of

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this kind. At an International Conference to be held at Baden Baden on September 12, the underwriters are going to consider whether premiums should not be lowered on all vessels seeking to insure which carry wireless apparatus, and, if so, to what extent. A substantial discrimination in this way would prove beneficial all round. It would quicken the adoption not only of ship-board equipments, but the multiplication of sea-board stations, and thus a great advance in rendering ocean travel less hazardous would be made. Probably, even if our Board of Trade adopted the policy of compulsion, other countries would be slow to follow; but an international progressive policy on the part of underwriters would be more effective as regards world-wide adoption, and also in extending the system to other vessels than the huge passenger liners. We are making progress, but not as fast as we should. Fifty-one stations in Great Britain and Ireland (twelve of which are monopolised by the Admiralty), some 120 in the United States, and only a little over 300 for the rest of the world is a small showing. We must multiply these considerably before great benefits can be felt. Meanwhile the Postmaster-General ought to take immediate steps to make its convention with the Marconi Co. effective. It ought to be possible to go into any post office and send off a "Marconigram." The Company state that they are quite ready; it is only the General Post Office that blocks the way.

HARNESSING THE DANUBE.

Herr Baurat von Fragstein has a grand project for harnessing the Danube. Every schoolboy knows that the mighty stream makes a plunge at a point between Immendingen in Bavaria and Fridingen in Wurtemburg, disappearing completely, and working underground, only to reappear at Aach. The worthy Baurat proposes to capture the stream by building a sluice about 8 ft. in diameter in the rocky mountain, and to conduct the sluice with a gentle slope to a point where a fall of some 450 ft. would be secured. It is estimated that the Danube would give an average of 11 cubic metres of flow per second, with a low water flow of 5 cubic metres and a minimum of 3½ cubic metres. This would give respectively 16,837, 7,897, and 5,215 h.p. per working day, available for conversion into electricity for long distance transmission.

HIGH TENSION CURRENTS IN STEEL ROLLING MILLS.

Speaking before the American Institute of Electrical Engineers, on the immense benefits conferred on steel rolling mills by the introduction of the electric-drive, Mr. E. Friedlander said that the use of higher direct-current voltages in connection with large rolling mill motors should be satisfactory. But he thought that high-tension alternating-current transmission and induction motors direct on the line will be generally employed. Where conditions demand it, the induction motor characteristics can now be made nearly similar to the compound-wound, direct-current motor. However, he is right in saying that much of its simplicity and efficiency would be sacrificed in doing this. Among some of the earlier disadvantages of the induction motor, he thought, were: very large current required for starting under heavy load; one speed fixed by the number of poles and the tendency always to run at synchronous speed; impracticability of reversing large units; and inability to change speed to fly-wheel requirements. In the design of the modern rolling mill motor, most of these objectionable points have been remedied by different means; such as wound rotors; the introduction of variable resistance; changing the number of poles; shifting the phases; slip-rings, and so on. He regarded as matters of detail whether direct-current power stations and direct-current motors are used, or alternating-current stations are installed for high-tension transmission with alternating-current motors directly on the line or fed through transformers, or direct-current motors are supplied from an alternating-current station through converters, or motor generators, batteries or fly-wheel sub-stations. It is quite true that any one of these systems will give satisfaction if properly designed and installed.

TRAMCAR ROLLING STOCK MISHAPS.

BY SPENCER ROBINSON.

The troubles connected with the rolling stock of electric tramcars cause a great amount of inconvenience to the passengers on the cars, who are very often, unfortunately, kept waiting some considerable time while the motor-man is tinkering about with a point bar endeavouring to assist the car over points, etc.

It is the object of this article to point out the probable causes of such breakdowns, and to mention a practical means of getting over the difficulty.

The cause of cars refusing to take the points is largely due to defective wheels; these should be re-tyred when considerably worn. To re-tyre the wheels it is first necessary to lift the car, and to do this all brake rods, plummer blocks, etc., must be removed, after which the wheels may be easily withdrawn. When this has been accomplished, it is then a good plan to drill holes in the periphery of the tyre, when chisel cuts from hole to hole should be made, after which the old tyre may be readily removed from the wheel.

The steel tyres are first placed in the furnace, where they remain until they have attained sufficient heat to enable them to be securely shrunk on the rims of the wheels. The tyres are cooled out by means of a suitable water spray, which is usually circular in shape, to enable the temperature of the tyre to be uniformly reduced.

Special care should be exercised when cooling; not to apply the water too soon after the tyres have been withdrawn from the furnace, otherwise it will be found impossible to turn them in the lathe owing to the extreme hardness. Should, however, this occur, it will be necessary to grind the tyres with a portable emery wheel, or other suitable appliance, until further progress can be made with the ordinary lathe-tool. When the turning has been completed, small studs must be fitted through the rim of the wheel, thus any possible chance of the tyre severing from the wheel is prevented.

When re-wheeling is necessary, due probably to a broken axle or for some other cause, it is advisable to adopt the pressing-on process in preference to shrinking the wheels on the axles, owing to the facility of pressing them on to gauge.

The wheels, when properly bored, are pressed on by hydraulic pressure, but sometimes, through incorrectness of the boring, wheels will "slip on" with considerably less than the required pressure. When this occurs the wheels must be pressed off and the axle "centre popped," after which a greater pressure will be necessary to press on the wheels securely. Loose gear is another fault of a purely mechanical nature, and that it should be attended to immediately it has been detected is of great importance, as this trouble, though only of a trivial nature, may lead to a serious breakdown. During the writer's experience in electric tramway work, several pinion wheels, having teeth almost as sharp as the edge of a razor, and also many of these absolutely broken, were frequently removed from cars.

To put this trouble right, it is necessary to withdraw the armature from the motor case, when the pinion may be easily removed from the armature shaft by unscrewing the pinion nut, after which a new pinion wheel can readily be replaced. Defective gear is usually suspected by the necessary unpleasant jerking of the car.

The brakegear causes an amount of trouble. Occasionally the brakes require adjusting owing to the motor-man being unable to hold his car back when descending a steep gradient. In cases of this kind it will be necessary to use the electric brake until the car is returned to the sheds, when a few turns on the turnbuckle underneath the car will generally be all that is necessary to enable the car to continue its journey. The electric brake should not be used more than is absolutely necessary, as this will considerably overheat the motors.

Special care should be taken by the motor-man when driving cars round sharp curves to see that the slipper brakes are right up or down, and not in an intermediate position, otherwise very often the wooden slipper blocks will be torn away from the castings, and these brakes consequently rendered useless.

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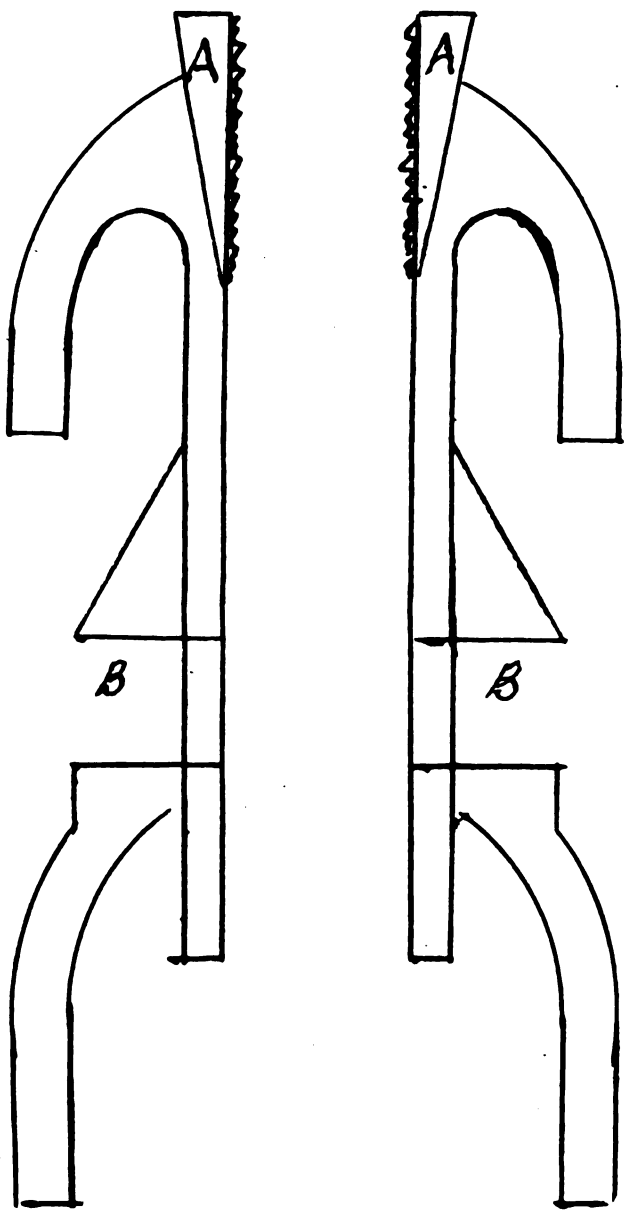
COLLIERY SHAFT CABLES.

BY WILLIAM COPELAND.

When dealing with this class of work there are many troubles to overcome, and to meet these various kinds of cables are used, all of which have their peculiar advantages and disadvantages. It is well known by engineers who have studied this work, and have had experience with it, that where one class of cable has proved a success in one pit shaft, it has been quite a failure in another.

The kinds of cables which have been used in pit shafts are as follows:—

(*a*) Vulcanised rubber taped and braided and armoured.
(*b*) Dialite.
(*c*) Vulcanised bitumen.



CABLE INSULATOR.

(*d*) Paper insulated lead covered.

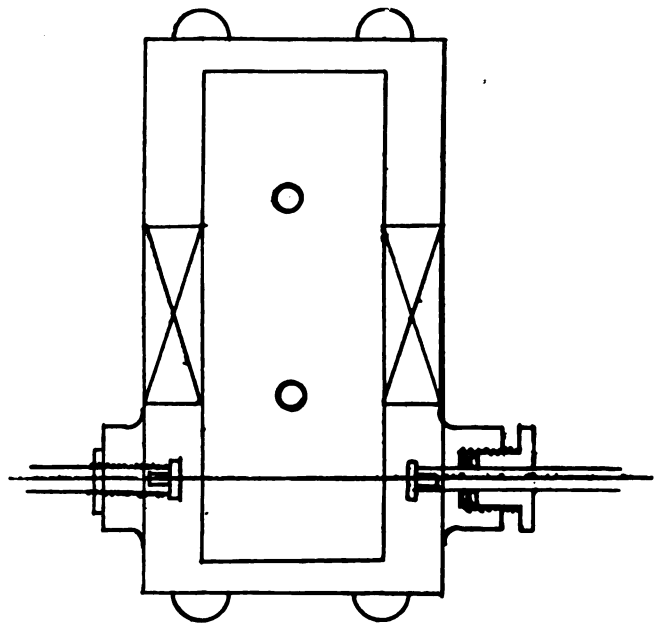
One of the chief causes of cable troubles in pit shafts is due to the shaft itself, as there is rarely sufficient space to erect the cable properly. Wherever a cable comes in contact with the tubing, buntings, wallings, etc., there is sure to be difficulty, through the deterioration of the insulation, no matter what kind of cable is used.

There are many troubles in pit shafts which cannot be prevented so far as the shaft is concerned, and the only remedy is to erect a suitable cable.

These difficulties are:—

(*a*) Impure water.
(*b*) High temperatures.
(*c*) Coal dust.
(*d*) Falling stones, etc.
(*e*) Mechanical injuries.

Bearing these points in mind, a strong, heavy cable is generally chosen. It is quite right to have a strong cable, but I am of the opinion that heavy cables are a prolific source of trouble. To erect a heavy cable from the top of the pit and leave the whole weight on the only suspension socket is a very bad plan. Cables erected this way are generally double armoured. The objection to this is that the contraction and expansion of the armouring in conjunction with the heavy strain is bound to damage the cable cores. When oak clips are used to clip the cables, the water and coal dust accumulates about the clips and cable. This soon destroys the insulation. I do not think armoured cables are good for shafts, except in so far that the armouring is a good mechanical protector for the cable cores. But other and more suitable cables can be mechanically protected in various ways without using the heavy and expensive armouring. One way of protecting a cable is to lay it solid in bitumen in wood troughing. Should this system be adopted the cables must be fixed between porcelain clips, the latter not to be a greater distance than three yards apart, or less, according to the weight of the cable. I was once in touch with a cable which was laid solid in this way, which, however, did not answer well. The difficulty here was that it was an up-cast shaft, the temperature probably being the fault. Cables in pit shafts do not give satisfactory results when they have their own weight to carry.



CLIP BOX.

A successful piece of work in a deep shaft, and where voltage was low, was carried out thus: the cable was laid in wood casing, well painted and varnished. The cable was pressed in the casing by a roller, and the capping of the casing was also pressed on by the roller and then screwed together by brass screws. This cable was in use a good many years. Bad water in colliery shafts is a source of trouble and one which is not easily got rid of, therefore a cable must be used in some way not to be affected by water. One method is to run the cables in welded iron pipes, and use a good vulcanized rubber insulated taped and braided cable, the number of boxes to be used according to the weight of the cable. The box, as shown in sketch given below, should be fitted to clip the cables and to take its weight.

It will be noticed that the box is designed to take the expansion and contraction of the iron pipes. There should also be a drain hole for the moisture or the water might accumulate in the pipes. Water will also affect the welded iron pipes. A good preservative for them is to steep them in quick lime for a week or so before erection and then paint them. Also paint the pipes and boxes occasionally after they have been in use in the shaft, say every three or six months, according to the nature of the water to contend with.

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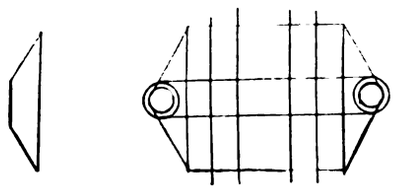
A great deal has to be contended against in an up-cast shaft in which exhaust steam is allowed to escape, for the temperature as it rises and falls, causes expansions and contractions. In such a case the iron barrel system in this particular case, with a good vulcanized rubber cable, taped and braided, is to be recommended.

As is well known, coal dust is troublesome to electric cables, and especially where water is apt to come in contact with them The coal dust resting on some conducting material, such as oak clips, which are in contact with the insulation of the cable and is subject to be dampened and then dries, soon forms into a carbon, which becomes dangerous. When deciding to erect a cable in a pit shaft that is exposed to bad water and coal dust, if there is sufficient room to allow the cable to be run without coming in contact with conducting material, a cheap and efficient way would be to support the cable say every three to six yards, according to the weight, on porcelain insulators. I designed such an insulator, illustrated in the accompanying sketch.

The idea of this insulator is to get over the deterioration of the insulation of the cable resulting from the coal dust and bad water which accumulates about the wooden clips and other conducting material. The insulator also takes the weight of the cable when fixed every few yards. The top of the insulator, where the cable is threaded through the hole, is a little expanded and then tapered. There are two porcelain wedges marked AA, which fit in with the cables; the weight of the latter effectually tightens the whole arrangement. The recess marked BB, is to be fitted with clams and held across the buntings; or the clams can be fitted into the shaft side.



Casing for Cable.

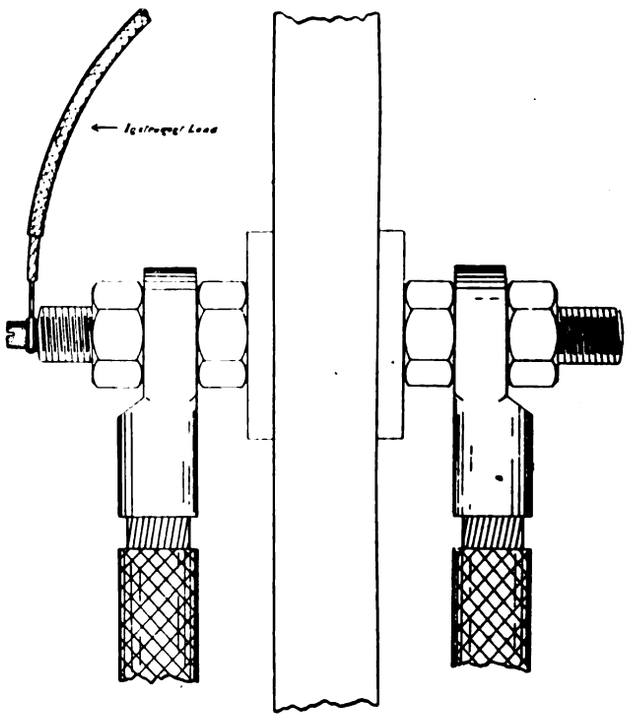
On selecting a pit shaft cable do not decide on a heavy cable. They are all troublesome sooner or later, if they have their own weight to carry. If there is plenty of room in the shaft, and the temperature be normal, a bitumen cable, or a dialite cable, will be found to answer well, and should be used with the above insulator. Wooden clips should not be used. They are not good for any class of cable in pit shafts. Should the shaft be very wet, I would recommend the iron barrel system, or the cable laid solid. The only time paper lead covered cables can be recommended in a pit shaft is when it is laid solid in bitumen. Paper lead covered cables have proved a success in other work, why should they not in pit shafts? It is, however, expensive, and also very difficult work, and the disadvantage is, when once erected, no alterations can be made. When erecting a cable as mentioned, the troughing should be first erected; then the cable clipped at both sides with porcelain clips, then the bitumen filled in from the bottom, working step by step to the top. This is very slow work, as it is necessary to wait for each layer of bitumen to set. Lead covered cables are bad to use in pit shafts where they are subjected to water from pits. There is sure to be trouble with the copper conductors and the lead covering. Should it be that there is not sufficient room in the shaft, a good idea is to use casing, a system which I believe is used by many firms. The sketch below gives the idea of the casing, and shows how it might be fixed to the buntings, etc.

When using iron about casings, keep it from the cable as far as possible. In the sketch it will be seen that there are no ledges for the coal dust to collect on, and the clams and their bolts are well away from the cables. Use yellow pine casing and well insulated cables. I also prefer shaft cables to be single, whether for continuous or alternating currents. I do not like the use of concentric cables. They are too heavy to handle, and not so simple to work with. Do not make joints in the shaft. Work of this class cannot be relied on. The making of good joints in shaft cables is essential. The joints should be made at the seams. When measuring for cables for pit shafts the lengths should be ordered from the manufacturers according to the depths of the seams. This will be found to be much simpler, and easier to work. When leading the cables in and out the seams, they should have a good sweep, and be well protected at this part. Whatever might be used, piping or otherwise, drainage should be carefully considered and attention to this part is most essential. I have never known aluminium cables to be used, but on account of their light weight they are worthy of consideration.

ARRANGEMENT OF INSTRUMENT LEADS FOR SWITCH BOARDS.

BY S. LEES.

The arrangement of instrument potential wires, testing leads, etc., on main switch-boards, often leaves much to be desired. To have a bunch of live wires, hanging loosely to pieces of tape is to court disaster. Yet, this is a too-common sight even in modern stations. The writer knows of at least one central station switch-board that was wrecked, the primary cause of which was an unprotected live wire. A practice which contributes largely to trouble of the kind in question, and, which cannot be too strongly condemned, is a method frequently employed in attaching instrument leads to their connections. The bared end of the wire is inserted between the face of the lug, or thimble, and nut, thereby destroying the efficiency of the joint



connection, besides weakening the wire at the point where it is bent round the connection. Separate terminals should always be provided for instrument leads. A safe and neat job is secured by fitting a screw (preferably with filister head) to the end of connecting stud or rod, as shown in the sketch, or if these points are not available for this purpose, small tapped holes (B.A. thread) should be provided at convenient points in the connecting strips or 'bus bars, as the case may be.

The "D.P." Battery Co., Ltd., of Bakewell, have recently received an order for a storage battery of 50 cells for Dundee University College from Messrs. Steinthal & Boydell, Ltd., of Manchester and Bradford, who are supplying the whole of the electrical equipment of the college.

The Simplex Conduits, Ltd., are now supplying high voltage lamps, suitable for burning direct on circuits from 200-250 volts of 25 c.p. The price of these new lamps will be 4s., and delivery can be effected in about a week from now.

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DIMENSIONS OF SINGLE-PHASE CORE AND SHELL TRANSFORMERS, WITH COPPER AND IRON CIRCUITS OF UNIFORM RECTANGULAR CROSS-SECTION.*

By A. R. Low, A.M.Inst.E.E.

Section 1.

Symbols used.

$P_o = \frac{1}{2}$ (input and output).

p_i = Iron loss as percentage of P_o.
p_c = Copper loss as percentage of P_o.
f_i = Iron space factor.
f_c = Copper space factor.
d_i = Flux density in lines $\times 10^{-4}$ per cm.^{2} $\left(\frac{B}{10000}\right)$ average value
d_c = Current density in ampere lines per mm.^{2} (average value).
w_i = Watts per kg. iron loss (average value).
w_c = Watts per kg. copper loss (average value).
N = Frequency in cycles per second.
l_i = Price of iron in £ per kg.
l_c = Price of copper in £ per kg.
x = Window width ..
y = Core width ..
z = Window height ..
u = Depth of laminations
} For a core transformer, the dimensions being in decimetres.

If we make the substitution $\left(\begin{matrix} y\ x\ u\ z \\ x\ y\ z\ u \end{matrix} \middle| \begin{matrix} 1 \div m'' \\ m' \div m'' \end{matrix}\right)$ throughout, the results obtained apply where—

x = Core width ..
y = Window width ..
z = Depth of laminations
u = Window height ..
} For a shell transformer.

Further—

$$h = 11.\ f_i.\ f.\ d_i.\ d_c \frac{N}{50}.$$

$g_i = 2.7, 7.\ f_i.\ w_i.$
$g_c = 2.8, 9.\ f_c.\ w_c.$
$k_i = 2.7, 7.\ f_i.\ l_i.$
$k_c = 2.8, 9.\ f_c.\ l_c.$

$$4\ F^4 = \frac{\pi}{4}\ c^4 = \frac{P_o}{h}.$$

$$a = \frac{g_i}{10\ .\ h\ .\ p_i}$$

$$b = \frac{g_c}{10\ .\ h\ .\ p_c}$$

$$m' \geq \frac{1}{2}\pi$$

$$m'' \geq \frac{4}{\pi}.$$

$$m = \frac{m' + m''}{2}.$$

$$M' = \frac{b}{a} m'.$$

$$M'' = \frac{b}{a} m''.$$

$$M = \frac{M' + M''}{2}$$

$$L^2 = \frac{a}{b}\ \frac{c^4}{a^4}.$$

The transformation is employed—

$x = a\,X$ $\quad$ $z = a\,Z$
$y = b\,Y$ $\quad$ $u = b\,U.$

Section 2.

The following expressions may be written down :—

Effective iron cross-section .. $= f_i.\ y.u$ dm.^{2}.
Mean iron circuit .. .. $= 2\ (x + z + m'\ y)$ dm.
Volume of iron .. .. $= 2.f_i.y.u\ (x+z+m'\ y)$ dm.^{3}.
Weight of iron .. .. $= 2.7, 7.\ f_i.\ y\ .u.\ (x+z+m'\ y)$ kgms.

Total iron loss .. .. $= (2.7, 7.f_i.w_i).y.u.(x + z + m'\ y)$ wts.
$= g_i.y.u.(x+z+m'\ y)$ watts.
50.

Effective copper cross-section $= f_c.\ x.\ z$ dm.^{2}.

Mean copper circuit .. .. $= 2\left(\ y + u\ \frac{x}{+m''}\right)$ dm.

Volume of copper .. .. $= 2.f_c.x.z.\left(y+u+\frac{x}{m''}\right)$ dm.^{3}.

Weight of copper .. $= 2.8, 9.f_c.x.z.\left(y+u+\frac{x}{m''}\right)$ kgms.

Total copper loss .. $= (2.8,9.f_c.w_c)\ x.z.\left(y+u+\frac{x}{m''}\right)$ wts.

$= g_c.x.z.\left(y+u+\frac{x}{m''}\right)$ watts.

The iron and copper losses are thus expressed in terms of the weight in kilograms multiplied by the watts per kilogram.

The losses may also be expressed as percentages of P_o.

$$\text{Iron loss} = \frac{p_i}{100} 1000\ P_o \text{ watts.}$$
$$= 10\ p_i\ P_o.$$

Equating this to the former expression—

$$10\ p_i\ P_o = g_i.\ y.\ u.\ (x + z + m'y) \quad . \quad . \quad . \quad . \quad (1)$$

and in exactly the same way—

$$10\ p_c\ P_o = g_c.x.z.\ (y + u + \frac{x}{m''}) \quad . \quad . \quad . \quad . \quad (2)$$

The total flux carried by the core is—

$$f_i.y.u.d_i.10^6.$$

The total current carried by the coils is—

$$f_c.x.z.d_c.10^4.$$

Since the total power—that is, the sum of the input and output—is the total current multiplied by the total flux with which it is interlinked, an expression for P_o may be written down—

$$P_o = \frac{1}{2}.\ 4,\ 4.\ 50.\ \frac{N}{50}.f_i.f_c.d_i.d_c.x.y.z.u.10^6.10^4.10^{-8}.10^{-3},$$

$$= 11.\ \frac{N}{50} f_i.f_c.d_i.d_c.x.y.z.u \text{ kilovolt-amperes} \quad . \quad . \quad . \quad . \quad (3)$$

Section 3.

Using the values of a, b, and c^4 (1) becomes—

$$a.y.u.\ (x + z + m'y) = x.y.z.u \quad . \quad . \quad . \quad . \quad . \quad (4)$$

(2) becomes—

$$b.x.z.\ (y + u + \frac{x}{m''}) = x.y.z.u \quad . \quad . \quad . \quad . \quad . \quad (5)$$

(3) becomes—

$$x.y.z.u = \frac{c^4}{m''} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

After some reduction (4), (5) may be written in the form—

$$z = \frac{a\ (x + m'y)}{x - a} \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

$$u = \frac{b\ (x + m''\ y)}{m''\ (y - b)} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Multiplying (7) by (8) and using (6)—

$$z\ u = \frac{c^4}{m''\ xy} = \frac{a\ b\ (x + m'\ y)\ (x + m''\ y)}{m''\ (x - a)\ (\ y - b)}.$$

That is—

$$x\ y\ (x + m'\ y)\ (x + m''\ y) = \frac{c^4}{a\ b}(x - a)\ (y - b)\ . \quad (9)$$

Section 4.

The system of equations—

$$\begin{cases} z = \dfrac{a\ (x + m'\ y)}{x - a} & . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7) \\ u = \dfrac{b\ (x + m''y)}{m''\ (y - b)} & . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8) \\ x\ y\ (x + m'\ y)\ (x + m''\ y) = \dfrac{c_4}{a\ b}(x - a)\ (y - b) & (9) \end{cases}$$

gives the fundamental relations between the dimensions of a transformer when all the other elements of design are kept constant.

This assumption may be justified by supposing that a fairly close design has been already obtained by slide-rule work, and that for the range between this design and the best dimensions the variations in densities and space factors is negligibly small.

* Paper read before the Institution of Electrical Engineers.

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It is seen from the system that there are three relations between four variables, and that there is, therefore, a one-fold infinity of values of $x\ y\ z\ u$, satisfying the system.

In fact, any values of x and y satisfying (9) when substituted in (7) and (8) give values of z and u, and the values of $x\ y\ z$ and u so obtained give the dimensions of a transformer satisfying the data of design.

Section 5.

The general form of the curve is shown in Fig. 1.*

Now, it is clear that $x\ y\ z$ and u must be real and positive, hence from equations (5), (6) we must have—

$$x > a$$
$$y > b.$$

It is seen from Fig. 1 that the oval branch lying beyond the straight lines $x = a$, $y = b$ is the only branch leading to positive values of $x\ y\ z$ and u.

It is, therefore, necessary only to consider the variation of the oval branch.

Section 6.

Let the ratio of p_i to p_e be kept constant.

It follows that $p_i \propto p_e \propto \frac{1}{a} \propto \frac{1}{b}$.

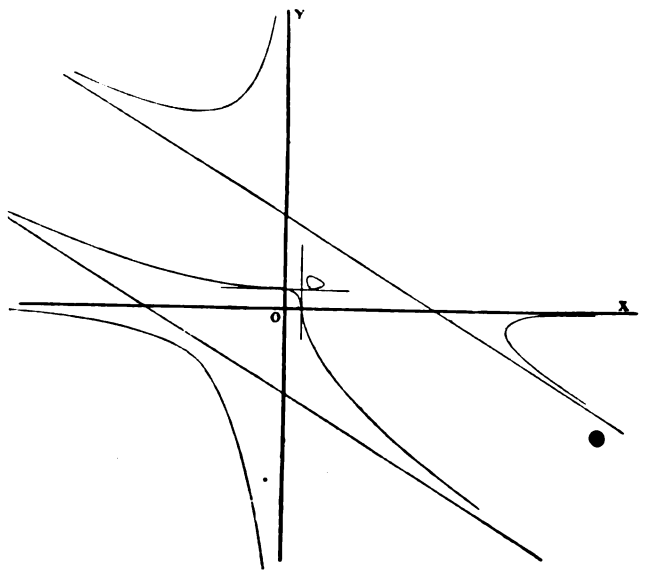

Fig. 1.

It is found that as p_i increases the oval swells until it coincides with the straight lines $x = o$, $y = o$ and the straight line at infinity, and as p_i decreases the oval shrinks until for definite values of p_i, p_e and the corresponding values of a and b it becomes a point.

No oval cuts any other oval, hence from geometrical considerations the point is a conjugate point.

This point gives unique values of x and y, from which unique values of z and u are derived by equations (7) and (8) taking the corresponding values of a and b.

For smaller values of p_i, p_e the oval branch disappears.

The values of $x\ y$ at the conjugate point and the derived values of $z\ u$ constitute a unique solution of the transformer dimensions for the given ratio $p_i : p_e$ and for minimum values of p_i and p_e.

Section 7.

Let now the ratio p_i to p_e vary continuously, the conjugate point also moves continuously, tracing out a locus of conjugate points.

Finally it rises to be determined what point on this locus corresponds to the transformer of least cost and of least losses, independently of the ratio of p_i to p_e.

* Note.—Cf. with some interesting quartics with and without oval branches discussed in Frost's Curve-Tracing.

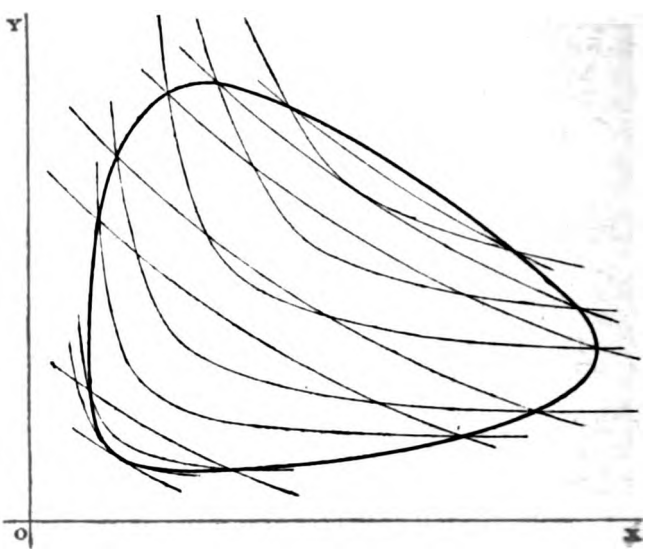

Fig. 2.

Section 8.

The analysis is much simplified by the transformation to X Y Z U.

(7) becomes—

$$Z = \frac{X + M' Y}{X - 1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

(8) becomes—

$$U = \frac{X + M'' Y}{M'' (Y - 1)} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11).$$

(9) becomes—

$$X\ Y\ (X + M' Y)\ (X + M'' Y) = L^2\ (X - 1)\ (Y - 1)\ . \quad (12)$$

The quartic (12) may be conveniently plotted as the intersection of the two families of hyperbolas—

$$(X + M'Y)\ (X + M'' Y) = L^2 \sin^2 i$$

and—

$$X\ Y \sin^2 i = (X - 1)\ (Y - 1),$$

which reduces to—

$$(X - \sec^2 i)\ (Y - \sec^2 i) = \sec^2 i \tan^2 i,$$

where i is a variable parameter (see Fig. 2).

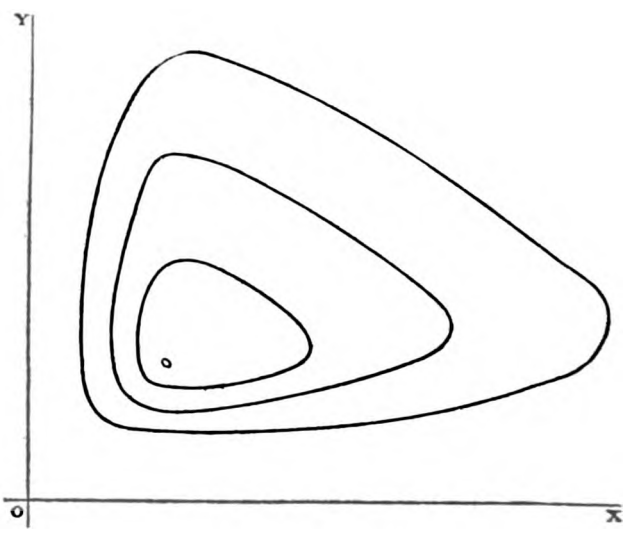

Fig. 3.

Different values of a give different values of $L^2\left(\frac{a}{b} = \text{const.}\right)$ corresponding to different ovals (see Fig. 3).

Section 9.

To find the locus of conjugate points we may rewrite (12), dividing by X Y—

$$V \equiv (X + M' Y)\ (X + M'' Y) - L^2 \left(1 - \frac{1}{X}\right)\left(1 - \frac{1}{Y}\right) = 0 \quad . \quad . \quad (13)$$

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and the conditions for a singular point—

$$\frac{dV}{dx} \equiv (X + M' Y) + (X + M'' Y) - L^2 \frac{1}{X^2}\left(1 - \frac{1}{Y}\right) = 0 \quad (14)$$

$$\frac{dV}{dy} \equiv M(X + M'' Y) + M''(X + M' Y) - L^2 \frac{1}{Y^2}\left(1 - \frac{1}{X}\right) = 0 \quad (15)$$

Add (14) multiplied by X to (15) multiplied by Y—

$$2(X + M' Y)(X + M'' Y) - L^2 \left\{ \frac{1}{X}\left(1 - \frac{1}{Y}\right) + \frac{1}{Y}\left(1 - \frac{1}{X}\right) \right\} = 0.$$

Using (13) this reduces to—

$$2\left(1 - \frac{1}{X}\right)\left(1 - \frac{1}{Y}\right) - \frac{1}{X}\left(1 - \frac{1}{Y}\right) - \frac{1}{Y}\left(1 - \frac{1}{X}\right) = 0.$$

After further reduction—

$$\left(X - \frac{3}{2}\right)\left(Y - \frac{3}{2}\right) = \frac{1}{4} \text{ (see Fig. 4)} \quad . \quad . \quad . \quad . \quad (16)$$

Since the equation is free of L^2, M', and M'' it is the locus of singular points.

Hence, noting that the lower branch passes through the point R (1, 1) at an angle of 45° with the negative directions of the axes, it is seen that only the upper branch satisfies the conditions of Section 5—

$$x > a \qquad y > b.$$

That is—

$$X > 1 \qquad Y > 1.$$

It is clear from physical and geometrical considerations that the singular points on the upper branch are conjugate points.

Dr. L. N. G. Filon has furnished an analytical proof, which is not printed here.

Section 10.

If to (14) multiplied by $M' + M''$ we add (15) multiplied by -2

$$(M' - M'')(X + M' Y - X - M'' Y) = L^2 \left\{ \frac{1}{X^2}\left(1 - \frac{1}{Y}\right) (M' + M'') - \frac{2}{Y^2}\left(1 - \frac{1}{X}\right) \right\}$$

after some reduction—

$$\left(X - \frac{1}{2}\right)^2 - \frac{M' + M''}{2}\left(Y - \frac{1}{2}\right)^2 = \frac{1}{4}\left(1 - \frac{M' + M''}{2}\right) + (M' - M'')^2 \frac{X^2 Y^3}{2 L^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

The intersection of (17) and (16) gives the values of XY corresponding to the given values of $M' M''$.

Section 11.

Graphical solution of the particular case where $M' = M''$ Equation (17) now becomes—

$$\left(X - \frac{1}{2}\right)^2 - M\left(Y - \frac{1}{2}\right)^2 = \frac{1}{4}(1 - M) \quad . \quad . \quad (18)$$

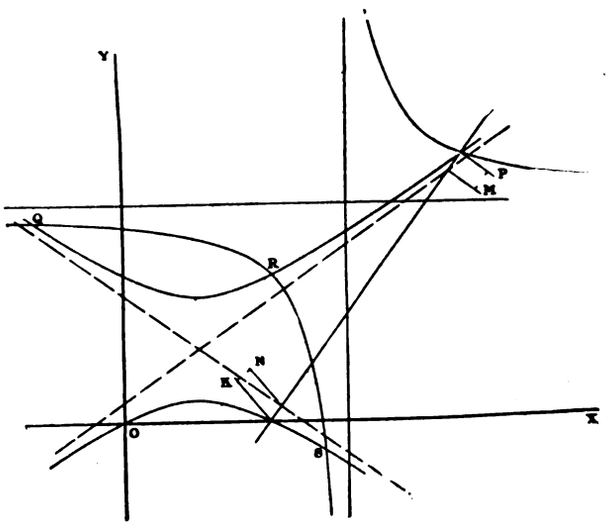

Fig. 4.

Curves (16) and (18) are shown in Fig. 4 intersecting in four points, P, Q, R, S, of which only P lies on the upper branch of (16).

To find P without drawing (18), draw the asymptotes—

$$\left(X - \frac{1}{2}\right) = \pm \sqrt{M}\left(Y - \frac{1}{2}\right)$$

and lay a straight edge across the figure so as to make PM = KN, K being the point (1, 0).

Section 12.

Taking X as the independent variable, Y and M may be calculated and tabulated.

Re-arranging the columns, we get values of X and Y tabulated against M.

M.	X.	Y.
12·50	4·00	1·600
12·08	3·95	1·600
11·66	3·90	1·605
11·25	3·85	1·605
10·85	3·80	1·610
10·46	3·75	1·610
10·07	3·70	1·615
9·70	3·65	1·615
9·34	3·60	1·620
8·98	3·55	1·620
8·61	3·50	1·625
8·26	3·45	1·630
7·92	3·40	1·630
7·58	3·35	1·635
7·25	3·30	1·640
6·93	3·25	1·645
6·61	3·20	1·645
6·30	3·15	1·650
6·00	3·10	1·655
5·70	3·05	1·660
5·41	3·00	1·665
5·13	2·95	1·675
4·85	2·90	1·680
4·58	2·85	1·685
4·32	2·80	1·690
4·06	2·75	1·700
3·81	2·70	1·710
3·57	2·65	1·715
3·33	2·60	1·725
3·10	2·55	1·740
2·87	2·50	1·750
2·65	2·45	1·765
2·44	2·40	1·780
2·24	2·35	1·795
2·04	2·30	1·810
1·85	2·25	1·830
1·67	2·20	1·855
1·49	2·15	1·885
1·32	2·10	1·915
1·16	2·05	1·955
1·00	2·00	2·000
$\frac{1}{M}$	Y.	X.

L^2 might also be tabulated, but it is calculable directly from X, Y, and M by means of equations (13), (14), (15), each of which should give the same value of L^2 if the graphical work or tabulation is accurate.

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SECTION 13.

From (13) and (14) by division—

$$\frac{(X + M'Y')(X + M''Y)}{X + M'Y + X + M''Y} = X^2\left(1 - \frac{1}{X}\right).$$

$\therefore$ From (10)—

$$Z = \frac{X + M'Y}{X - 1} = \frac{X[2X + (M' + M'')Y]}{X + M''Y}.$$

$$Z = 2X\left[1 + \frac{(M' - M'')Y}{2(X + M''Y)}\right].$$

$$z = 2x\left[1 + \frac{(m' - m'')y}{2(x + m''y)}\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

From (13) and (15) by division—

$$\frac{(X + M'Y)(X + M''Y)}{M'''(X + M'Y) + M'(X + M''Y)} = Y^2\left(1 - \frac{1}{Y}\right).$$

$\therefore$ From (9)—

$$U = \frac{X + M''Y}{M''(Y - 1)} = \frac{Y[M'(X + M''Y) + M''(X + M'Y)]}{M''(X + M'Y)}$$

$$U = 2Y\left[1 + \frac{(M' - M'')X}{2M''(X + M'Y)}\right]$$

$$u = 2y\left[1 + \frac{(m' - m'')x}{2m''(x + m'y)}\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

SECTION 14.

When $M' = M''$ (19) becomes—

$$Z = 2X$$
$$z = 2x \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (21)$$

(20) becomes—

$$U = 2Y$$
$$u = 2y \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (22)$$

Hence we have a complete solution in the particular case where $M' = M''$ of the dimensions corresponding to any given ratio of the losses.

Since $M' - M''$ is usually small, the solution obtained by putting $M = \frac{M' + M''}{2}$ for both M' and M'' throughout will give an approximate solution of the general case, equations (17), (19), (20) enabling us to examine the degree of approximation.

SECTION 15.

A complete algebraic solution is also found, in the particular case, for the problems of Section 7.

Taking the problem of finding the most efficient transformer, and putting $m' = m'' = m$, we may write down the total losses—

$$Q \equiv g_i.y.u.(x + z + my) + g_c.x.z.\left(y + u + \frac{x}{m}\right) \quad (23)$$

From (6)—

$$4R^2 \equiv x.y.z.u - 4F^4 = 0,$$

using (21), (22).

$$Q \equiv 2g_i y^2(3x + my) + 2g_c x^2\left(3y + \frac{x}{m}\right) \quad . \quad . \quad . \quad (24)$$

$$R^2 \equiv x^2y^2 - F^4 = 0.$$

$$R \equiv xy - F^2 = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (25)$$

The condition that Q is a minimum subject to $R = 0$ is—

$$\frac{dQ}{dx}\frac{dR}{dy} - \frac{dQ}{dy}\frac{dR}{dx} = 0,$$

or—

$$x\left(6g_i y^2 + 12g_c xy + 6g_c\frac{x^2}{m}\right) - y(6g_i my^2 + 12g_i xy + 6g_c x^2) = 0.$$

After some reduction—

$$6(x + my)\left(g\frac{x^2}{m} - g_i y^2\right) = 0,$$

rejecting the solution $x + my = 0$—

$$\frac{x^2}{y^2} = \frac{mg_i}{g_c}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (26)$$

whence by (24)—

$$Q \equiv 2g_i y^2\{(3x + my) + (3my + x)\},$$

and the ratio of iron and copper losses is—

$$\frac{3x + my}{3my + x}$$

a quantity whose upper and lower limits are 3 and $\frac{1}{3}$.

By (25) and (26)—

$$\frac{x^4}{F^4} = \frac{mg_i}{g_c},$$

rejecting all negative roots—

$$\left.\begin{aligned} x &= \sqrt[4]{\frac{mg_i}{g_c}}\,F \\ y &= \sqrt[4]{\frac{g_c}{mg_i}}\,F \\ z &= 2x \\ y &= 2w \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (27)$$

SECTION 16.

If k_i, k_c be substituted for g_i, g_c in (27), we get the dimensions of the cheapest transformer as far as cost of active materials go.

It is seen at once that the two solutions are the same only if $\frac{k_i}{k_c} = \frac{g_i}{g_c}$, and not otherwise.

This solution is evidently an approximate solution of the general case when $M' - M''$ is small.

SECTION 17.

It has hitherto been supposed that both copper and iron densities are rated up as high as possible, leaving a reasonable margin of safety.

Under these circumstances the assumption is justified that the flux and current densities are constant for a pretty wide range of dimensions.

In British practice another case arises where a large amount of material is put into a transformer at low densities to keep down the no-load losses without sacrificing regulation.

If we replace d_i and d_c by two variables y and v, we may vary y and v subject to the condition $y \times v$ = constant, without altering the output.

Again, if—

$$w_i = a u^n \ (n = 1{\cdot}5 \text{ to } 2),$$
$$w_c = B v^2.$$

we may increase the efficiency by increasing all the linear dimensions in the same proportion.

It has already been established that for any values of y and v we can find unique values of the dimensions which give minimum losses in any arbitrary ratio.

Combining these two methods, it is clear that by varying the densities and dimensions we can obtain any values for the iron and copper losses for any ratio of y and v.

The new problem is, what ratio of y and v gives the cheapest transformer while meeting the specified losses.

The solution leads to abnormally low flux densities.

The analysis is beyond the scope of the present paper.

SECTION 18.

Example.

(50 Kilovolt-amperes Transformer, 2000,200 Volts.)

$$P_o = 50{\cdot}5.$$
$$d_i = 1. \qquad w_i = 2{\cdot}2.$$
$$d_c = 1. \qquad w_c = 2{\cdot}2.$$
$$f_i = 0{\cdot}9.$$
$$f_c = 0{\cdot}4.$$
$$N = 50.$$

$$F^4 = \frac{50{\cdot}5}{4 \times 11 \times 0{\cdot}9 \times 0{\cdot}4 \times 1 \times 1} = 3{\cdot}19.$$

$$F = 1{\cdot}337.$$
$$g_i = 2 \times 7{\cdot}7 \times 0{\cdot}9 \times 2{\cdot}2 = 30{\cdot}5.$$
$$g_c = 2 \times 8{\cdot}9 \times 0{\cdot}4 \times 2{\cdot}2 = 15{\cdot}7.$$
$$m' = 1{\cdot}57. \qquad m'' = 1{\cdot}27. \qquad m = 1{\cdot}42.$$

Approximate solution—

$$\left.\begin{aligned} x_1 &= \sqrt[4]{\frac{1{\cdot}42 \times 30{\cdot}5}{15{\cdot}7}} \times 1{\cdot}337 = 1{\cdot}72. \\ z_1 &= 3{\cdot}44. \\ y_1 &= \sqrt[4]{\frac{15{\cdot}7}{1{\cdot}42 \times 30{\cdot}5}} \times 1{\cdot}337 = 1{\cdot}035. \\ u_1 &= 2{\cdot}07. \end{aligned}\right.$$

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The losses calculated on the supposition that $m' = m''$ are by (26)—

$$2\,g\,y_1^2\,(3\,x_1 + m\,y_1) \quad \text{and} \quad 2\,g_i\,y_1^2(3\,m\,y_1 + x_1).$$

Iron loss $= 2 \times 30{\cdot}5 \times 1{\cdot}035^2 \times 6{\cdot}63 = 430$ watts.
Copper loss $= 2 \times 30{\cdot}5 \times 1{\cdot}035^2 \times 6{\cdot}12 = 400$ watts.

The actual losses for the abave values of $x\,y\,z\,u$ are—

$$\text{Iron loss} = 2\,g_i y_1^2\,(3\,x_1 + m'\,y_1) = 440 \text{ watts.}$$
$$\text{Copper loss} = 2\,g_c x_1^2 \left(3\,y_1 + \frac{x_1}{m''}\right) = 415 \text{ watts.}$$

The ratio of actual losses is $\dfrac{3\,x_1 + m'\,y_1}{3\,m y_1 + \dfrac{m}{m''}x_1}$, which here $= 0{\cdot}95$, and,

in general, is not necessarily unity.

We may test the degree of approximation by means of (19) and (20).

A second approximation is—

$$z = 2\,x\left[1 + \frac{0{\cdot}3 \times 1{\cdot}04}{2\,(3{\cdot}03)}\right].$$
$$= 2\,x\,[1 + 0{\cdot}052].$$
$$u = 2\,y\left[1 + \frac{0{\cdot}3 \times 1{\cdot}72}{2 \times 1{\cdot}27 \times 3{\cdot}35}\right].$$
$$= 2\,y\,[1 + 0{\cdot}061].$$

Hence the dimensions are within 5 or 6 % of the theoretically best design, and as we are in the neighbourhood of a turning value the total losses will not be out by more than a small quantity of the order of $(0{\cdot}05)^2$ or $(0{\cdot}06)^2$—that is, $\frac{1}{4}$ or $\frac{1}{3}$%.

Section 19.

Example of Graphical Method and Use of the Table.

$P_0 = 40{\cdot}5.$
$N = 50.$
$p_i : p_c = 1 : 2{\cdot}5.$
$f_i = 0{\cdot}9.$
$f = 0{\cdot}35.$
$d_i = 1. \qquad w_i = 2. \qquad g_i = 27{\cdot}6.$
$d_c = 1. \qquad w_c = 2{\cdot}22. \qquad g_c = 13{\cdot}8.$

$$c^4 = \frac{4}{\pi} \times \frac{40{\cdot}5}{11 \times 0{\cdot}9 \times 0{\cdot}35 \times 1 \times 1} \times \frac{50}{50} = 15.$$

$$a = \frac{2 \times 7{\cdot}7 \times 2}{110 \times 0{\cdot}35 \times p_i} = \frac{0{\cdot}8}{p_i}.$$

$$b = \frac{2 \times 8{\cdot}9 \times 2{\cdot}22}{110 \times 0{\cdot}9 \times p_c} = \frac{0{\cdot}4}{p_c}.$$

$$\frac{a}{b} = \frac{0{\cdot}8}{0{\cdot}4} \times \frac{p_c}{p_i} = 5.$$

$m' = 1{\cdot}57. \qquad m'' = 1{\cdot}27. \qquad m = 1{\cdot}42.$

$$M = m \div \frac{a}{b} = 0{\cdot}284.$$

$$\sqrt{M} = 0{\cdot}533.$$

Approximate Solution

Drawing the line pair—

$$\left(X - \frac{1}{2}\right) = \pm \sqrt{M}\left(Y - \frac{1}{2}\right),$$

and laying off P M = K N as in Fig. 4, we get—

$$X = 1{\cdot}7, \qquad Y = 2{\cdot}7.$$

Or, using the table and reading from the bottom, by proportional parts—

$$\frac{1}{M} = 3{\cdot}52, \qquad Y = 2{\cdot}65, \qquad X = 1{\cdot}71.$$

Substituting these values of X Y and M in (13), (14), or (15) we get—

$$L^2 = 23{\cdot}5 = \frac{a\,c^4}{b\,a^4}.$$

Whence in succession—

$$a^4 = \frac{5 \times 15}{23{\cdot}5} = 3{\cdot}2.$$
$$a = 1{\cdot}34.$$
$$b = \frac{a}{5} = 0{\cdot}268.$$
$$p_i = \frac{0{\cdot}8}{a} = 0{\cdot}6 \text{ per cent.}$$
$$p_c = \frac{0{\cdot}4}{b} = 1{\cdot}5 \text{ per cent.}$$
Iron loss $= 242$ watts.
Copper loss $= 610$ watts.

Again—

$$x = a\,X = 1{\cdot}34 \times 1{\cdot}7 = 2{\cdot}28.$$
$$y = b\,Y = 0{\cdot}268 \times 2{\cdot}7 = 0{\cdot}725.$$
$$z = 2\,x = 4{\cdot}56.$$
$$u = 2\,y = 1{\cdot}45.$$

Substituting these values in the right-hand side of (1) and (2)—

Iron loss $= 2 \times 27{\cdot}6 \times 0{\cdot}725^2 \times 7{\cdot}98 = 230.$
Copper loss $= 2 \times 13{\cdot}8 \times 2{\cdot}28^2 \times 3{\cdot}97 = 570.$

There is a discrepancy of 5 or 6% between the two evaluations of the losses.

The ratio required, however, is accurately enough attained.

Section 20.

I am specially indebted to Dr. L. N. G. Filon, to whom I owe the method of Sections 9 and 10, and the elegant graphical solution of paragraph 11; and my thanks are due to Professor Kapp, without whose encouragement the work would at one time have been laid aside.

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DEATH OF A LAMP TRIMMER.

Mr. Troutbeck held an inquest at Battersea on the 10th inst. with reference to the death of Ernest Lennard, a lamp trimmer in the employ of the Battersea Borough Council, who was reported to have been electrocuted in Bolingbroke-grove. The evidence showed that deceased had suffered with heart disease, and on the previous Friday evening he was engaged at an electric lamp standard in Bolingbroke-grove when he suddenly fell and died immediately. It was stated on behalf of the Battersea Council that it was almost impossible for a man to receive a shock. Dr. Trevor said death was due to heart failure, and the jury returned a verdict of death from natural causes.

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ELECTRICITY IN BRITISH COAL MINES.

A digest of H.M. Inspectors of Mines on coal mining has been issued as usual by *The Colliery Guardian*, and it contains certain passages from the official reports that directly concern our readers.

Mr. Arthur H. Stakes, Inspector for the Midland District, says: "There appears to be a disposition on the part of many owners and managers to adopt or extend the use of electricity as a motive power. One reason for the tendency is no doubt the facility with which the power can be carried or transported from place to place, and the expeditious erection of the plant. There is economic advantage in this, provided that it is well designed with a due regard to the question of load, but many plants have been erected with very meagre, if any, provision for surplus power, more especially those designed for haulage purposes, where little consideration has been given to inertia, or the extra power required in the first few moments when starting to run after standing for a week-end. To those electricians who have not yet experienced difficulty with underground motors a timely warning may save them disaster and disappointment at some future date." A warning which must be taken in good part, and due note made of it. Mr. J. S. Martin, Inspector for the Southern District, also makes a special point of the rapid strides that are being made in the adoption of electricity in the mines throughout the district in Cornwall, Gloucestershire (Bristol and the Forest of Dean), Kent, Monmouthshire and Somersetshire). It is used for pumping, underground haulage, and the working of about a dozen coal-cutters. Mr. Martin, however, expresses the hope that no attempt will be made to work electrically driven coal-cutters at the face of any of the more fiery mines of Monmouthshire, for the working of which his advice would be to erect air-compressors underground as far in-bye in the intake airway as it may be safe to work electrically, and supply compressed air to the coal-cutters at the face. In face of success elsewhere, we may well hold these fears as exaggerated. He says that electricity has been a disappointment to some people, more especially in Cornwall, but thinks the explanation is that the parties obtained their generating plant from the makers, without having had the scheme gone into by an efficient and experienced electrical engineer on their own behalf, in order to see whether it was suitable for the proposed work, with the result that they have not got the necessary power or the work satisfactorily carried out.

Coming from the general to the particular, we will now abstract notes relating to accidents in the various districts. In the East Scottish district, where there were 126 deaths and 524 non-fatal accidents, there were two fatal accidents due to electricity. The first accident occurred at Dysart Colliery, Fife. A concentric cable, carrying three cores 37-12 W.G. wires, for a three-phase current, was placed in a wooden box or rhone, and the space inside filled with bitumen. The box was laid on one side of the haulage roadway. At one part of the roadway water dripped from the roof, and in order to protect the box deceased was instructed to lay corrugated iron sheets on top, and to fix them by tying. Instead, however, of tying, he drove a nail into the box, which passed in through to the cable, and reaching one of the box wires caused the iron sheets to become live. His left hand rested on the sheet while he drove in the nail, and current passing through his body to earth, he received a fatal shock. The voltage was 250. The second case took place in Aitken Colliery, Fife. Electric lighting wires were taken from main cables, which had previously been in use to work a motor, and part of a haulage way was lighted. A number of men were making some repairs on the roadway when a small stone fell away from the side and threw down the lighting wires. Two of the men lifted the wires, and while tying them up temporarily one man's body came in contact with a live part, causing a fatal shock. An examination afterwards was made, and it was found that the wire had been broken, the wires joined together by twisting, and the bare part covered by a piece of string. This piece of string was wet and acted as a conductor, and it was this part which came in contact with deceased's naked body. Evidence could not be obtained as to who twisted the wires, but it was quite evident the work was done by a novice, in contravention of the Electrical Special Rules. A short distance out-bye was a switch which was easily accessible, and had it been used to cut off the current before interfering with the wires, no accident would have happened. The voltage was 450.

In the West Scotland district, where there were 85 deaths and 374 non-fatal accidents, there was one man supposed to have been killed by an electric shock in Tannochside No. 3 pit, Lanarkshire, but there seems to be some uncertainty as to whether or not he did not die from natural causes. A three-cored armoured cable conveying an alternating current of electricity of 400 volts to a pump is taken down one side of a dook in which the deceased acted as chain runner. The signal wire was fixed alongside the cable, being separated from it by a distance of 9 in. except at one part, where they were about 2½ in. apart. It appears that the deceased was found dead in a sitting position at a point where the dook is 4½ ft. wide, with his back against the side opposite to that along which the cable and the signal wire were suspended about 2 ft. above the rails. His attitude was similar to that assumed by a person taking a rest. Several of the miners stated that shortly before the body of the deceased was found they saw electric sparks at the bench where they worked, coming either from the cable or the signal wire where they crossed beneath a wet crown. One of these men stated that on touching the signal wire he got a shock, another stated that he got a slight shock from a damp screen when passing up through it to look for deceased. The only mark on the body of the deceased was a slight abrasion on the back of one hand, and this the overman stated was caused by his moving the arms while trying to restore life, while the doctor employed by the workmen certified that this was a burn caused by electricity, and that the death was due to an electric shock. No defect could afterwards be found in the cable or connections, nor could it be ascertained what could have made the signal wire live. Mr. Nelson, after commencing his duties as electrical inspector of mines, made a careful examination of the plant, but could not ascertain how the deceased got an electric shock. There was one non-fatal accident from an electric shock which was not reported, as should have been done, and this took place in Home Farm Colliery, Lanarkshire. A brusher was handling the trailing cable of a coal-cutting machine, and while doing so got a shock which was caused by the insulation having worn off. There is a tendency among some officials to disregard the regulations which are so necessary to prevent shocks from cables with defective insulation, and it is not unusual to see cables below ground placed in positions that invite the destruction of insulating material.

In the Newcastle district, where 42 electrically driven coal-cutting machines are used, there were no electrical accidents.

In the Durham district, where there were 104 deaths and 570 persons injured, there was only one accident, and that non-fatal, from electricity underground. A coal-cutting machine man received a shock when switching the current on to a coal-cutter. The explanation appeared to be that the man, in starting the machine, did not put the switch right over; an arc was formed and it burned out the insulating material, thus causing the machine to be alive.

In the Yorkshire and Lincolnshire district, where 111 electrically driven coal-cutting machines were in use, no accident attributable to electricity occurred. The same satisfactory result was reported from Manchester and Ireland, where 16 electric coal-cutters are used.

In the Liverpool and North Wales district, where there were 155 deaths and 300 persons injured, one workman was killed by an electric shock of 500 volts at the Bispham Hall Colliery, near Wigan. Mr. Ram, of the Factory Department, examined the installation, and gave evidence at the inquest. He said he considered it was quite wrong to have fuses on switches on the outer conductor in such a system as that; in fact, the rules he was acquainted with strictly forbade it. It appeared, however, that Mr. Woods and Mr. Marsden had somewhat been misled by Rule 9, which specified the conditions under the ordinary system.

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The concentric system was a special system, for which special precautions had to be taken. The rules were specially drafted for use of electricity in mines, and were supposed to be for people who knew about electrical work; they were not detailed specifications for people who had not much knowledge of those things. It was presumed that the person who was in charge of that kind of work knew a good deal about it, and he thought that was where the trouble had come in in that case. Mr. Woods appeared to have been careful in providing a special earth connection in addition to the one at the generating station. But one of the fuses which they had, ought not to have been there at all. If the earth connection had been in order the accident would not have happened. Mr. Woods was quite right in having that earth connection, but unfortunately it was loose and did not act. If there had been no fuse at all it would have been quite unnecessary to have another earth connection. Then there was another important point, if they were to have the concentric system in the mine at all, it should be concentric throughout. The deceased man was travelling up a steep inclined road on his way home, on one side of this road the cable was suspended carrying electricity into the mine, he used the cable to help himself along, and, in doing so, touched a part which had been damaged in some way so as to destroy the insulation. This damage ought to have been discovered and repaired, the earth connection was also out of repair. Mr. Hall finds that the electric installations at the mines are not carried out so as to ensure the maximum degree of safety. In the power house or generating station on the surface no expense is spared, and the fittings are generally of a high class and the work well done, but this is by no means always the case *in the distributio' of the current undergrou d*. Electrical machinery is dumped down into motor houses, where the space is so restricted that the attendant cannot move about without constantly coming into contact with the cables; it is true these cables are supposed to be insulated, but this is no excuse for their being left hanging loose or fixed in such posi ions that the attendant may accidently fall over them or entangle himself among them. A charge made by Mr. Hall is worth noting. He says he has observed that professional electricians seem to treat with contempt any suggestion of danger from shock; they themselves are aware, of course, that sudden death lies hidden under the cotton covering of the cables; also in the exposed uninsulated metal work of the machines, but they forget that the class of person who are made into attendants in these places cannot and do not realise the imminent risk there is, should the cables become frayed or worn so as to expose the tiniest bit of metal conductor, or should any of the numerous joinings of the cables go wrong. Of these latter joinings together of cables he found as many as a dozen in a small motor house, more than half of which were quite unnecessary.

In the Midland district, where there were 97 fatal accidents, and where 91 electrically driven coal-cutters are in use, two fatal accidents were caused by electricity. In one of these the accident occurred at a small motor used for haulage for a deep heading. The onsetter in the heading required the tubs pulling up and gave a signal accordingly, but failed to get the rope to move. He went up to the motor to see the cause, and found deceased lying on the floor between the motor and the switchboard. He spoke to him but got no reply, and after obtaining assistance artificial respiration was tried for over an hour, but he failed to recover. There were three incandescent electric lamps burning, and the motor house was well lighted. The previous motor driver had only left the place a few minutes and he declared that the switch and controller were off when he left the motor. He met deceased about 20 yards from the motor and told him about the signalling battery. Both the switch and controller were off when deceased was found. The floor was of wood, but damp, and so were the trousers and feet of the deceased, for he had been working in a wet place before going to the motor. The installation was unsatisfactory, for one of the terminals was bare and so near the handle of the switch that, unless great care was taken, the hand of the person working it was liable to come in contact with the live terminal. This was probably the explanation of the way deceased received the electric shock. It was an unsuitable switch for a motor in a mine because of its liability to give shock to those having to use it. The electricity was a continuous current, and about 550 volts at the motor. In the other case deceased was in charge of the hauling arrangements at the junction of two roads, and from this junction to the haulage motor the signals are given by electricity from a battery in the usual form for signalling; running parallel, and for a short distance near together were two power cables, taking current to a pump some distance from the junction. Deceased was seen to be examining the signal bell, which was sparking badly, and a blue flame playing round it. Soon afterwards deceased was heard to cry out and, upon some workmen going to him, they found the lower bell wire under his left arm-pit. The colliery electrician found that part of the bell had been burned off, and going further along the road way found a place 150 yards away where there appeared to have been a contact between one of the cables and one of the signal wires. The signal wire showed signs of contact with a bare place in the power cable, but they were some distance apart. Some repairers were at work a few yards below the place where the contact occurred, and it is probable that their work had in some way interfered with the position of the signal wires and the power cable, and so brought them temporarily together, causing the power current to enter the signal wire, and so pass to the bell where deceased was at work; or it may be that a fall of stone or side had pressed them together. It was clear that, however caused, the power current had got into the signal wire and deceased's examination of the bell and wire caused his death. The power cable was carrying a continuous current of 500 volts. Four non-fatal electrical accidents have occurred during the year. The driver of a haulage motor when finishing his day's work sent a youth to draw up a train of tubs, and this youth left the controller upon the first contact with the switch in contact and the brake on the haulage drum pegged down tight, the result being that the resistances heated and were burned, and also the side of the motor house, which was cut out of the solid coal, caught fire. It was not discovered until some time afterwards, when the fire was quickly put out. A haulage motor driver was slightly burned on the hand, and in explanation stated that when putting the switch in with his left hand he got his wrist on the terminal of the pole. More probably he was doing his work carelessly, and a flash occurred at the poles of the switch. The burn was very slight. Another haulage motor driver received a shock when hauling a train of tubs. The motor is fitted with a tramway-type controller, and after the accident it was found that the contacts of the controller were burned off. It was probably due to carelessness in passing the dead stop slot with the controller and going on to reverse the load. He had been previously warned by the electrician not to do this. In one case the fusing of a switch and the burning of the motor driver's hand occurred at a motor used for driving a screening plant. It was probably due either to putting in the switch, which is the first duty, and the controller at the same time, or the controller was on at the same time he put the switch in. A colliery mechanic was holding a portable electric light while some fitters were at work repairing a pump. He fell and broke the lamp, receiving a shock from the projecting wires being in contact with the lamp holder. A driver was taking two empty tubs with a pony into a working place, when he found that a piece of roof had fallen and broken down the electric cable, taking power to the coal-cutters. The pony's gear caught in the cable, and in pulling to get free the gears abraded the covering and bared the wire. The continuous current of 350 volts passed into the gears and through the pony, killing it before the current could be cut off. The driver, a youth of good age, got into the first tub to escape, and placing his hand on the draw-bar of the tub he got a shock. He then got over into the second tub and received another shock from the draw-bar, and he then fell over the end of the tub into the roadway. A workman going down the roadway to see what was the matter received a shock by stepping on a rail, but both persons received little injury. At the time of the accident the coal-cutter was standing, which may probably explain why the fuse did not at once blow out. The pony passed

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sufficient current through its body to kill it, but not sufficient to blow out the fuse (100 ampéres).

In the Stafford district, where 111 men were killed and 423 injured, no fatal and only one non-fatal accident from electricity was reported. At New Haden Colliery (North Staffordshire), on December 4, a loader foolishly ran his hand along one of the cables of a three-phase installation and, at a point where the installation was defective, received a slight shock.

In the Cardiff district, out of a total of 134 deaths and 597 persons injured, there were two accidents during the year through the use of electricity, by which one life was lost and one person injured slightly. The fatal accident occurred at Ferndale No. 1 Colliery on August 27. It occurred at a haulage plant on the main level. The plant consists of a 200 b.h.p. motor of the slip-ring pattern with enclosed slip-rings, which works a pair of main and tail rope drums. The voltage was 2,200, and the amperage ran up to 50. On August 26 arcing was noticed at the point where one of the three cables was attached to the stator coils of the motor, and the electrician who had charge of the haulage engines wrote a note to deceased telling him to remake the joint during the night shift. Deceased and another electrician went to do so at 8 p.m. He put out the switch and laid everything dead, opened and re-made the joint by soldering it. It was then covered with insulating material called sterling tape. The motor was worked soon after in deceased's presence, and no arcing was observed. About 2.30 a.m. he returned to the motor room. He saw the motor was idle, with the controller on the "off," and he, without knocking out the switch, which he passed, went and sat on the iron bedplate, and put his hand on the joint to see if it was cold, and received a severe shock. Artificial respiration was resorted to, and continued after the arrival of the medical man for three hours without success. In the three-phase system only two cables are laid dead by putting the controller in the "off" position; the third remains alive. This fact deceased appears to have forgotten or he may have thought the insulation he had put on the joint was sufficient protection. He should have thrown out the switch before going to the joint. The motor was properly earthed, and an automatic switch was provided by which the current could be cut off the motor. About 1,400 volts passed through him. On April 29 at Penallta Colliery, a fuse on the high-pressure side of a transformer in a lodge room blew out, and the lights at the sinking pit bottom went out. Instead of sending for the electrician as he had been instructed, the leading sinker tried to renew the fuse and in doing so caused an arc which burned his face slightly. The electrician on being sent for found that the current had not been switched off. It was fortunate he had india-rubber gloves on, and that he was standing on a rubber mat. The voltage was 3,000.

In the Swansea district one fatal accident occurred which resulted in the deaths of 3 workmen. It took place at 5.10 a.m. on September 30, at Glyncorrwg Pits, Blaengwynfi belonging to Messrs. Glyncorrwg Colliery Co., Ltd. Gelignite electrically fired was the explosive adopted. Five holes had been bored, three in the left side, one in the centre of the heading near the floor, and one in the centre near the roof. It was decided first to charge and fire the hole near the floor. Eight pellets of gelignite were placed in it and clay stemming was used. The shot was fired electrically, and according to the report heard, apparently did good work; but upon subsequent examination it was found that the shot had partialy blown out, and only a small portion of the ground at the mouth of the hole was shot away. The leader resolved after clearing out the hole to recharge it; a further charge of gelignite was inserted, and as the work of stemming was approaching completion, the explosive fired while the men were engaged at the hole. One of the men, who subsequently died, described the process of throwing a bucket full of water into the shot-hole, thus pointing to the probability of a part of the explosive remaining in the hole as hot residue. He could not, however, say what was actually being done at the moment of explosion. It does not seem possible with the available information to say with any degree of certainty, what caused the accident; nor is it known what degree of mere heat would cause the detonator to explode. If there was anything left smouldering in the hole it might ignite the explosive, and result in the explosion. Possibly a jerk of the wires might ignite the detonator.

In the Southern district, where there were 93 men killed and 277 injured, one accident, with 1 death, occurred from the use of electricity at Bargoed Colliery. The deceased was an electrician, and was called to the underground haulage engine owing to a defect. He was in the act of examining the controller for the third time for a latent defect, which was afterwards found by testing, when, in some accidental manner, he made contact, and got a current of 3,000 h.p. through him, which had not been cut off as was done on each previous occasion of taking out the controller, and which he no doubt expected the lad in charge of the engine had done.

AMERICAN NOTES.

[From Our Own Correspondent.]

NEW YORK.

The Post Office Department are well satisfied with their experimental use of electric mail wagons in a section of the borough of Manhattan, New York City. There are 14 such wagons, supplied by the Motor Delivery Co. They vary in size, two having a carrying capacity of 4,500 lb., two of 2,500 lb., and eight of 1,300 lb. It is found that the service is considerably hastened, and the experiment is to be extended.

The Ohio Electric Light Association has been sitting in Convention. Among other subjects discussed was the advisability of grouping small towns together to be served with light and power from one central station. There has been too great a multiplication of generating stations, with the result that many are in far from a flourishing condition. In a good many cases, companies have sprung up which do not own any plant, but contract to light a town and supply the citizens with power. These companies buy the power in bulk from a generating station, find the capital for all mains and fittings, and make a profit over the deal. But small stations cannot afford to supply bulk electricity at a low enough figure to pay them and leave a margin to the retail concerns. Hence the cry for grouping.

Commissioner of Wires, J. E. Coles, of Boston, reports that the streets of the City are fast being cleared of overhead wires. Within the past 15 years 57,000,000 ft. of overhead wires have been placed underground; this was mostly by franchise companies, the Commissioners of Wires only being responsible for less than one-fifth of the total. The cables used vary from two-conductor messenger and fire-alarm lines to 200-conductor telegraph and 600-pair telephone cables, and from No. 8 lighting cable to 2,000,000 circ. mil rubber-covered feeders for railway service. There are about 1,572,100 ft. of conduit installed in Boston, with 9,885,000 ft. of single duct, 12,800,000 ft. of cable, 7,143 manholes, 15,862 services, 620 Edison distribution boxes, and about 600,000 ft. of Edison three-wire tube. The largest amount of underground work carried out during the past year was by the Boston Edison Co., with its 17,936 ft. of conduit, carrying 223,776 ft. of cable. The Boston Elevated Railway Co. installed 14,977 ft. of conduit, or 73,862 ft. of cable, and the New England Telephone and Telegraph Co., 2,860 conduit ft., with 77,409 ft. of cable. The various companies using underground service installed 747 new services in the year, a gain of 43 compared with the previous year.

The twin tunnel tubes of the Hudson and Manhattan Railroad Co., running between the Hudson Terminal-buildings, New York, and the Pennsylvania Railroad Station, Jersey City, and is working smoothly. A sub station has been installed under the New York terminal, and here the high-tension alternating current is converted into 625-volt current for the railway circuits and to 240 volts for the lighting circuits in the buildings. There are at present two 1,500-kw. General Electric rotary converters for railway load and four 750-kw. rotaries for lighting load, but provision is made for two additional 1,500-kw. units, giving the substation an ultimate output of 9,000 kw. Each of the railway units has a separate set of three 750-kw., air-cooled transformers, taking 25,000 25-cycle current and delivering 390-volt current at the secondaries. The rotaries deliver 625-volt, direct current to the third-rail feeders. Each of the four lighting units is supplied from three air-cooled transformers. Cooling air for the transformers is supplied by motor-driven fans taking air from an intake running from the roof.

The Boston and Maine Railroad Co. have acquired hydro-electric installation privileges on the Penrigewasset River. They require electrical power to operate their extensive workshops, and also certain trolley lines.

A bulletin just issued by the Joint Committee on Conservation gives some interesting figures. It shows that the United States has 5,250,000 h.p. in water-power in use. The undeveloped water-power controlled by the National Government aggregates only 1,400,000 h.p.

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CONTENTS.

	PAGE
Notes	173
Tramcar Rolling Stock Mishaps	174
Colliery Shaft Cables	175
Arrangement of Instrument Leads for Switch Boards	176
Dimensions of Single-phase Core and Shell Transformers, with Copper and Iron Circuits of Uniform Rectangular Cross-Section	177
Electricity in British Coal Mines	182
American Notes	184
Mining and Electricity ..	185
Petrol Electric Power ..	186
New Catalogues	186
The Application of Electric Motors to Industrial Service	187
Live Rail on the Mersey Railway	188
Lighting a Pageant	188
Electricity in New South Wales Coal Mines ..	189
Electralytic Corrosion of Telephone Cables ..	193
Electromobile Instruments	195
Technical Problems, with Solutions by Practical Men	196
Personal	198
Books Received	198
Companies' Meetings and Reports	198
Companies Registered ..	200
Liens Registered	201
Receivers Appointed ..	201
Lighting & General Notes	201
Traction Notes	202
Contracts Open	202
Results of Tenders	203
Patents	203
Classified Directory of Electrical Trades ..	xv.

MINING AND ELECTRICITY.

When we consider the relative conditions of coal mining in Great Britain and the United States we at once see the enormous future for electricity below ground. After over fifty years' experience we have only some 2,000 cutting machines in use. If we take the latest full statistics we find that in 1907 we had 1,493 machines in use, as against 10,212 in America in 1906, yet our mining population was 1,059,000, as against their 940,000. Our machines gave an average output of 8,630 tons per machine, their's 11,638. It is true that all these machines are not worked by electricity, compressed air being a serious competitor. According to Mr. R. D. Bain, Chief Inspector of Mines for the Durham District, there are now 175 coal cutting machines at work, showing an increase of 23 over the previous year. Both electricity and compressed air are used, a preference being shown for the latter, owing, it is said, to the fact that it iseasy to handle and assists ventilation. But this plea of assisting ventilation, of course, demonstrates a weak point, that is to say, a serious wastage of power. The claim that compressed air is less liable to produce accidents in fiery mines than electricity, merely proves that all due precautions in the latter case are not taken. We have already pointed out that in Australia the use of electricity and immunity from accidents appear to go together, and in this connection the New South Wales mining report on electricity in coal mines, and especially the regulations as to its use, published in another column, will afford interesting reading. So too will the abstracts from H. M. Inspectors of Mines reports on accidents in British Coal Mines. As regards compressed air, to secure efficiency small bore tubing and high pressure are necessary. Where the tubes are increased in size there is less chance of accident from bursts, less loss from leakage, but also a great fall in efficiency. It is probably this tendency

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to play for safety that accounts for much of the lower output per machine with us as compared with America. On the Rand, where compressed air is also largely used, for cutting machines, large piping is the rule. Under the circumstances, electricity should have an easy victory, being more controllable, and with proper insulation really far safer and more economical. As regards the relative advantage of machine over hand mining there can be no doubt. Not only is the output greater, but there is less need for blasting, the coal won is firmer and has a better face, and there is less waste. With the shorter hours of work there is sure to be a considerable increase in the adoption of coal-cutters, and the electrical industry should benefit thereby. But, if this benefit is to be reaped to the full extent, we must improve upon present-day practice. Given a close study of the conditions as touching upon electricity chiefly in connection with fiery mines, the coal mines should offer a splendid field for enterprise.

If we consider electricity in its wider application to mining, there can be no doubt that it leads to efficiency and economy. Indeed, this question of cheapening of power, which is of such importance to mining operations,—frequently a small economy meaning all the difference between profit and loss—is troubling the labour world of the Rand. There the attitude taken up by Mr. P. Whiteside, M.L.A., and representatives of the South African Drivers' and Firemen's Association, is that the adoption of electricity for winding and cutting machinery will displace white labour. There were 2,539 steam engines in the Transvaal last year, entailing not only the employment of white drivers, but also chief firemen, boilersmiths, fitters' turners, and so on. It is argued that these, and also the men engaged in connection with the air compressors, would be displaced. The increase of output also gives ground for alarm. Yet Mr. Whiteside acknowledged before the Power Commission that cheap power meant prosperity for the industry. It, indeed, means that mines with low grade ores, or hampered in other ways, need not be closed down. Although for a time there may be displacement of labour, increased output and prosperity can only lead to increase of employment. This will be found to be the case on the Rand, where certainly skilled men will have to be employed in attending not only to electricity generation, but to its local application in every mine. It is certain that for winding purposes electricity is assured an early and easy victory on the Rand. Another direction in which it seems called upon to render a smaller but sufficiently important service, is in the provision of electric furnaces underground for the sharpening of drills. At present all drills, to the number of over 300,000 daily, have to be hauled to the surface, at an estimated cost of ½d. each, to be sharpened in the coal furnaces above ground. But electric furnaces, giving off no sulphur or smoke, could be placed underground, and thus much time and the cost of hoisting saved. This is an aspect of the question that will apply to mining in other colonies as well as at home, so the electric furnace for tool repairing is deserving of attention, as are other smaller details. For the present the main problem is how to secure safety under the most trying conditions, then the economy and other advantages of electricity in mining will be patent to mine owners and to miners.

PETROL ELECTRIC DRIVING.*

BY MR. F. M. GREEN, A.M.Inst.C.E.

(Of the Daimler Motor Co.)

The "auto-mixte" system, the author stated, consists of a petrol engine, mounted on the crankshaft on which was the armature of a machine which we should call a dyna-motor—a machine which worked either as a dynamo or a motor—and the functions of this dynamotor was to supply extra torque to the back axle if it was needed. For that purpose a small accumulator was fitted, which was kept more or less constantly charged by the surplus power of the engine, and which was also very useful for braking and other purposes. When the dynamotor was driven at a certain rate of speed it pushed back the current from the accumulator, and consequently they got a back electro motive force. As the speed got greater and greater, the back electro motive force exactly balanced the current that was flowing from the accumulator, and this point might be termed the critical speed when there was no current flowing at all either way. If this speed was exceeded, the back electro motive force would become greater than the current from the dynamotor, which would then work as a dynamo and pump current back into the accumulator which became charged.

Directly the engine slowed down through any resistance, such as the mounting of a hill, it ceased to push the current back, and consequently the current from the accumulator flowed into the dynamotor which acted as a motor. The control was obtained alone by varying the magnetic field, and it was not necessary to have any elaborate arrangement of switches on the main current; the speed regulation was obtained simply by altering the strength of the field. For each notch of the control it followed that there was a certain critical speed when the accumulator neither charged nor discharged. If this was exceeded, it pumped the current back into the accumulator; if it went slower, current was taken from the accumulator. In practice, they got a variation of speed of about five to one. The stronger the magnetic field, the slower the motor ran normally. If they came to a steep hill, they strengthened the field; when they came down hill or on the level the machine automatically adjusted itself, and started to charge the accumulator. So that it should not overcharge, there was a simple device on the carburetter, which consisted of a solenoid connected up to a butterfly throttle, and when the charging current exceeded a certain limit, the solenoid acted and shut off the throttle, thus acting as a governor. The clutch could be, of course, any sort of a friction clutch, but as they had any amount of electrical current, they used a dry plate clutch with a single plate operated magnetically. There was on the crankshaft a magnet which was energised by the main current, and when the current was switched on it dragged a floating plate to it, and consequently the clutch action was obtained. More than double the usual starting torque could be obtained by using the accumulator to assist. With the petrol motor and accumulator powers combined, it could surmount a gradient of 1 in 12 at the legal speed limit. The engine could not race, and it was self-starting. In case the petrol ran out, it was possible to run 3 miles on the accumulators alone.

NEW CATALOGUES.

Messrs. Siemens Brothers & Co. have just issued the following publications: Leaflet No. 506 V, "Applications of Electricity to Medicine and Surgery."; June Supplement to Catalogue No. 506, describing our clinical recording thermometer; July Supplement to Catalogue No. 506, relating to radium, radio-active salts, etc.; and Reprint No. 509 A, describing the Siemens electric motor horn for motor cars. All of these are illustrated.

Messrs. Neville, Kaye & Co., Ltd., have issued an illustrated pamphlet describing their electric lifts, light cranes, and overhead railways.

Mr. G. Braulik has brought out a prize list of his "Eclipse" metallic filament lamps, which gives useful information in a handy form.

The Simplex Conduits' *Installation News* for August contains some excellent short articles, likely to interest customers.

* Abstract of paper read before the Coventry Branch of the Institution of Automobile Engineers.

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THE APPLICATION OF ELECTRIC MOTORS TO INDUSTRIAL SERVICE.*

BY E. B. PARSONS.

The application of motors to industrial service has become such a broad one and has been so interwoven with our everyday life, that it deserves more than ordinary consideration. Twenty years ago an electric motor was comparatively unknown in our industrial life; in fact, was a scientific toy only, whose latent possibilities were barely dreamed of. Shunt wound direct-current motors in small capacities and high speeds were just then being exploited by a few small manufacturers, and their applicability to such service as machine tool drive or other special or direct connected service was scouted (if considered at all) as impossible of attainment. The series direct-current motor was then used for shop service, though its characteristics were such that its application was necessarily limited to small sizes and constant, or nearly constant, load conditions. There existed in Oakland about that time a so-called commercial circuit supplying current to several motors of this type. The development of the constant potential direct current generator permitted the use of constant speed constant potential direct current motors, the first of which were of the straight shunt wound type.

The next step in development was the Sprague compound wound or differential direct current motor. With the bridging out of this type came the first real understanding of speed control of direct current motors. These motors were designed particulary for what were then considered the extreme conditions of constant speed work; one, the straight compound motor to take care of variable loads, such as hoists, industrial elevators, etc.; another the so-called differential, to take care of such work as required constant speed where great or sudden variations, in load were not likely to occur; and third, ordinary constant speed work where great variations in load did not occur and very close regulation in speed was not requisite.

Up to 1895 practically all motors on the market were of the direct current type, following generally the lines laid down ten years preceding.

During the period from 1885 to 1895, the series direct current railway motor was exploited and developed to a high point of efficiency, being finally brought to a standard of 500 volts, all series wound. As our discussion appertains more to industrial than to railway service, I will not attempt to follow the development of railway motors more than to say that the lines laid down twenty years ago have been followed very closely, the series motor, whether direct current or alternating current, having demonstrated its superiority for this class of work.

In the early days of motor drive, it was only considered possible to belt from motor to driven machine, direct coupling being out of the question on account of the high speeds which were the rule in motor designs. Naturally, at that time, there was not very much call for variable speed motors; cone pulleys and other mechanical speed-changing devices taking care of such cases.

With the development of the induction motor, however, there came a wonderful change over our entire industrial purview. Theretofore, it was possible to utilise motors in ordinary industrial work only within a decidedly restricted area. This was due to the impractibility of transmitting any appreciable amount of power over great distances by the use of direct current. The alternating current motor opened an apparently unlimited field for such work, bringing forth the high voltage transmission line, the rotary converter, and the motor generator set, which latter devices permitted the upbuilding of direct current power centres, practically without restriction.

Another benefit of the induction motor, which has become so common as to go unnoted, has been the upbuilding of a very large number of industrial enterprises, such as small shoe-repairing shops, machine shops, woodworking shops, and a multitude of kindred enterprises which would not exist were it not for the small motor and the central station.

* Paper read at Westinghouse Motor Dealers' Convention, San Francisco June 1st, 1909.

It should not be inferred from the foregoing that onl induction motors can be, or are, used for such work, for the direct current and alternating current motors have kept pace with each other in development, each in its respective field.

This brings us to the question—what is the field for direct current motors—what for alternating current motors? If direct current, shunt, compound or series? If alternating current, constant or variable speed; squirrel cage, or wound, secondary, or series? And with these comes the very important question of method of control.

All these questions are as a rule difficult of solution, though the general characteristics, *i.e.*, alternating or direct current are usually solved by the available current supply. Each individual case requires careful study from both an engineering and a commercial viewpoint.

First: considering direct current application, we must, to get the best result, know whether the work to be done is of an intermittent or continuous character, whether the speed required is constant or variable. The first question will generally determine whether or not the motor must be shunt or compound, and will also have great bearing on the capacity and consequent weight, dimensions and cost. Manifestly, a motor applied to intermittent load service need not be of such large capacity as one designed for continuous load service, for the reason that temperature determines the size of frame, armature core and armature conductors within a wide limit.

A motor designed for 10 h.p. continuous output can, with comparatively slight and inexpensive modifications, take care of a 15 h.p. intermittent load, the only material difference in design for the latter being a larger commutator to take care of the larger current flow. During the period of maximum input this motor would tend to excessive armature temperature, but as this period is of short duration the armature has not sufficient time to reach a dangerous temperature. During the no load period the armature cools off, the resultant temperature curve being well within good operating limits. *Per contra*, with continuous load there is no cooling period, and the motor cannot be rated is high in capacity as in the first instance.

Hoist and elevator motors, particularly the latter, are rated at their commutation limit; motors for continuous load service are rated at their temperature limit.

Again, the character of intermittent work will determine whether a motor should be compound or shunt, or of the interpole type. Such intermittent load service as reciprocating bed planers, printing presses, etc., should be handled by compound wound motors only. The same applies to single cylinder reciprocating pump work, air and ammonia compressors, etc. This is desirable for three reasons; one, commutation; two, effect on driven apparatus; three, effect on line conditions. A sudden change in load means a change in armature reaction, and consequent change in neutral point or point of commutation, *i.e.*, field distortion. In a shunt wound motor this is likely under extreme conditions, to reach such a dangerous point as to cause flashing over at the brushes. Compounding tends to prevent this distortion by strengthening the field, counteracting armature reaction, and thus maintaining the point of commutation within reasonable limits. Another beneficial result is a tendency to slow the motor down as the load increases, this relieving the driven apparatus of excessive shock, and the circuit of such excessive current flow as would be the case if the speed were kept constant with consequent greater peak load.

Another method of taking care of such intermittent work is by the interposition or interpoles, which neutralizes to a very great degree, armature reaction. Such method of correcting commutator troubles is excellent where the work is so intermittent that commutation alone governs the size of the motor, and is well adapted to variable speed work and intermittent service. Intermittent service must not be confounded with intermittent load, however; and such motors, *i.e.*, interval, do not give the best results where the slowing down of the motor is an advantage such an planer work, etc., for the reason that there is a tendency to maintain constant speed unless a compound interpole motor is used. This latter type seems undesirable because the functions of compounding and interpoles are, so far as

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commutation is concerned, so nearly alike, that the use of both implies unnecessary expense in construction. Another objection to the shunt wound interpole type for such work is that the current in the circuit rises to higher values than with the compound motor. Straight shunt wound motors should never be applied to the foregoing classes of work, for they will sooner or later give trouble.

For constant load constant speed service, there is no better direct current motor than the straight shunt type. For hoist service, either the compound or series type should be used. Where the load is picked up and carried at a constant speed after attaining a fixed point, the compound motor must be used, the shunt winding on this type being necessary to hold the speed down to this fixed limit.

Control of these various types under various conditions requires as careful study as the motor itself. For ordinary constant speed work the no voltage release starting rheostat, which is designed to give the moto full field with maximum resistance in the armature circuit at the instant of starting, the resistance being cut out step by step until full voltage is applied to the armature terminals, gives most excellent results. Where excessive load is likely to be applied to the motor, either overload release attachment on the starting rheostat or separate automatic circuit breaker should be used. Where frequent starting and stopping are required, this type of starting device will not give satisfaction. The apparatus is not designed for such work. Too much time is lost in handling. A drum type of controller is better adapted for such work and easier handled.

These controllers are designed to start under the same conditions as the starting and stopping rheostat mentioned above, or in some cases, with more than normal field current in the shunt windings of the motor and maximum resistance in the armature circuit. With this latter type, in starting, the armature resistance is gradually cut out, and the resistance later interposed in the shunt field circuit, thus weakening the field with resultant increase in speed. This method of control is particularly adapted for variable speed work, as the shunt field current is relatively small and easily handled. Fifty per cent. variation in speed by shunt field control alone can be obtained with moderate increase in cost over the straight shunt wound type of motor, provided full rated output is not required at maximum speed. Under such conditions, *i.e.*, full rated output at maximum speed, a much larger frame and consequently heavier and more costly motor must be used.

For hoist work the drum or regulating type of control is the only practical one for moderate size equipment, ease and rapdity of operation being the object of prime importance. For elevator or large hoist work and especially for electric shovel or dredge work, or other type of control now on the market compares with the automatic or semi-automatic magnetic switch type. This type of control equipped with relays is the most flexible and safest. It can be so adjusted that in case of excessive load on the motor, the control switches will drop out one by one, interposing resistance as they do so, thus reducing the speed, even to zero, thus relieving the equipment of undue strain and when the overload condition has been overcome, again coming into action, cutting out resistance and bringing the motor up to speed. This system of control is especially adapted to distant control; for example, a shovel equipment, consisting of swinging, thrust and hoist motors, can all be easily handled by one man in the cab just as steam equipment is.

All standard starting and stopping rheostats now furnished by the Westinghouse Electric and Manufacturing Co. are so designed that the retaining magnet winding must be connected directly across the line, *i.e.*, the magnet winding is not in series with the shunt field of the motor, as used to be the universal practice. These coils are connected in series with a special bar of high resistance wire, which is enclosed in the frame of the resistance itself, so that there is no difference in the external appearance of the rheostat. There is a distinct advantage in this method of construction, in that it makes it possible to design and manufacture a line of rheostats, which will take care of a wide range of motors, that is to say, with the older practice where the magnet spool was in series with the shunt winding of the motor, the resistance and carrying capacity of this spool was necessarily proportioned to the resistance and current required for the shunt winding of the motor. This would vary in every variation in either speed or capacity of the motor, as no two motors of various speeds and capacities require exactly the same field current. On the contrary, for starting motors only, it is not essential that the armature resistance be exactly proportioned to the winding of the armature, hence, it can readily be seen that with the later design, that is, with the retaining magnet spool connected directly across the line, a greater flexibility in interchange of starting rheostats is permissible and there is not anywhere nearly as much likelihood of, trouble with the rehostat as under the old method.

Now, a word of explanation and caution with reference to direct current motors and controllers. Direct current motor windings have been standardized by practically all the manufacturers at from 220 to 230 volts and 500 volts. The maximum voltage to which these motors should be subjected should not exceed 250 to 550 volts, and even at those voltages, trouble is likely to arise, due to change in magnetic conditions and brush troubles. One of the results of high voltage is a tendency to bridge the mica segments in the commutator, and the only remedy appears to be grooving out the mica to a depth of approximately $\frac{1}{8}$ inch, thus depending on air rather than mica insulation. This is directly contrary to all of our older practices, as we used to consider it most important to keep the mica even with the copper, to prevent copper or carbon dust from collecting between the segments.

LIVE RAIL ON THE MERSEY RAILWAY.

Mr. A. F. Cotton, deputy coroner for Birkenhead, held an inquest on the body of Edward M'Bride, the ten-year-old son of Edward M'Bride, a dock labourer, of 10, Field-street, Birkenhead, who was electrocuted on the line of the Mersey Railway.

The Coroner remarked that it was gratifying that it was very seldom that occasion arose for holding inquests under such circumstances.

It was stated that in the afternoon Mr. Johnson, stationmaster at the Park Station, noticed the boy with two other companions on the line of the Mersey Railway near Arthur-street. He sent an engine-driver named Thomas Ward down the line to see what they were doing, and when Ward got up to them he found the boy M'Bride lying across the rails face downwards with his throat on the live rail. Ward went back and obtained a pair of rubber gloves, and returning lifted the boy up and carried him to the police station. The ambulance was telephoned for, and the boy was conveyed to the Borough Hospital, where he was received by Dr. Muir, who pronounced life extinct.

The boys had climbed over the fence in Arthur-street, which is 8 feet 6 inches in height, with barbed wire running along the top. They had gone on to the line to look for lawn tennis balls. When in the centre of the rails M'Bride, who was in his bare feet, stepped on to the live rail and immediately fell.

The Coroner said the railway company seemed to have taken adequate precautions to protect their lines, but boys would be boys, and he wished to impress upon parents the necessity of warning their children of the dangers of electrified lines.

The jury returned a verdict of "Accidental death," expressed the opinion that the railway company had sufficiently protected their line, and sympathised with the relatives.

Allusion was also made to the endeavour made by Ward to save the boy's life. Ward was inexperienced with the live rail, and his action was all the more praiseworthy.

LIGHTING A PAGEANT.

Cardiff may well be pleased with the illumination of the grounds at the National Pageant of Wales. It is the most extensive temporary electric display that has ever taken place in Wales or the West of England. The motive power for driving the electric generators was a high speed vertical engine, by Messrs. Bellis & Morcom, of Birmingham, running at 450 revolutions per minute, and driving an 80 kw. shunt-wound dynamo, directly coupled to the crank shaft, and generating at a voltage of 110. The steam for driving this engine was supplied by a locomotive-type boiler at a pressure of 120 to 140lb. per sq. in. There were five large searchlights on the top of the grand-stand of 10,000 c.p. each, and besides these, several electric flares were provided for lighting the ground near the stand. There were about 2,500 small incandescent lamps placed in the foliage of the trees and in the tents and grand-stand, and in addition to these 16 flare arc lamps for lighting the performers' field and the stand. The whole of this was supplied by Messrs. J. B. Saunders & Co., of Cardiff.

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ELECTRICITY IN NEW SOUTH WALES COAL MINES.

The annual report of the Department of Mines, New South Wales, just to hand, contains the following interesting section dealing with electricity in coal mines. The report also states that the works of the Electrolytic Refining and Smelting Co. of Australia (Ltd), at Port Kembla, for the refining and treatment of copper matte, etc., were completed towards the close of the year. These works must undoubtedly prove of very material benefit to the copper mining industry, not alone of this State, but the whole Commonwealth.

As the result of arbitration, the special rules which follow became established (May 29) at most of the large collieries where electrical installations existed. The proceedings, of which these rules were the outcome, were marked by close attention on the part of all concerned. Mr. T. Parton was appointed arbitrator on behalf of the Department, Mr. D. A. W. Robertson represented the mine-owners in that capacity and Mr. H. A. Russell acted as umpire.

SPECIAL RULES FOR THE INSTALLATION AND USE OF ELECTRICITY.

The following rules shall be observed, as far as is reasonably practicable, in the mine:—

DEFINITIONS.

The expression "pressure" means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and earth, as read by a hot wire or electrostatic volt-meter; and—

(*a*) Where the conditions of the supply are such that the pressure at the terminals where the electricity is used cannot exceed 250 volts, the supply shall be deemed a low-pressure supply.

(*b*) Where the conditions of supply are such that the pressure at the terminals where the electricity is used between any two conductors, or between one conductor and earth, may at any time exceed 250 volts, but cannot exceed 650 volts, the supply shall be deemed a medium-pressure supply.

(*c*) Where the conditions of supply are such that the pressure at the terminals where the electricity is used, between any two conductors, or between one conductor and earth, may at any time exceed 650 volts, but cannot exceed 3,000 volts, the supply shall be deemed a high-pressure supply.

(*d*) Where the conditions of supply are such that the pressure at the terminals where the electricity is used, between any two conductors, or between one conductor and earth, may at any time exceed 3,000 volts, the supply shall be deemed an extra high-pressure supply.

The expression "the minimum" signifies the least reasonably possible to be attained, by the proper use of the means from time to time known and available, so as to secure safety, with efficiency.

The expression "a gassy place" means any place which is either—

(*a*) Any place, or part of a mine, where General Rule 8, of section 47 of the Coal Mines Regulation Act, 1902, applies; or,

(*b*) Any place or part of a mine where any quantity, however small (capable of being detected by an ordinary safety-lamp), of inflammable gas has been given off within the previous six months; or,

(*c*) Any working which is within 20 yards of, or is being advanced towards, any locality where it is doubtful whether or not there may be an accumulation of inflammable gas, or any place in the same district on the return airway side of such working.

GENERAL.

1. All electrical apparatus and conductors shall be sufficient in size and power for the work they may be called upon to do, and efficiently covered or safeguarded, and so installed, worked, and maintained as to reduce the danger, through accidental shock or fire or over-heating, to the minimum, and shall be of such construction, and so worked, that the rise in temperature caused by ordinary working will not injure the insulating materials.

In any gassy place the covering shall be constructed so that there is no danger of firing gas by sparking or flashing which may occur during the normal or abnormal working of the apparatus.

All metallic coverings, armouring of cables, and the frames and bed-plates of generators, transformers, and motors other than portable motors, shall be efficiently earthed, if the pressure at the terminals where the electricity is used exceeds the limits of low pressure.

2. Where a medium-pressure supply is used for power purposes, or for arc or incandescent lamps in series, the conductors which form the connections to the motors, transformers, or lamps, or are otherwise used in connection with the supply, shall be completely enclosed in strong armouring or metal casing efficiently connected with earth; or they shall be fixed at such a distance apart, or in such a manner, that danger from fire or shock shall be reduced to the minimum. This rule shall not apply to trailing cables, which are dealt with under Rules 34 to 41.

3. Motors of coal-cutting and other portable machines shall not be used at a pressure higher than a medium pressure.

4. A higher pressure than a medium pressure shall not be used underground except for transmission, and shall then be applied only to transformers and induction motors in which the whole of the high-pressure circuit is stationary.

The high-pressure conductors (other than overhead lines above ground) which form the connections of such motors or transformers, or are otherwise used in connection with the supply, shall be completely enclosed in a strong armouring or metal casing efficiently connected with earth; or they shall be fixed at such a distance apart, or in such a manner, that danger from fire or shock shall be reduced to the minimum.

All high-pressure machines, apparatus, and lines shall be so marked by the use of the word "Danger" at frequent intervals, or by red paint properly renewed when necessary, or in some other conspicuous manner, as to clearly indicate that they are high-pressure.

For work underground, when furnished with current at a pressure higher than medium pressure, a transformer shall not be of less normal rating than 10 kws., nor shall a motor be of less normal rating than 20 brake h.p.

5. In any gassy place, a higher pressure than a medium pressure shall not be transmitted beyond the inbye ends of the main intake airways; and all motors, transformers, and other apparatus, connected with such high-pressure supply, must be placed in suitable chambers ventilated by intake air.

6. A test of the insulation of every complete lighting and power circuit, including all machinery, apparatus, and devices, forming part of or in connection with such circuit (either collectively or in parts), shall be taken at least once a month; and a record of such test shall be made and signed by the person making the test in a book kept for the purpose. The insulation of every such circuit shall be so maintained that the leakage current shall not exceed 1-1000th of the maximum supply current; and, in the event of the leakage current exceeding this maximum, suitable steps shall be taken at once to localise and remedy the leakage.

7. In every completely insulated circuit, earth or fault detectors shall be kept connected up in every generating and transforming station, to show immediately any defect in the insulation of the system. These instruments shall be inspected daily by a competent person.

8. Main and distribution switch and fuse boards shall be made of incombustible insulating material, such as marble or slate free from metallic veins, and be fixed in as dry a situation as practicable.

9. Every sub-circuit shall be protected by a fuse on each pole; except in the case of the earthed middle wire of a 3-wire system, in which case the fuses may be on the outers only. Every circuit having a current of more than 5 amp. at any pressure up to 125 volts, or 3 amp. at any pressure above 125 volts, must be protected by one of the following alternative methods:—

(*a*) By an automatic maximum-current circuit-breaker on each pole.

(*b*) By a detachable fuse on each pole, constructed in such a manner that it can be removed from a live circuit with the minimum risk of shock.

(*c*) By a switch and fuse on each pole.

10. No repair or cleaning of the live parts of any electrical apparatus, except mere wiping or oiling, shall be done when the current is on.

Where the live parts of switches or machines working at a pressure exceeding the limits of low pressure, may have to be handled for the purpose of adjustment, or for such wiping or oiling, gloves, mats, or shoes, of india-rubber or other non-conducting material, shall be supplied by the manager and shall be used by the attendants.

11. Where electricity is used below ground for power or lighting purposes, there shall be employed a competent person, who shall be subject to the authority of the manager, and, in his absence, the under-manager, and shall have charge of all electrical machinery and apparatus in or about the mine, and who is in these rules called the electrician.

The electrician or some other competent person shall be on duty at the mine when the electrical apparatus or machinery is in use.

Every person appointed to work any electric apparatus shall have been instructed in his duty, and be competent for the work that he is set to do.

12. No person other than an authorised person shall enter a machine-room or motor-room; and no person shall wilfully damage, interfere with, or, without proper authority, remove or render useless, any electric line, or any machine, apparatus, or part thereof, used in connection with the supply or use of electricity.

13. Fire-buckets, filled with clean dry sand, shall be kept in electrical machine rooms, ready for immediate use in extinguishing fires.

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14. Instructions shall be posted up at the pit-top or mine-entrance, and in every generating transforming and motor house, containing directions as to the restoration of persons suffering from electric shock. All employees working in connection with the electrical apparatus shall be required to acquaint themselves with the instructions in question.

15. In every mine where electricity is used below ground for power or lighting purposes, direct telephonic or other equivalent means of communication shall be provided between the surface and the shaft bottom or main distributing centre underground.

16. Within three months after the coming into force of these Rules, notice in writing of any existing electric installation must be sent to the District Inspector of Collieries.

17. A plan, of a scale not smaller than 4 chains to 1 in., shall be kept at the mine, showing the position of all permanent electrical machinery and fixed cables in the mine, and shall be corrected as often as may be necessary to keep it as nearly as practicable up to date, and never more than three months in arrear; and the Inspector shall be entitled to examine the plan, and for official purposes only, to make a copy of every part thereof.

18. Record of Electrical Accidents.—Every personal accident occurring in connection with the operation of the electrical equipment (including electric shocks and burns) shall be promptly reported by the person injured or by some other person on his behalf at the office of the mine, and shall be there recorded.

19. Report of Breakdowns, etc.—In the event of any instance occurring of breakdown of, or damage or injury to, any portion of the electrical equipment in the mine, or of over-heating, or of the appearance of sparks or arcs outside the enclosing casings; or in the event of any portion of the equipment (not being a proper part of the electrical circuit) becoming alive; every such occurrence shall be promptly reported in a book, kept at the mine for the purpose, and signed by the person making such report.

Generating Stations and Machine Rooms.

20. Where the generating station under the control of the owner or manager of the mine is not within 400 yards of the shaft mouth, or mine entrance, a switch-box or boxes, efficiently enclosed and locked, or a locked switch-house, shall be provided near the mine entrance, for cutting off the supply of electricity to the mine.

21. There shall be a passage-way in front of the switch-board of not less than 3 ft. in width; and, if there are any connections at the back of the switchboard, the passage-way, if any, behind the switchboard shall not be of less width than 3 ft. clear. This space shall not be utilised as a storeroom or a lumber room, or obstructed in any manner by resistance frames or meters, or otherwise. If space is required for resistance frames, or other electrical apparatus behind the board, the passage-way must be widened accordingly.

No cable shall cross the passage-way at the back of the board except below the floor, or at a height of not less than 7 ft. above the floor.

The space at the back of the switchboards shall be properly floored, accessible from each end, and, except in the case of low-pressure switchboards, shall be kept locked up; but the lock must allow of the door being opened from the inside without the use of a key. The floor at the back shall be firm and even.

22. Every generator shall be provided with a switch on each pole, between the generator and the bus-bars.

Suitable instruments shall be provided for measuring the current and pressure of each generator.

Every feeder connected to the bus-bars in the generating station shall be furnished with an ammeter on the main switch-board.

23. Circuit-breakers must be arranged so that when the contact lever opens outwards no danger exists of its striking the attendant. If unenclosed fuses are used, they must be placed within 2 ft. of the floor, or must be suitably guarded.

Where the supply is at a pressure exceeding the limits of medium pressure, there shall be no live metal work on the front of the main switchboard within 8 ft. of the floor or platform, and the space provided under Rule 21 shall be not less than 4 ft. in the clear. Insulating floors or mats shall be provided for switch-boards where medium or higher pressure is used.

24. All terminals and live metal on machines over medium pressure above ground, and over low pressure underground, shall, where practicable, be protected with insulating covers or with metal covers connected to earth.

25. If the transmission lines from the generating station to the shaft or mine entrance are overhead, there shall be lightning arresters in connection therewith.

Cables.

26. All conductors inside a mine, except as hereinafter provided, shall be continuously covered with insulating material, and guarantees shall be obtained from the makers that the cables have been subjected to the following tests:—

(*a*) A continuously insulated cable must be so constructed that, when a test piece of it has been immersed in water for 24 hours, it will, while still immersed, in the case of cables intended for low or medium pressures, withstand 2,000 volts for 10 min. between the conductor and the water, and between cores if there are more than one in the cable.

(*b*) If the cable is intended for high or extra high pressure, twice the working pressure shall be taken for this test.

(*c*) Prior to the immerson, the test piece must have been bent six times (three times in one direction and three times in the opposite direction) round a cylindrical surface not more than 12 times the diameter (or the shorter axis, in case the section is not circular) of the finished cable.

27. The size of the conductor (except in the case of overhead wires upon the surface and leads inside motors) will be determined in accordance with the table showing maximum current for copper conductors appended to these Rules, column 3 of which refers to cables having insulation of Class A, and column 4 to cables having insulation of Class B, according to the following definitions:—

(A) A dielectric which is impervious to moisture, and only needs mechanical protection ("dielectric" does not include the braiding or taping).

(B) A dielectric which, to be effective, must be kept perfectly dry, and, therefore, needs to be encased in a waterproof sheath, generally of soft metal such as lead, drawn closely over the dielectric.

Below ground, however, column 4 may be applied to cables having insulation of Class A, in cases where the atmospheric temperature never exceeds 100° Fah.

For the purpose of applying the table, the current in the conductor must be taken as equal to that required for the maximum number of motors, or other current-using apparatus, that are at any time used simultaneously on the circuit.

Provided that, in the case of coal cutters, not in a long-wall working, 20% shall be deducted from the normal working current. This rule does not apply to trailing cables.

28. All conductors (except as hereinafter provided) shall in every case be maintained completely insulated from earth; but it is permissible to use the concentric system with earthed outer conductor, if proper arrangements are made to reduce the danger from fire or shock to the minimum; and the neutral point of polyphase systems, and the middle-wire of three-wire continuous-current systems, may be earthed at one point.

29. Unless fixed out of reach of injury, all conductors, other than armoured cables, must, in addition to the insulation, be protected by a suitable covering. Where lead-covered cable is used, the lead shall be earthed, and shall be electrically continuous throughout.

The exposed ends of cables, where they enter the terminals of switches, fuses, and other appliances, shall be properly protected and finished off, so that moisture cannot creep along the insulating material within the waterproof sheaths or the insulating material, if of an oily nature, leak out of the cable.

30. All joints must be mechanically and electrically efficient, and, where reasonably practicable, must be suitably soldered. In any gassy place suitable joint-boxes must be used, and the conductors shall be connected by means of metal screw-clamps, or connectors; or some other equally safe construction must be adopted. Provided, however, that, in any gassy place where a shot may be fired, joints may be soldered by or in the presence of a person authorised in that behalf by the manager; but the same precautions in regard to examination and removal of workmen as are prescribed by paragraphs (*f*) and (*i*) of General Rule 12 shall be observed in all such cases, and, where the place is dry and dusty, the precautions as to watering prescribed by paragraph (*h*) shall also be observed. Wires, other than blasting wires or cables, must not be joined by merely twisting them together.

This Rule does not apply to trailing cables.

31. Overhead bare wries on the surface shall be properly secured to insulators, and clear of any traffic, and provided with efficient lightning arresters.

32. All cables used in shafts must be highly insulated and substantially fixed. Shaft cables not capable of sustaining their own weight shall be properly supported at intervals, varying according to the weight of the cable. Where the cables are not completely boxed in and protected from falling material, space shall be left between them and the side of the shaft, that they may yield and thus lessen a blow given by falling material.

33. Where the cables in main haulage roads cannot be kept at least 1 foot from any part of the tub or tram, they shall be specially protected. When separate cables are used, they shall be fixed on opposite sides of the road, unless it is safer to have them on the same side, in which case they shall be kept as far apart as possible.

Cables and wires, unless provided with metallic coverings, shall not be fixed to walls or timbers by means of metallic fastenings.

Cables underground, when suspended, shall be supported by leather or other flexible material, in such a manner as to allow of their readily breaking away when struck, before the cables themselves can be seriously damaged.

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Where main or other roads are being repaired, or blasting is being carried out, suitable temporary protection must be used, so that the cables are reasonably protected from damage.

34. Trailing cables for portable machines shall be specially flexible, heavily insulated, and protected with extra stout braiding, hose pipes, or other equally effective covering. Bare metal armouring shall not be used upon any trailing cable carrying current at a pressure exceeding the limits of low pressure.

35. In any gassy place, the joints, if any, made in trailing cables shall be soldered. Screw clamps of any kind must not be used for this purpose in any place in any mine.

36. The two cables of the twin trailing cable shall be divided at the motor end only for such a length as is necessary for the making of connection to the motor; and the twin table with its outer covering complete shall be securely held by a suitable clamp on the motor frame in such manner as to protect the trailing cable from injury, and to prevent any mechanical strain being borne by the single ends making electrical connection with the motor.

37. At points where the flexible conductors are joined to the main cables, a fixed terminal box shall be provided; and a switch and fuses shall be fitted in the terminal box capable of entirely cutting off the supply from the trailing cable, unless the machine is operated on a circuit of its own, either from the power house or some sub-station, at which point it shall be permissible to place the fuse of circuit-breaker.

38. A spare trailing cable shall be kept in each district of the mine where electric coal-cutting machines are in use; and in the event of the trailing cable in service breaking down, or being damaged in any way, or of its inflicting a shock upon any person, it shall be at once put out of service, and the spare cable shall be substituted therefor. The faulty cable shall not again be used until after it has been repaired and tested, at the surface of the mine, and passed by some competent person.

39. Each trailing cable in use shall be examined daily by a competent person for abrasions and other defects; and the result of such examination shall be recorded daily in a book, kept at the mine for the purpose, and shall be signed by the person making such report.

The machinemen shall also be required to carefully observe the trailing cable, while in use, so as to detect defects; and, in the event of any defect becoming apparent, notice of the same shall at once be sent to an official of the mine.

40. All horse traffic shall be suspended on the part of every road along which a trailing cable is extended for the purpose of flitting a machine.

Trailing cables shall at all times be supported clear of the rails and traffic, except when flitting.

41. Each trailing cable shall have a distinguishing number, which shall be clearly indicated on a suitable label securely attached to the cable.

Record of insulation test of trailing cables.—The insulation resistance of each conductor of every trailing cable shall be measured and recorded at least once per month; the resistance being taken between the conductor and the surrounding water after the whole cable, with the exception of the ends, has been immersed for at least six hours.

For this test the manager must supply an instrument suitable for measuring resistance up to at least 5 megohms.

The trailing cable must not be put into service unless the insulation resistance of each conductor measures at least 1 megohm after immersion.

Fuses, Circuit-breakers, and Switches.

42. Fuses and automatic circuit-breakers shall be so constructed as effectually to interrupt the current when a short circuit occurs, or when the current through them exceeds by 200% the working current in the case of motors, or by 100% the permissible current of the cables which the fuses protect. Fuses shall be stamped or marked, or shall have a label attached, indicating the current at which they are intended to fuse; or, where fuse wire is used, each coil in use shall be so stamped or labelled. Fuses shall only be adjusted or replaced by a competent person authorised by the manager.

43. All switches, circuit-breakers, and fuses must have incombustible bases of marble, slate, or porcelain, or other suitable incombustible insulating material. All live parts of switches, circuit-breakers, and fuses, not in machine-rooms, or in compartments specially arranged for the purpose, must be covered. These covers must be of incombustible material, and must be either non-conducting or of rigid metal, clear of all internal mechanism.

44. All points at which a circuit (other than those for signals) has to be made or broken shall be fitted with proper switches. The use of hooks or other makeshifts is prohibited; provided that, excepting gassy places, hooks may be used if the junctions are completely protected by rubber sleeves; and, in any gassy place switches, circuit-breakers, and fuses (except as provided in Rule 50, hereafter) shall not be of the open type, but must either be enclosed in gas-tight boxes or break under oil.

45. Record of generator circuit-breaker or generator fuse-opening.—Fuses shall not be replaced by anyone except the electrician, or some other competent person appointed by the manager. A record of each instance of a generator, circuit-breaker, or generator fuse opening shall be made in a book kept in each generating station or room, and signed by the person making the record.

Motors.

46. Every motor, together with its starting resistance, shall be protected by a fuse in accordance with Rule 44, and by switches capable of entirely cutting off the pressure. The switches shall be fixed in a convenient position near the motor; and every motor of 10 b.h.p. or over in a machine room underground shall be provided with a suitable ammeter to indicate the load on the machine.

47. Where unarmoured cables or wires pass through metal frames or into boxes or motor casings, the holes shall be substantially bushed with insulating collars, and, where necessary, with gas-tight bushings which cannot readily become displaced.

48. Terminal boxes of portable motors shall be securely attached to the machine, or must form a part thereof.

49. Where the insulation of a motor is found to become damp during a stoppage, suitable steps shall be taken to ensure that the insulation shall be dry before the working of the motor is resumed, in order that its base may not become alive.

50. In any gassy place, all motors, unless placed in such rooms as are separately ventilated with intake air, or placed on the main intake air courses, shall have all their current-carrying parts, also their switches, starters, terminals, and connections, completely enclosed in flame-tight enclosures, made of incombustible material, and of sufficient strength to escape damage in the event of an explosion of firedamp occurring in the interior; and such enclosures shall not be opened except by an authorised person, and then only when the current is switched off, except for the purpose of adjusting brushes, which may be done subject to the same conditions and precautions as are laid down under Rule 30, in the case of soldering. The pressure shall not be switched on while the enclosures are open.

51. In any gassy place, a safety-lamp, or other suitable apparatus for the detection of firedamp, shall be provided for the use of the attendant with each stationary machine, when working; and, should any indication of firedamp appear on the flame of the safety-lamp, or other apparatus used for the detection of firedamp, the person in charge shall immediately stop the machine, cut off the current at the nearest switch, and report the matter to an official of the mine.

52. Report of examination for gas.—In any gassy place and where coal-cutting machines are flitted by electric power, or the machinemen are paid at tonnage rates, a competent person shall make, at least once in the course of each shift, an examination for gas in each place in which an electric coal-cutter is, or is to be, employed during that shift. A report of every such examination shall be made in a book kept at the mine for the purpose, and shall be signed by the person making such examination.

53. The machineman in charge for the time being of a coal-cutting machine must be a competent person, capable of examining the roof and sides and detecting the presence of inflammable gas.

54. In any gassy place before a coal-cutting machine is brought within 20 yards of the working face, the machineman who is about to operate the starting-switch of the machine shall make an inspection for gas in the place where the machine is to work, unless such an examination is then made by some other competent person authorised or appointed for that purpose by the manager. If any inflammable gas is found in the place, the machine shall not enter therein.

No coal-cutting machine shall be continued in operation for a longer period than half-an-hour without such an examination as above described being made for gas; and if gas is found when the machine is present the current shall at once be switched off the machine, and the trailing cable shall forthwith be disconnected at the junction-box.

The person finding the gas shall at once erect a danger fence to warn persons against entering the place.

The trailing cable shall not be reconnected until the deputy has examined such place and has pronounced it free from gas and has removed the danger-board.

Report of examination for gas.—The person finding gas shall forthwith report the same to the deputy of the district, who at the end of the shift shall make and sign a written report in a book kept at the mine for the purpose.

55. In order that the roof may be carefully examined, a coal-cutter motor shall not be kept continuously at work for a length of time exceeding a maximum period which shall be specified in writing by the manager.

56. The person in charge of a coal-cutter or drilling machine shall not leave the machine while it is working, and shall, before leaving the working-place, see that the pressure is cut off from the trailing cables. Special care must be taken to prevent injury to the trailing cables during flitting and during the process of loading the machine on to, or unloading it from, the power truck. No repairs shall be made to any portable machine until the pressure has been cut off from the trailing cables.

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57. If any electric sparking or arc be produced outside a coal-cutting or other portable motor, or about the cables or rails, the machine shall be stopped, and shall not be worked again until the defect is repaired; and the occurrence shall be at once reported to an official of the mine.

58. Weekly report of examination of all portable motors underground.—The casing or inspection doors of all portable motors used underground, and the casings of their switches and other appliances, shall at least once a week be opened by a competent person appointed by the manager; and the parts so disclosed shall be cleaned and examined before the coverings are replaced. In special cases requiring a motor to run continuously longer than one week, the motor shall be examined at the end of the run. A report of all such examinations shall be entered in a report book, and signed by the person who made the examination.

ELECTRIC LOCOMOTIVES.

59. Electric haulage by locomotives on the trolley-wire system shall not be allowed in any gassy place.

60. In underground roads the trolley-wires, unless sufficiently guarded, must be placed so that they are throughout at least 7 ft. above the level of the road or track, or the pressure must be cut off from the wires at all times when such roads are used for travelling on foot. The hours during which travelling on foot therein is permitted shall be clearly indicated by notices and signals placed in conspicuous positions at the ends of, and at all entrances into, the roads. At other times no one except a person duly authorised by the manager shall be permitted to travel on foot along such roads.

61. Under the conditions indicated in the foregoing Rule, trolley-wires may be used with current at a pressure not exceeding low pressure; but a pressure not exceeding medium pressure may be used on roads on which travelling on foot is not at any time permitted, except in the case of drivers of locomotives or of persons duly authorised by the management to travel only for purposes of inspection and to effect repairs.

62. In connection with the use of electric locomotives, either insulated returns or uninsulated metallic returns of low resistance may be employed.

63. In order to prevent the earthing of any other electric circuit in the mine, by connection with the trolley system, the current supplied for use on the latter, when the return is uninsulated, shall (except when low pressure is employed, or the concentric system, with earthed outer conductor, is used) be generated by a separate machine, and shall not be taken from, or be in connection with, any electric line otherwise completely insulated from earth.

64. If storage-battery locomotives are employed in any gassy place, the Rules applying to motors in such places shall also be deemed to apply to the boxes containing the cells.

ELECTRIC LIGHTING.

65. Arc lamps shall be so guarded as to prevent pieces of heated carbon falling from them, and shall not be used in situations where there is likely to be danger from the presence of coal-dust. They shall be so screened as to prevent risk of contact with persons.

66. Small wires for lighting-circuits shall either be conveyed in pipes or casings; or they may be suspended from porcelain insulators, or tied to them with some non-conducting material which will not cut the covering, and so that they do not touch any timbering or metal work. On no account shall staples be used. If metallic pipes are used, they must be electrically continuous and earthed. If separate uncased wires are used, they shall be kept at least 2 in. apart, and not brought together except at lamps or switches or fittings.

67. In any gassy place, electric lamps, if installed, must be of the vacuum or enclosed type, and, except on the main intake airways and mechanical haulage roads, being also on the outbye side of relighting stations, they shall be protected by gas-tight fittings of strong glass, and shall have no flexible cord connections. Electric lamps shall be replaced by a duly authorised competent person only; and, while the lamps are being replaced, the current shall be switched off.

68. In all machine-rooms and other places underground, where a failure of electric light is likely to cause danger, some safety-lamps, or other proper lights, shall be kept for use in the event of such failure.

SHOT-FIRING.

69. Electricity from lighting or power cables shall not be used for firing shots.

70. When shot-firing cables or wires are used in the vicinity of power or lighting cables, sufficient precautions shall be taken to prevent the shot-firing cables or wires from coming in contact with the lighting or power cables.

71. Only competent persons who have been properly instructed in the work, and duly authorised by the Manager in writing, shall be allowed to fire shots electrically in any part of a mine.

72. The exploder, fuses, and wires shall be suitable for the conditions under which the blasting is carried out.

73. High-tension magneto-generators shall be enclosed in flame-tight cases when employed in any gassy place.

74. The exploder shall be in the charge of the shot-firer, and shall be fitted with a handle or key, which shall be detached when not required for firing, and shall not under any conditions pass from the personal custody of the shot-firer whilst on duty. A primary or secondary battery shall not be used for shot-firing.

75. The exploder shall not be connected to the shot-firing cable until all other steps preparatory to the firing of the shot have been completed and all persons have removed to a position of safety.

Immediately after the firing of the shot the firing cable shall be disconnected from the exploder; and no person shall approach a shot which has been attempted to be fired by electricity, and has failed to explode, until the firing cable has been so disconnected, and an interval of five minutes has elapsed since the last attempt to fire the shot.

The foregoing Rules shall not apply to apparatus used for telephone, telegraph, and signal purposes, which are provided for by the three following Rules:—

SIGNALLING, ETC.

76. All proper precautions must be taken to prevent electric signal and telephone wires from coming into contact with other electric conductors, whether insulated or not.

77. Bells, wires, insulators, contact-makers, and other apparatus, used in connection with electric signals underground, shall be of a substantial and reliable description, and shall be erected in such a manner as to reduce the liability to failures or false signals to the minimum.

78. In any gassy place the pressure employed for signalling purposes shall not in any one circuit exceed 15 volts in an intake airway, or 10 volts elsewhere; and bare wires shall not be used for such purposes except in haulage roads.

ELECTRIC RELIGHTING OF SAFETY-LAMPS.

79. If, in any gassy place, safety-lamps are relighted underground by electricity, the Manager shall select a suitable station or stations, not being in the return airway, and where there is not likely to be any accumulation of inflammable gas; and no electric relighting apparatus shall be used in any other place. All electrical relighting apparatus shall be securely locked, and shall not be available for use except by persons authorised by the manager to relight safety-lamps; and such persons shall examine all safety-lamps, brought for relighting, before they are reissued.

EXEMPTIONS AND MISCELLANEOUS.

80. Notwithstanding anything contained in these Rules, any electrical plant or apparatus installed or in use or contracted to be bought before May 26, 1908, before the coming into force of these Rules, may be continued in use or used unless an inspector shall otherwise direct, or subject to any conditions affecting safety that he may prescribe; but an Inspector shall not object to the use (if sufficiently earthed) of any bare-armoured cables in use or owned or contracted to be bought by any mine on May 26, 1908, on the ground merely of there being bare-armoured cables.

In case any difference of opinion shall arise between an Inspector and Owner, Agent, or Manager, of a mine under this Rule, the same shall be settled as provided in Section 25 of the Coal Mines Regulation Act, 1902.

83. Exemption from any of the foregoing requirements may be granted by the Minister, on the ground either of emergency or special circumstances, on such conditions and to such extent as the Minister shall prescribe. Such exemption must be in writing, signed by the Minister or the Under Secretary for Mines.

Mr. Henry Hall, H.M. Inspector of Mines for the Liverpool and North Wales district, in his report for 1907, has the following pertinent remark:—

> "It is remarkable how quickly the persons put in charge of electrical machinery grasp its details and dangers, and are thus able to handle it with safety."

It gives me great pleasure to verify this observation, from my own experience in this State, and to testify to the quick intelligence and ready resource of Australian workmen in handling machines which a very few years back were, if not absolutely unknown to them, quite unfamiliar.

It is, however, somewhat regrettable that at some large collieries using electricity on a considerable scale, the so-called electrician has had little or no experience in regard to this new power; but it is hoped that this matter will be placed on a better basis as soon as the examinations are held to qualify electricians, as required by Electrical Special Rule No. 11, and provided for by the Coal Mines Regulation (Amending) Act, 1908.

Mr. Hall proceeds to criticise the Imperial Electrical Special Rules:—

> "I should have preferred that the Electrical Special Rules should have required the precautions against the ignition of firedamp to be enforced throughout every part of a mine where safety-lamps are in use, instead of only to such parts *where General Rule No. 8 applies.* I notice that a recent committee sitting at Sydney, New South Wales, to consider and make rules for the use of electricity in mines, have avoided this difficulty. Their rule reads: 'In any place or part of a mine *where safety-lamps are used*, all motors, etc., . . . must be completely enclosed in flame-tight enclosures.' The New South Wales authorities also enforce more numerous precautions where electrical coal-cutters are employed."

(To be continued.)

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ALPHABETICAL INDEX TO ADVERTISEMENTS.

	PAGE
Abbott and Co.	—
Adams Manufacturing Co.	—
Aerators Limited	—
Allen, W. H., and Son	—
Ammon, A. F.	12
Andrews, R. W., and Co.	—
"Approved"	13
Auto Controller and Switch Co.	19
Babcock and Wilcox	3
Bailey, W. H., and Co.	—
Bastian Meter Company	—
Bates, C. G.	—
Bellis and Morcom, Ltd.	2
Bill, S., and Co.	—
Birkbeck Bank	19
Boddy, G. M., and Co.	—
Braulik, G.	—
British Insulated and Helsby Cables, Ltd.	6
British Mica Company	12
British Thomson-Houston Company	14
British Westinghouse Electric and Mfg. Co.	—
Brockie-Pell Arc Lamp Company	—
Brook, E.	—
Browett, Lindley, and Co.	5
Callender's Cable & Construction Co.	19
Capell Fan Company	—
Churton, T. H., and Co.	1
Concordia Electric Wire Co., Ltd.	1
Cort, A., and Co.	—
Croft and Perkins	1
Crossley Bros.	17
Cryselco Limited	1
Derby and Co.	—
Dick, Kerr, and Co.	6
Diesel Engine Company	—
Dore, J., and Co.	—
D. P. Battery Co.	—
Dorman and Smith	3
Edison and Swan Company	2
Electrical Standardising, Testing, and Training Institution	—
Electric and Ordnance Accessories Co	—
Electric Construction Co.	—
Electrical Engineer Institute	—
Electrical Trades Supply Limited.	12
Electromotors Limited	—
Everett, Edgcumbe, and Co.	14
Everitt and Co.	12
Evershed and Vignoles	—
Ferranti, Limited	17
Fischers Ball and Bearing Co.	—
Flexible Metallic Tubing Company	1
Foster Arc Lamp and Engineering Co.	—
General Electric Company	—
Gibbs, J., and Son	—
Gilkes, G., and Co.	—
Griffiths Bros.	—
Grimshaw Bros.	—
Hardy Patent Pick Co., Ltd.	1
Harris, A. E., and Co.	—
Hart Accumulator Company	20
Harvey, G. A., and Co.	1
Heathman and Co.	—
Heenan and Froude	14
Hendry, J.	—
Henley's Telegraph Works Company	—
Home and Rowland	12
Hooper's Telegraph & Indiarubber Works	—
Hudson, J., and Co.'s Successors	1
India Rubber Company	4
Johnson and Phillips, Ltd.	1
Kaye, J., and Sons	3
Keys, W. H.	—
Key Engineering Co., Ltd.	—
Lancashire Dynamo and Motor Co.	—
Ledward and Beckett	20
Liverpool Electric Cable Co.	6
London Electric Firm Co.	—
London Electric Wire Co.	3
Lorrain, J. G.	19
Lundberg, A. P., and Sons	—
Lunken Valve Co.	12
Macintyre, J., and Co., Ltd.	1
Major and Co.	—
Marryat and Place	—
Matthews and Yates	1
Mayer, H. G., and Co.	—
McClure and Whitfield	—
McGeoch, W., and Co.	2
Merryweather and Sons	12
Metallic Seamless Tube Company	—
Millar's Karri and Jarrah Co.	—
Mitcham Electric Fan Company	—
Morris-Hawkins, Ltd.	1
Moseley, D., and Sons	19
Mosses and Mitchell	19
Nalder Bros. and Thompson	—
New Brotherton Tube Company	—
Pass, C., and Son, Ltd.	19
Petter, J. B., and Sons, Ltd.	1
Phœnix Fire Office	—
Price, Powell, and Co.	6
Railway Passengers' Assurance Company	13
Reason Manufacturing Company	—
Reyrolle, A., and Co.	—
St. Helens Cable and Rubber Company	—
Sandycroft Foundry Co.	—
Schaffer and Budenberg	—
Siemens Bros., Dynamo Works, Ltd.	—
Simplex Conduits, Limited	—
Sloan Electrical Co.	—
Small Power Dynamo & Motor Co.	—
Smith, Geo.	—
Spencer Chapman and Messel	—
Stearn Electric Lamp Co., Ltd.	—
Süddeutsche Kabelwerke, A.G.	1
Sun Electrical Company	—
Switchgear Co., Ltd.	12
Taylor and Co.	1
Thermit, Limited	—
Tilbury Contracting and Dredging Co., Ltd.	—
Tormo Manufacturing Co.	—
Townshends, Limited	—
Traun, Dr. Heinr.	19
Tucker, J. H., and Co.	—
Tudor Accumulator Company	—
Turnbull, A., and Co.	—
Union Electric Co., Ltd.	5
United Electric Car Company	—
United States Metallic Packing Co.	—
Verey and Co.	13
Victoria Electrical Works	—
Vlasto, Clark, and Watson	—
Webb and Son	—
Western Electric Company	3
Weston Electrical Instrument Co.	—
White, J. G., and Co.	—
Wilkinson, G.	—
Willans and Robinson	20
Willcox, W. H., and Co., Ltd.	18
Wilson, L. E., and Co.	—
Winter, F.	—
Youngs	—

ELECTROLYTIC CORROSION OF TELEPHONE CABLES.*

BY ELAM MILLER.

The electrolytic corrosion of telephone cables, due to direct current electrolysis, has been experienced ever since the general introduction of the electric traction system with a track or ground return. Telephone systems in the larger cities have underground plants covering extensive areas, which are generally coincident with the principal areas covered by the traction system. The leakage of some current from the track to neighbouring underground metallic structures, particularly water pipes and lead cables, even under the best conditions of track bonding, is a condition that has been shown must be accepted as unavoidable, and if preventative steps are not resorted to, corrosion of such structures results.

An examination of a table of the electrochemical equivalents of elements will show that lead is more susceptible to electrolysis than iron; in fact, assuming a valency of 2 for both metals, which holds in the more common compound of these elements, lead is approximately 3·7 times more susceptible to electrolytic action than iron. Accepting as unalterable the fact that more or less current is certain to stray from the track returns to the lead sheathed cables of the telephone companies, studies of a more or less elaborate nature have been made to determine the conditions most favourable to electrolytic action on such cables and methods of relief have been fairly definitely outlined. It was at first thought that trouble need not be anticipated where the cables were negative to the track or to paralleling metallic structures, such as water pipes, from which current might flow to the cables, and as a general proposition this is true. It has, however, been shown that where a large amount of current flows to the sheaths, there is danger of injury to the cable through the action of alkaline substances formed about the cable through the decomposition, by the current of the soluble salts contained in the surrounding earth, these alkaline substances being capable, under favourable conditions, of attacking the cable chemically when the currents are shut off or very much reduced, as would be the case at night. In general, however, the points to be feared are those where the current tends to leave the cable for other conductors in the immediate vicinity. The amount of lead dissolved per ampère-hour by direct current electrolysis is 3·858 grams, and as the maximum thickness of sheath for full sized (2 11/16 inches) telephone cables is but one-eighth of an inch, and further, as the contact area of the sheath from which current is flowing may be restricted, the resistance low, and the current density consequently high, a relatively small amount of current flowing from the sheath for a sufficient time will inevitably result in a perforation. Further, the action has been shown to be not entirely electrolytic, but where, in the soil, nitrates predominate, the corrosion is greater than the theoretical electrolytic corrosion calculated from the electrochemical equivalent of lead, due to the chemical attack of the nitric acid which is liberated by the passage of current. Ordinary city soil contains a large percentage of nitrates. As all modern telephone cables are of the dry core types, the result is an admission of moisture to the paper core, with the consequent loss of, in most cases, a section of rather expensive cable, and what is probably of greater importance, a serious interruption to the service.

As the corrosion of the cable sheath is in general due to the passage of the foreign return current from the sheath to the earth where the cable is in contact either with the damp porous concrete of a manhole or with the damp sides of a saturated duct, the cable may obviously be protected

* A paper read before the San Francisco Section American Institute Electrical Engineers.

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either by preventing the passage of current into the sheath or by preventing the current from flowing from the sheath. The former method would require the insulation of all cables throughout their entire length, including the manholes, and is absolutely impracticable. The latter consists in providing conductors between the grounded power terminals and the cables sufficiently low in resistance to reduce the potential of the cable sheaths to a point where they are no longer positive to their surroundings, and consequently current cannot flow from them to the earth. Another expedient which has been resorted to is making insulated joints in the cable sheath for the purpose of breaking the continuity of a long cable, and preventing the picking up of current at one point and its distribution at another. This, however, is an expedient of questionable utility, and is not in general to be recommended.

In making an electrolytic survey it is of the utmost importance that the condition of an underground cable system, with respect to the potential of the cable sheaths to water mains in the immediate vicinity of the cable, the sides of the manholes and the earth adjacent to or within the manhole, be determined at various times during the day, notations also being made of the volume of traffic on the street railway system at the time of the potential observation. An electrolytic survey consists of a series of such observations made at all manholes where conditions are thought to be critical, and the results of these observations plotted on maps of the underground cable system, on which are also shown the traction company's lines and locations of power houses. All of the underground cable sheaths of a telephone system are usually bonded together in the office manholes, and bonds between all cables are placed at frequent intervals along the main runs. Where an electrolytic survey indicates a positive condition of the cable with respect to adjacent underground structures or the earth, bonds are occasionally run to such structures. In general, however, a study of the potential chart will show that areas where the potential of the cable sheath is positive to the earth are nearest the grounded terminal of the foreign source of current. This indicates that the sheaths of the cables are acting as return conductors for the grounded power system and to complete the return to the grounded terminal of the power generators, the current leaves the sheaths and passes through the earth. It is, of course, evident that this is the condition which it is desirable to prevent. The method usually adopted to accomplish this is to provide a path of low resistance from the cables to the grounded power terminal by a heavy conductor; never by bonding to the rails of a street railway system, as such an arrangement would give rise to difficulty in the event of broken track bonds or changes in load, of which no warning would be given.

The size of the conductor to be connected to the grounded power terminal, and its point of attachment to the telephone cables should be such as to render negative the district shown on the potential map as positive. The actual size of this conductor is usually determined by experiment, as there are so many variable conditions that any attempt to calculate it would be a waste of time. The conductor must be large enough to bring about the desired results of rendering the sheaths of the cables in the danger area negative, but at the same time should not be unnecessarily large so that more current is conducted through the cable sheaths than need be, as this tends to increase the chemical corrosion to which attention has been called. Where the circuits of the electric traction system are arranged with return feeders, it may be necessary to treat the return feeder grounds as so many distributed power houses. Complications may also occur where there are a number of power houses that may be run at different times. Under such conditions, the connections from the telephone cables to the power houses should be so arranged as to ensure the proper relations of all cables to their surroundings under any combination of sources of current supply that the electric railway company or companies may employ. This can only be accomplished by frequent and careful potential observations in a district that has been determined as dangerous from careful surveys.

I believe it may be safely said that it is the feeling today, at least among telephone companies, that they are able to cope successfully with direct current electrolysis. It is, of course, true that some damage is done each year to the underground plant from this cause, but with a fairly frequent system of potential observations, this can be reduced to a minimum. The worst condition with which we have had to contend is a change in the method of feed adopted by the traction system and the installation of new sub-stations. If advice could be immediately obtained of both of these conditions, precautionary measures could be taken that would render our system practically immune from electrolytic corrosion by direct current. I have in mind a rather serious case of electrolytic corrosion that took place in one of our larger exchanges some two years ago as a result of a rather general change in feed of the traction system. In this instance all of the damage occurred between the visits of the inspector' which were not over three months apart.

In order to guard against changes of this sort, we have considered the advisability of bringing certain cable pairs through the lead sheath at critical points, attaching one wire to the sheath and the other to a ground connection in the manhole. The office ends of these pairs are then connected to a row of jacks at the wire chief's desk, in conjunction with which may also be associated small reverse current relays to operate either a visual or audible signal. Such an installation, omitting the reverse current relays and signals, has been made in one of the medium sized telephone exchanges in California, and it is thought that the insurance against electrolytic action that it certainly affords is well worth the cost of installation and fixed charges on the cable pairs. An electrolytic survey in this particular exchange is made as a matter of routine each day by simply plugging into the jacks with a voltmeter.

With the advent of the single phase road it was thought, in that the methods applicable to the prevention of corrosion by direct current electrolysis would evidently not apply with alternating current since the potential was periodically reversing, serious trouble might be anticipated —the thought being that the effect of the flow of current from the cable would not be entirely overcome by the flow in the reverse direction, particularly at low frequencies. An apparently very thorough investigation of the question of alternating current electrolysis undertaken by Mr. J. L. R. Hayden, and published in the *Proceedings* for March, 1907, indicates that the action of the positive half wave is not quite overcome by the action of the negative half, but the difference is so small as to hardly exceed one-half of 1% of the electrolytic action of an equal direct current. Mr. Hayden also outlines what appears to be a most effective preventative method. This consists of the superimposing upon the stray alternating current of an extremely small direct current, in the tests made by Mr. Hayden a direct current as small as 1·5% of the total value of the stray alternating current afforded complete protection. To quote from Mr. Hayden's paper his explanation of the protective action of the small direct current is as follows:

"Since electrolytic action of the alternating current appears as a small difference between two large and nearly equal quantities, the action of the positive and of the negative half wave, a very small variation in the action of either half wave makes a very large difference in the result, and this probably accounts for the very large variation in the electrolytic action of alternating current compared with the constancy of the electrolytic action of direct current.

"Regarding the protective action of a small direct current, against alternating-current electrolysis, it must be understood that this is not due to maintaining the lead negative against the ground. It is obvious that the lead would be protected against corrosion, if upon the alternating current a direct current were superimposed sufficiently large to maintain the lead always negative. This, however, would require a direct current more than 2 times the alternating current, which is not practical. From the previous tests, it appears that a direct current of 1·5% of the alternating current gives practically complete protection against the electrolytic action of the alternating current. Such a small direct current would not appreciably change the duration of the successive half waves of alternating current, but the lead would still be positive for practically half the time: and with such a current graphically super-

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imposed upon the alternating current, the eye would hardly see the difference in size of the two half waves o fthe resultant current.

"It seems that a very small increase of the negative half wave over the positive half wave of the current is sufficient to make the negative half wave completely reverse and thus neutralise the action of the preceding positive half wave."

I should conclude from this that serious trouble need not be anticipated from the alternating current electrolytic corrosion if proper precautions based on these facts be followed.

ELECTROMOBILE INSTRUMENTS.

BY A. HECKER.*

One of the most troublesome difficulties of our electromobile companies certainly is the indicator, placed by the driver's seat. Unfortunately the improvement in this instrument has not kept pace with the enormous development of the automobile industry and those related to it. When the need of measuring instruments on an electromobile was first felt what was done was to take two ordinary switch-board meters, a volt meter, and an amperemeter, clap them together into an iron case, and, lo! the new type of instrument was there. No wonder that they were merely makeshifts, and were always giving trouble and wanting repair.

It may perhaps be of interest to enquire somewhat closely into the causes of this difficulty, for the first thing to be considered in seeking for a remedy is the cause of the disease. The electromobile instrument has three main enemies: exposure to the weather, bad treatment by careless and unskilled chauffeurs, and the shocks and jars inseparable from driving, especially at high speeds, over ordinary roads. As regards weather-influences, we find that wind and rain, snow and ice-water, and last, but not least, dust, find almost unhindered access to all the outer parts of our instrument. All these agencies must be made harmless by suitable construction. It is of the first importance to prevent them from getting at the interior of the instrument, and to provide for the free draining of rain and snow water. Rubber packings, unless of the very best material, are of very little use. The rubber rings become hard, dry and cracked in a very short time, and, when perished, they offer practically no obstacle to the penetration of dust and damp. The best safeguard is to cement on the glass of the dia. with some waterproof composition, and to protect the base of the instrument with the same. The composition must have a fusion point of above 50° C., so as to stand hot water and accidental heating. Compositions of beeswax, pitch, rosin, and glycerine have given good results, as have very fusible alloys, melting at about 60° C. In pouring in the melted composition, some heating of the apparatus is, of course, unavoidable. Hence the instruments should be fixed, although insulated on a metal floor, for if the floor itself is of insulating material, the fixing screws are readily loosened by the heat.

The case must, of course, be constructed with special care, and so that it is impossible for water to collect in it. The cover glass must not be depressed below its enclosing ring, but project above it, and the top of the case must be somewhat convex. The floor of the case is provided with a circular groove to receive the upper part, and when the instrument is inside, the groove is packed with a rubber washer. In this way a case is obtained which is at first, at least, a perfect excluder of dust and water. As, however, the joints get loosened in time, means must be taken that what dirt and water do get in will do as little harm as possible until the casing should be put right. Needless to say, the case should be frequently examined. Iron structural parts, such as screws, springs, etc., should be avoided, or at least painted with some rust-proof composition. All insulating material used must be carefully selected from the point of view of being unaffected by damp. Finally, all connections, and the winding of the coils must be insulated as well as possible, best with silk or enamel. It is, nevertheless, of the utmost importance to make and keep the case as tight as can possibly be done.

* In the *Elektrotckniischer Anzeiger*.

Our instrument, now having as good a casing as we can give it, is installed upon the vehicle, and the period of its probation begins. In starting, in stopping, and between those operations there is a constant succession of jars and shakings. These affect chiefly the axle bearings of the instrument. In them we have the weakest point of the current types of construction, and hence the various firms which undertake the construction of automobile instruments have paid most of their attention to the bearings. Many plans have been tried for producing an unobjectionable and durable kind of bearing. The best of them are probably those of Nadir, of Rixdorf, and of Siemens and Halske, of Berlin. Both firms have provided the rotating parts of their instruments with spring bearings, whereby the jolting due to the motion of the vehicle is realised to a large extent, but they leave something to be desired as regards the protection of the axle ends. Hartmann & Braun, of Frankfort-am-Main, give a paraboloid form to their axle ends, and neutralise the resulting increased friction in the bearings by the use of stronger springs. This arrangement is so far the best invented, so far as spring bearings are concerned.

There is another difficulty to be met, viz., the loosening of screws by jolts on the road, and shocks incidental to rapid changes in velocity. All metal screws should be soldered up after fixing in position, but if this cannot be done, the utmost care must be taken to use only screws made of the best possible material, and with a well-cut thread of the proper pitch. If one of these two precautions is taken, we can say that we have done all we can.

We now proceed to consider the chauffeur. It is astonishwhat confidence these gentlemen show in the fitness of the instruments attached to their vehicles. They are too apt to use them as foot rests, and the maker is not really responsible for any evil results that may ensue from this practice, but he must take precautions against it, notwithstanding. Observation will show how the glass cover of the dial is frequently subjected to the action of heavy boots. It must, therefore, be protected somehow. One plan is to use a thick glass. One a quarter of an inch thick will stand a good thump. An additional precaution is to divide the the glass into two ring segments. This will not interfere with the readings, and greatly increase the protection from injury.

The best plan of all, however, is to remove the instrument entirely from its present unfortunate position at the feet of the chauffeur. By so doing, it will not only be removed from the sphere of action of his ever-moving feet, but the reading of it will be greatly facilitated. The chauffeur ought to be able to see the position of the pointer at a glance, and without undue exertion. To aid this still further, the pointer itself must be of such a form and size as to be easily seen, and the graduations of the dial must be free from any ornamentation that can hinder rapid reading. Everything bordering on the white paper of the scale must be a dead black to make it conspicuous by contrast, and all yellow lacquering or nickelling is to be avoided.

Here we have the main features of the points noteworthy of consideration in the construction of these instruments. All the types at present on the market show neglect of these points in one or more ways. It is only right to mention that the firms concerned are showing great interest in the matter, and it is to be hoped that we shall soon be in possession of a really good and unexceptionable automobile instrument. The Allgemeine Elektricitats Gesellschaft, of Berlin, is about to put some new instruments on the market, and they will arouse special attention.

The following note from K. S. Consul Grant, at Odessa, Russia, may interest your readers: "Odessa has a well-established and growing telephone system. Some time ago the management sent an order to a certain manufacturing firm in the United States for a lot of instruments. The goods were desired at once in order to meet almost immediate demands. Delay succeeded delay in receiving the goods, and it was six months before they arrived, during which time the management was obliged to order from Germany supplies sufficient to provide the most pressing demands. Owing to this lack of attention on the part of the American firm, the local company has decided henceforth to order its supplies from Berlin and of German make."

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

"If thou hast knowledge, let others light their candle at it."

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should be *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

Question No. 1,202.—State the merits and demerits of worm gearing for use with electric motors. Instance examples of its use, and state the best design and materials to employ in various cases.—R.

Question No. 1,203.—Consider the effect of the air gap of an induction motor on its size, cost and general characteristics. State and explain its limiting values, and compare with the gaps of D.C. machines.—"TEMPO."

Question No. 1,193.—Since the "wound" rotor of a large turbine pump motor has been replaced by a "squirrel-cage" rotor, it has not been possible to get the motor to start. State the cause of this, and suggest a means of getting over the difficulty. The supply is three-phase at 1,000 volts 25 ~.

Answer to No. 1,193 (*awarded* 10*s.*).—That the starting torque of an ordinary squirrel-cage induction motor is small is well-known, and substituting a squirrel-cage rotor for one of the slip-ring type in a motor driving a large turbine pump cannot be regarded as altogether expedient. The starting torque required by small centrifugal pumps is very small, since no water is delivered until the critical speed is reached, and squirrel-cage motors for driving such pumps are quite satisfactory. The inertia of the parts of large turbine pumps having a number of stages, together with the inertia of the water and the friction in the bearings, give rise to a fair amount of resistance, and it is quite easy to conceive that a squirrel-cage motor having a very small amount of Ohmic resistance in the rotor circuit, would fail to start such a pump. The question does not state whether the motor is started with an auto-transformer for lowering the pressure with a view to reducing the starting current; but if it is, it is possible that the impressed voltage at starting is too low, and it would be well to try to get the motor to start with a higher voltage by taking tappings off the transformer at different points. However, before considering what can be done to overcome the trouble, let us consider the first part of the question, viz., the reason for the motor failing to start. Now when the current is first switched on to the stator windings, the slip is 100%, and since the current in the short circuited conductors depends on the relative velocity of the revolving field and the rotor, the current in the rotor will be great also. The heavy current in the rotor conductors would give rise to a powerful torque if the direction of the current in the rotor conductors was correct with respect to the current in the stator coils, but, unfortunately owing to the low Ohmic resistance of the rotor windings, the current does not change rapidly enough, and the result is that a differential action takes place. That is to say, if we consider the rotor conductors under one poll only, the current in some of those conductors is tending to turn the rotor in one direction, whilst that in the others is tending to turn it in the opposite direction. The rapidity with which the current in the rotor conductors changes is dependent upon the time constant of the windings. The time constant of a circuit is the quotient of its inductance by its Ohmic resistance. In a circuit having a large time constant, the current takes a long time to rise to its normal value. Now, when the slip-ring rotor was used, at the time of starting a large Ohmic resistance was inserted in the rotor circuit by means of the resistance starting switch, so that the time constant $\frac{L}{R}$ became small.

Now, however, with the squirrel-cage rotor the ends of the rotor conductors are short-circuited by means of low resistance rings, and the time-constant of the circuit is much greater, with the result that the current does not grow and die down quick enough, and the differential action referred to takes place, which gives rise to a poor starting torque. When the rotor gets up to speed—assuming that it can do so—the periodicity of the rotor voltage is very much less, and at the same time the speed of the rotor will be nearly equal to that of the revolving field, and the rotor current will have time to die down and build up again, so that all the conductors under a given pace will be in the correct direction for producing a good torque.

As regards what can be done to improve the starting torque, the best thing would be to replace the original slip-ring rotor. Assuming, however, that for some reason this is prohibitive, the impressed voltage might be raised as previously suggested, by taking tappings from different points on the auto-transformer. If this cannot be done, or it does not have the desired effect, an endeavour should be made to start the pump with no water in it. The effect of trying to start with the delivery valve shut should also be tried. If the pump will start without water, it could be charged afterwards by fitting a cock to the suction or delivery pipe, so that water under the pressure from the main could afterwards be injected. If the above remedies have no effect, the only way out of the difficulty appears to be to have higher resistance end rings fitted to the rotor, or to provide a friction clutch between the motor and pump, so that the pump could be started after the motor. New end rings are bound to cause the motor to start, provided that they are of sufficient resistance. It should be observed, however, that the employment of such rings will reduce the efficiency of the motor somewhat.—B. T.

Answer to No. 1,193 (*awarded* 5*s.*).—By the following considerations of the principle and characteristics of induction motors, the reason for the failure to start in the present instance will be appreciated. As is well-known, the stator field of a three-phase machine is uniform, and rotate with a frequency equal to that of the supply current. Hence the field may be considered as due to the rotating magnet N S (Fig. 1). This field cuts the rotor conductors with a frequency equal to difference in revs. per sec. of the stator

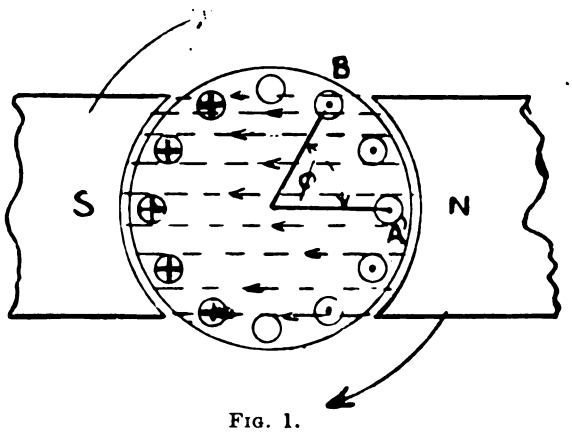

FIG. 1.

field and rotor speeds, *i.e.*, equal to rotor "slip" frequency. The E.M.F. so induced causes a current flow, which, in conjunction with the stator field, produces the motor torque. Now, the maximum E.M.F. is always induced in conductors situated at A (Fig. 1) with regard to the instantaneous position of the stator field, and for maximum torque the maximum rotor current should always occupy this position also, *i.e.*, the current should be in phase with the E.M.F. which produces it. Whether this is so or not depends on the angle of lag of the rotor winding, *i.e.*, on (Fig. 2), where $\tan \psi = \frac{2 \pi n L}{R}$ (n = frequency of

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rotor current: L = inductance of rotor winding: R = resistance of rotor winding). Now, as the frequency of the rotor slip increases the E.M.F. induced in its windings increases in direct proportion, and hence the current flowing increases directly with $\sim$ (assuming the stator field and the rotor R and L to remain constant). When the rotor runs synchronously with the stator field, which is only theoretically possible, there is no rotor E.M.F. induced, and hence no rotor current or torque; but if the rotor slip be 1%, there is a certain C and a certain torque.

Rotor

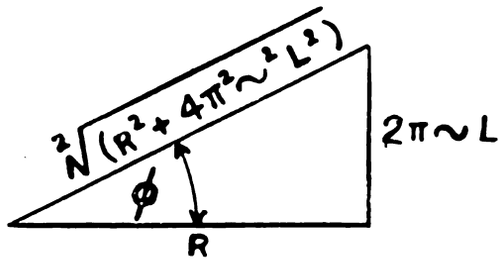


FIG. 2.

This torque always $\propto$ C max $\times$ N $\times$ cos ϕ, and while ϕ is small, cos ϕ remains practically constant, so that the torque $\propto$ current induced in the rotor, *i.e.*, with the frequency of slip of the latter. As the $\sim$ rises, however, cos ϕ soon begins to differ materially from unity, so that the torque rises less rapidly than $\sim$, and ultimately as the load on the motor exceeds its capabilities, the $\sim$ rises very rapidly, and the torque attains the "starting torque" value, the motor then being stopped, and the $\sim$ of silp equals the full frequency of supply. These points are illustrated in Fig. 3, in which, to a $\sim$ of rotor slip base, are plotted tan ϕ, cos ϕ, and a product proportional to the motor torque (the rotor resistance being assumed = 0·077 Ohm. per phase and the inductance 0·0007 henry per phase). These results (Fig. 3) assume the stator flux N and the rotor L and R to be constant, an assumption which is not justified in practice. Actually the resistance will rise as the current rises, owing to the heating and the positive

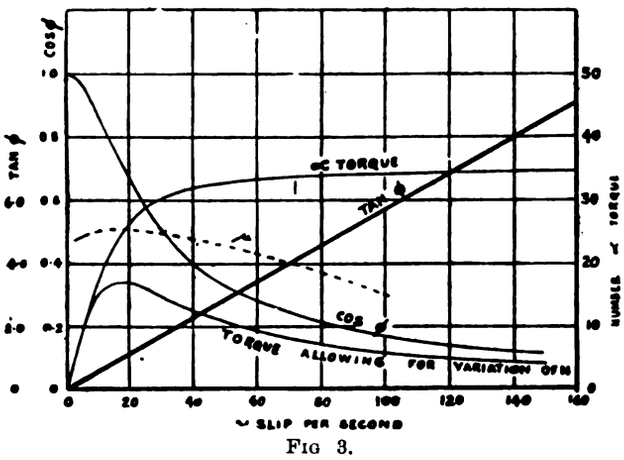
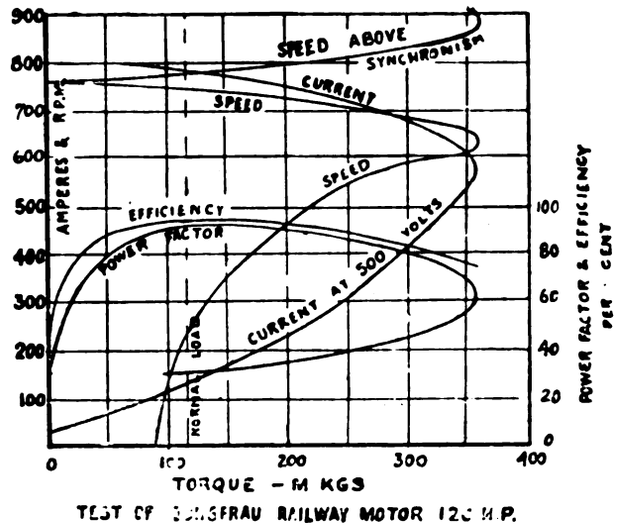


FIG 3.

temperature co-efficient of resistance of the copper. The inductance of the winding depends on the permeability of the iron, which, in turns, depends on the flux density rising for a time as the rotor flux density increases from its short circuit value and decreasing possibly at certain of the higher values of the flux density. (The rotor B may rise to 11,000 lines per sq. centimetre, and may be only 1,000 lines per square centimetre on starting: the maximum ϕ will be reached at about B = 7,000 lines per sq. centimetre (see Fig. 4). The result of these variations in R and L will be to increase and decrease respectively the resultant torque, and the extent to which these factors balance depends on the precise design of the motor. The rotor permeability curve (which is proportional to the rotor inductance due to the iron embedded portion of its winding, but does not affect the L of the length of winding-in air) may well be as dotted in Fig. 3. In an actual motor N becomes weaker and weaker as ϕ, the angle between A, B Fig. 1, *increases*, and the net result



TEST OF [illegible]SFRAU RAILWAY MOTOR 12[illegible] H.P.

FIG. 4.

of these departures from the above assumed conditions is that, although the torque first $\propto$ $\sim$ and then becomes nearly constant, as in Fig. 3, it soon begins to decrease with rising $\sim$ of slip, and the motor then being in an unstable condition, the machine pulls up. Though the current rises during this stage, the product C $\times$ N $\times$ cos ϕ decreases, hence the motor stops. This is clearly shown by the actual test curves (Fig. 5). If, in Fig. 3, a load of 35 torque units be applied to the motor the frequency of supply being 50 $\sim$ per sec., then the motor cannot generate this torque even with a rotor slip = 50 $\sim$ per sec., *i.e.*, the motor pulls up in the endeavour to increase its torque to the value demanded. Now, were it not for the inductance effect of the rotor, the torque of the machine would always vary directly with the $\sim$ of rotor slip, and would then easily supply the required torque.

Clearly, the means of increasing the torque, whether at starting or during normal running, depends on reducing ϕ as far as possible, *ie.*, on making $\frac{2\pi \sim L}{R}$ a minimum. L cannot be reduced below a certain minimum, and 2 is constant, hence we must reduce $\sim$ and increase R: hence it is that in designing an induction motor the slip at full load is kept as low as possible. On starting, however, the

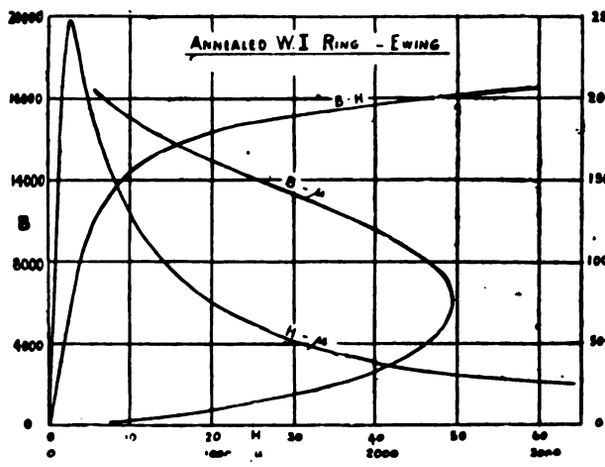


FIG. 5.

slip is perfectly definite and equal frequency of supply, hence the only means of increasing the starting torque is by increasing the rotor resistance. If this be done permanently by using high resistance coils or high resistance end rings, then the slip on full load is proportionately increased, and the machine efficiency is lowered. Any such permanent increase in R is thus very undesirable. The only remaining course of procedure is to use temporary rotor resistance on starting, *i.e.*, go back to the use of a wound rotor. Until this is done, "Z" will not be able to start his motor on load, though he can, if convenient, start the motor light (using an autotransformer) and gradually add the load. If autotransformers are at present used for starting, their ratio of reduction should be decreased, if

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the motor windings will stand the heavier starting current then taken. Since the starting torque $\propto$ (stator volts)^2, such a change may enable the motor to start on load without further alteration.—L. C.

Answer to No. 1,193 (*awarded* 5*s.*)—There are three causes to which may be attributed the failure of the motor to start. They may be classed under the following heads :—

1. "Cogging."
2. Insufficient resistance in rotor windings.
3. Unsuitable starter.

Taking the *first cause* of a failure to start : "Cogging" is caused by the rotor taking up such a position so that the reluctance to the magnetic flux is a minimum. This occurs when the teeth of the rotor come opposite to the teeth of the stator ; the rotor will stick in this position and hum. To avoid this, the number of teeth per pole per phase in the stator and rotor should not have a common factor ; to take an example, suppose a machine was desinged to have 3 slots per pole per phase in the stator, and contained 8 poles, the number of slots per phase would be 24 ; a suitable number of slots per pole per phase in the rotor would be 5, the number of slots per phase would be 40 ; if a squirrel-cage winding was adopted, this number would be adjusted so as to be incommensurable, and 41 slots per phase would be taken, so that the numbers would work out as follows : total number of slots in stator, 72 ; total number of slots in rotor, 123. With such numbers as these the rotor would not stick in any position whatever.

Second Cause.—If the stator and rotor windings had no resistance, and the current was switched straight on to the stator windings, we should get currents in the rotor which would be 90° out of phase with the rotor E.M.F. ; the stator currents would also be 90° (approximately) out of phase with the stator E.M.F. ; the reason why the stator currents would not be exactly 90° out of phase would be due to the iron losses, which tend to make the currents come more in phase with the E.M.F. Since these currents are wattless, their fields do not react in such a way so as to produce a torque. To get this starting torque, resistance must be introduced into the rotor windings in the case of a wound rotor, so as to bring the rotor currents more in phase with the rotor E.M.F., the stator currents will also be brought more in phase with the stator E.M.F., due to this introduction of resistance in the rotor. In the case of a squirrel-cage rotor, the windings must have sufficient resistance in them to enable the motor to start ; the short circuiting rings are often made of a high resistance material for this reason : to get the highest efficiency from an induction motor rotor, the resistance must be kept down, so that there is just enough to enable the motor to start ; this resistance, which is so useful at starting, has its disadvantages, that it brings down the efficiency when running. Professor Thompson's "Dynamo Electric Machine" (vol. ii.) gives full information on this subject ; it is also explained mathematically.

Third Cause.—An unsuitable starting gear may be the cause of failure, although I should think Cause 2 the most probable. Small motors are generally switched straight on to the mains, the amount of current taken being insufficient to harm the windings and to produce too great a voltage drop in the line. With a large motor, an auto-starter is generally used ; this supplies the motor with large currents at a reduced pressure, the pressure being gradually increased as the motor speeds up. The starting gear with this motor, perhaps, is at fault, not giving the motor enough current.

If Cause 1 be the fault, a new rotor will be required. If Cause 2 be the fault, reduce the area of the short circuiting rings, take care the current density is not made too high, 2,000 amsp per sq. inch if of brass and 3,000 amps. per sq. inch in the copper parts If there is fear of this, try some high-resisting material. If Cause 3 is the fault the starter will have to be altered to give the requred, current, which should be about 25% full load current or even more, if there is no fear of damaging the stator windings ; if the starter cannot be altered, a new one will have to be purchased.—E. A.

PERSONAL.

At a meeting of the Council of the Leeds Local Section of the Institution of Electrical Engineers, held at the Hotel Metropole on May 17, 1909, Mr. W. M. Rogerson, President, in the chair, it was resolved that in view of the approaching marriage of the Hon. Secretary (Mr. Harold Dickinson), and as some acknowledgment of his valuable services in founding the Leeds Section of the Institution of Electrical Engineers, and as its first chairman, together with the keen interest displayed by him in the interests of the section as Hon. Secretary, and as a tribute of the high esteem in which he is held by all the members, a suitable wedding gift should be presented to him. The presentation was made on Thursday, August 5, 1909, when a very ornamental silver table centre was presented to him, along with the hearty good wishes of his fellow members of the Society.

The Managers of the Dundee Technical College have appointed as lecturer on Electrical and Mechanical Engineering Mr. Robert D. Archibald, B.Sc., A.M.I.C.E., A.M.I.E.E., principal assistant to Dr. Magnus Maclean, Professor of Electrical Engineering in the Glasgow and West of Scotland Technical College.

At the last meeting of the Bridlington Town Council, the salary of the Borough Electrical Engineer (Mr. A. J. Beckett) was increased by £25, with a further increase of £25 in twelve months to £300 ; the salary of the Chief Clerk of the Electricity Department (Mr. T. E. Mott) was increased by £13 to £117 per annum, with two further yearly increases of £6 10s. to £130 per annum. Both increases to date from July 1, 1909.

BOOKS RECEIVED.

"Engineering Units of Measurement : with Symbols and Abbreviations, British and Metric Equivalents." By John Ramsay, A.M.Inst.C.E. (Glasgow : John Smith & Son, Ltd. Price 1s. net.)

"Electrical Installations of Electric Light, Power, Traction and Industrial Electrical Machinery." By Rankin Kennedy, C.E. : Vol. v.—Electrical Signals, Telegraphs, Telephones, X-Ray, Wireless Telegraphy, Induction Coils, Medical Electrical Apparatus. (London : Caxton Publishing Co. 7s. 6d. net.)

COMPANIES' MEETINGS AND REPORTS.

CHILIAN ELECTRIC TRAMWAY AND LIGHT.

The report of the Chilian Electric Tramway and Light Co., Ltd., states that the result of the company's operations for the year, after deducting interest and redemption of Debentures, London office and other charges, shows a balance to credii of profit and loss account of £8,832, to which must be added the balance to the credit of this account brought forward—namely, £1,712—which makes a net balance to credit of £10,545. From this sum £8,000 has been transferred to renewals reserve account, leaving a balance of £2,545 to be carried forward to credit of profit and loss account for the year 1909. The Chilian currency has suffered still further depreciation in 1908, the rate of exchange being on an average about 9 11-16d. per peso, and at one time falling as low as 7¾d. This has, of course, adversely affected the profits earned.

LIVERPOOL OVERHEAD RAILWAY.

The report of the Liverpool Overhead Railway Co. for the half-year ended June 30 last, to be submitted to the meeting at Liverpool on the 17th instant, states that the gross revenue receipts amount to £35,188, and the working expenses to £27,372. There has been a further shrinkage in passenger traffic during the past half-year, resulting in a reduction in the revenue of £2,486. This decrease in traffic is mainly attributable to the depression in trade. The directors, by introducing a more frequent but less costly service of trains, and effecting other small economies in working expenses, have made a saving of £3,138. The structure and the rolling stock have been maintained in efficient condition. The sum of £1,500 has been carried to credit of renewal fund, which now amounts to £38,082. The directors have to record with regret the death of Sir Edward Lawrence, who was one of the original directors, and who has rendered to the company very valuable service. Including the balance brought forward at December 31, 1908, £4,210, there is now available for dividend £7,696, and the directors recommend a distribution at the rate of 5% per annum on the (1892) Preference shares (less income-tax), leaving a balance of £4,696 to be carried forward.

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BAKER-STREET AND WATERLOO.

The report of the Baker-street and Waterloo Railway Co. for the half-year ended June 30 last, submitted to the meeting yesterday, states that the capital expenditure during the half-year amounted to £71,880, representing the expenditure which at the close of last half-year remained chargeable to the capital expenditure account. The share capital still remaining to be issued to the contractors under the construction contracts amounts to £33,000. Gross receipts on revenue account during the half-year amounted to £91,510, being an increase of £7,981 on the receipts for the corresponding half of last year. The working expenses have amounted to £42,224, being a decrease of £3,228. After providing for interest, rents and Preference dividend and reserving £4,000 for contingencies and renewals there remains a balance of £18,304 available for Ordinary dividend, and the directors recommend that a distribution at the rate of 1½% per annum be declared on the Ordinary shares, and an additional dividend at the rate of 1½% per annum (making 3% per annum in all) on the Ordinary shares other than those held by the Underground Electric Railways Co. of London, Ltd., or their nominees, leaving a balance of £3,105 to be carried forward. The terms of the agreement with the North-West London Railway Co., referred to in the directors' last half-yearly report, which provided for the working by this company of the projected railway from Edgware-road to Brondesbury, were settled, subject to confirmation by the shareholders, but it did not become necessary to seek such confirmation, as the Bill of the North-West London Railway Co. did not pass through Parliament. The extension to Paddington, which this company have power to construct, was so laid out on the Parliamentary plans that if it were constructed any extension beyond Paddington would be practically impossible, and its construction would also debar the company from arranging to work, as a continuous line, any extension in the direction of Brondesbury and Cricklewood, which, in the opinion of the directors, would be of more value than the Paddington extension. In these circumstances the directors recommend that the Paddington extension, as authorised, should be abandoned, and all questions as to extension of the railway beyond Edgware-road left for future consideration.

LONDON, BRIGHTON & SOUTH COAST RAILWAY.

The ordinary meeting of shareholders of the London, Brighton and South Coast Railway Co. was held at London Bridge, the Earl of Bessborough, C.V.O., C.B., presiding.

The Chairman, in moving the adoption of the report and accounts, said the work of equipping the South London Railway for electrical working was now very nearly completed. A trial service of some 16 trains had been running continually between Battersea Park and Peckham Rye in each direction for the last three months, and the full service between Victoria and London Bridge would commence on October The men had been receiving most careful training, both as regarded driving the trains and dealing with all the novel conditions of the system, and he was glad to report that everything had worked most satisfactorily. They intended to open the public service between Peckham Rye and Victoria at the end of the month, but they had been careful not to start until the men had been thoroughly trained and tested. The consulting electrical engineer and the contractors had carried out the work in a most able manner, and were entitled to every praise for overcoming the many difficulties and obstacles with which they had had to contend. With the establishment of the full service between Victoria and London Bridge, a distance of between eight and nine miles, a very considerable acceleration in time would be effected between those termini, as where steam trains had taken 36 minutes, the electric trains would run in 24 minutes, with the same number of stops. A much more frequent service would be run, and both season ticket and ordinary rates would be revised to meet the new conditions. They hoped, therefore, that in a very short time they would regain some of the business which had been lost to the electric tram and motor-bus competition. They had started the current half-year fairly well, and there were indications that the improvement in their business which had been shown druing the past two half-years was likely to be maintained.

GREAT NORTHERN, PICCADILLY & BROMPTON RAILWAY.

The report of the Great Northern, Piccadilly and Brompton Railway Co. for the half-year ended June 30 last, submitted to the meeting yesterday, states that the capital expenditure during the half-year amounted to £169,488, representing the expenditure which, at the close of last half-year, remained chargeable to the capital expenditure account. Gross receipts on revenue account amounted to £157,993, being an increase of £10,229. Working expenses amounted to £73,404, being a decrease of £1,578. After providing for interest, rents, and Preference dividend, and reserving £6,000 for contingencies and renewals, there remains a balance of £33,592 available for Ordinary dividend, and the directors recommend a dividend at the rate of 1% per annum on this issue, leaving a balance of £8,352 to be carried forward.

CHARING CROSS, EUSTON & HAMPSTEAD RAILWAY.

The report of the Charing Cross, Euston and Hampstead Railway Co. for the half-year ended June 30 last, submitted to the meeting yesterday, states that the capital expenditure during the half-year amounted to £145,798, representing the expenditure which at the close of last half-year remained chargeable to the capital expenditure account. Gross receipts on revenue account amounted to £105,182, an increase of £16,299. Working expenses amounted to £57,795, an increase of £1,302. After providing for interest and rents, and reserving £3,000 for contingencies and renewals, there remains a balance of £18,813 available for Ordinary dividend, and the directors recommend that a dividend at the rate of ¾% per annum be declared on this issue, leaving a balance of £2,590 to be carried forward.

METROPOLITAN ELECTRIC SUPPLY.

An interim dividend of 2s. 6d. per share has been declared.

SINGAPORE ELECTRIC TRAMWAYS.

The ordinary general meeting of the Singapore Electric Tramways, Limited, was held at 19, St. Swithin's-lane, E.C., under the presidency of Mr. Edmund Davis, in the absence of the Chairman (Sir Frank Swettenham).

Mr. Davis said: We have presented the report and accounts nearly four months earlier than last year, and next year we hope to have them in your hands within the first half of the year. In reference to the balance-sheet, I would draw your attention to creditors and credit balances, which in the accounts to December 31, 1907, stood at £10,693 7s. 1d., and in those now under review at £6,701 8s. 3d., showing a reduction of nearly £4,000. Turning to the other side of the accounts, you will see that during the period under review we have outlaid £12,884 8s. 6d. on our tramway undertaking, or about £4,500 more than in 1907, though we have written off a little over £10,000, as against £13,000 in 1907, the general rearrangement of provision for depreciation having been arrived at after consultation with our general manager, who advises us that, owing to the excellent condition of the plant, the reduced rate is justified. Cash at bankers and in hand and in transit is practically the same as in the previous year, though we now have only £6,000 on loan against security to compare with £15,000 in 1907. Debit balances and stocks of stores, tickets, coal, and sundries are about the same for the two years, and the balance of profit and loss account has been increased by £4,040 18s. 6d., making the total under this heading £16,217 6s. 6d., which is caused by the large amounts debited to our profit and loss account from year to year by way of depreciation.

Turning to the profit and loss account, it is unsatisfactory to note that our total receipts are £917 7s. 9d. less than for 1907, and you will notice that we have debited the account with depreciation amounting to £10,233 11s. 4d., debenture interest £17,500, and the royalty payable to the municipality of Singapore £601 9s., and then show a loss for the year of £4,040 18s. 6d. In abstract D the item commission and discount is again heavy, amounting to £740 2s. You will have noticed that the total traffic receipts amount to £55,985 12s. 9d., or very nearly 4% less than in 1907, the receipts per mile being 6·89d., as against 7·41d. in 1907. The falling off in revenue is to a large extent due to the great depression in trade in the colony, and more particularly among the Chinese community. The receipts for the current year up to July 31 show an increase over the corresponding period of 1908 of £7,070. The tramway expenses amount to £35,086 12s., or an increase on 1907 of about 2·8%, though the cost per car mile is 3·99d., against 4·07d. in 1907, the reduction being due to the fact that 63,104 more car miles have been run. The system of reserving first-class accommodation, which was introduced on August 22, 1908, has been found to be of benefit to the company, and is therefore being continued; but at present it cannot be profitably extended over the whole system. From the date mentioned to the end of the year the first-class receipts averaged 8·32% of the gross receipts, and as 5 cents per section is charged, against 3 cents for second class, we consider this satisfactory.

The receipts from the supply of energy for lighting and power purposes show a very gratifying increase, being $31,126, as against $15,999, or, say, a little short of double the receipts for 1907. This branch of the company's business is one with great potentialities, and, as further installations are brought on to the municipal mains, the returns should increase largely. Up to April 30 of the present year—to which date we have received detailed returns—the revenue under this heading shows a further increase of 43% when compared with the corresponding four months of 1908. With an improvement in trade in Singapore, the completion of the tramway system, and an increase in the sale of energy for lighting and power purposes, the time should shortly arrive when the company will show more satisfactory results than those shown in the accounts we are submitting for your adoption to-day. It will be noticed in the report that Sir Robert Hampson has resigned his seat as a director of the

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company. We have completed arrangements with our agents in Singapore whereby our general expenditure will be reduced, they having agreed to accept a greatly reduced amount as their remuneration, and you may rest assured that we shall do all we possibly can to carry on the affairs of the company in as economical a manner as possible compatible with the retention of efficiency. I now beg to move: "That the accounts at December 31, 1908, together with the reports of the directors and auditors thereon, submitted to this meeting, be, and the same are hereby, approved and adopted."

Sir Charles Petrie seconded the motion, which was carried unanimously.

Mr. F. Baynes moved the re-election of Mr. Edmund Davis and Sir Charles Petrie, the retiring directors, which was seconded by Mr. D. C. Ellis and unanimously agreed to.

The reappointment of the auditors (Messrs. Annan, Dexter and Co.) brought the proceedings to a close.

WESTINGHOUSE ELECTRIC AND MANUFACTURING.

The annual report of the Westinghouse Electric and Manufacturing Co. (the parent concern) has just reached us. The affairs of the company were taken out of the hands of the receivers December 5, 1908. The present Board was elected November 30, 1908, the officers were appointed December 7, 1908, and an executive committee elected January 5, 1909; but the Board was not permanently organisd until the election of Mr. Robert Mather as Chairman, January 19th, 1909. The intervening time has been required to complete the adjustments resulting from the receivership and the readjustment of the debt of the company, and to determine the reductions to be made with reference to the company's business in America. There was a decrease in the surplus account during the year ended March 31 last of $2,992,662, as follows:—Loss from operations of the business after providing for all interest charges and making fair allowances for depreciation, $918,683; expenses incurred in connection with the adjustment of the debt existing October 23, 1907, $460,490; compensation and expenses of receivers and their attorneys, $265,883; charged off to reduce the book value of assets, such as discount and expenses incurred in connection with bond issues of previous years; depreciation of patents, depreciation of various stocks and bonds, provision for possible losses on inactive finished parts and machines on hand at the close of the year, and other minor items of similar nature, $1,347,606. The loss during the fiscal year of $918,683, after providing for interest on the debt and all expenses, is chiefly accounted for by a small volume of business, the utilisation of high-priced material, by sales at reduced prices and by very considerable extra expenses incurred in completing the departmentalising of the manufacturing operations of the company and in the rearranging of the machinery, which work was carried on without interruption by the receivers. These important changes in manufacturing methods have reduced greatly the amount of material, raw, in process and finished, required to be kept in stock for a given amount of output (the amount of material in stock, work in progress, goods on consignment and apparatus with customers on March 31, 1909, was $9,961,182, as compared with $17,740,178 on October 23, 1907), and has also increased the space available for manufacturing operations. The company received from stockholders, merchandise and other creditors, subscriptions to capital stock at par amounting to $12,778,825; to Five per Cent. Convertible bonds at par amounting to $3,586,000, and to 4, 5, 6 and 15-year notes $1,392,150, making a total of new capital raised at par by the sale of stock and securities of $17,756,975. The officials estimate that the plants have an annual output capacity of $50,000,000, and that the cash capital provided as above is ample for conducting a business of that magnitude. Under the provisions of the Convertible bond indenture, the company is required to provide a sinking fund of $500,000 annually and to invest the same in its Convertible bonds. Since the termination of the receivership the company has turned into the sinking fund $1,500,000, covering the requirements up to the end of the present calendar year. This sum was invested in Convertible bonds, yielding a profit of $105,479. While there has been a decided improvement in the business of the company since the beginning of the year, it has not yet reached normal proportions, but the outlook and inquiries indicate that in the near future the full capacity of the various works will be required to meet the demand.

THE YORKSHIRE ELECTRIC POWER CO.

The report of the directors to be submitted to the shareholders at the thirteenth ordinary half-yearly meeting of the company, to be held at the Hotel Metropole, Leeds, on Tuesday, September 21, runs as follows: In accordance with the resolution passed at the shareholders' meeting in February, 1908, the directors have pleasure in reporting on the progress of the company for the half-year from January 1 to June 30, 1909. The receipts from the sale of energy and for work charged out to consumers, etc., for the half-year ending June 30 last amount to £11,163 4s. 2d.; against for the half-year ending June 30, 1908, £8,698 9s.; and for the half-year ending June 30, 1907, £4,700 9s. 1d. The gross profit on the revenue account for the half-year is £2,598 12s. 11d.; against a gross profit for the half-year ending June 30, 1908, of £1,249 16s.; and a gross loss for the half-year ending June 30, 1907, of £403 4s. 3d. After payment of mortgage interest the net revenue account shows a profit on the half-year just ended of £1,069 17s. 11d.; compared with a profit for the corresponding half-year in 1908 of £363 6s. 10d.; and a loss for the half-year ending June 30, 1907, of £1,211 3s. 9d. During the half-year further agreements have been made with power users to an extent equal to the average of preceding half years; these include a number of contracts with collieries and other consumers on the Barnsley extension. The full benefit from these arrangements does not appear during the period under review. The demand for energy per h.p. connected has been low owing to the depressed state of nearly all the industries in the company's area; notwithstanding the adverse conditions of trade there has been a steady increase in the use of the company's supplyl. Owing to these increases it will shortly be necessary to instal further generating plant for which space was reserved when the Thornhill Power Station was erected. The whole of the issue of £45,000 of second mortgages has been applied for and allotted. The directors are glad to report that Mr. Walter Geoffrey Jackson has consented to fill the vacancy on the Board and they have appointed him under the powers conferred upon them.

WASTE HEAT AND GAS ELECTRICAL GENERATING STATIONS.

The directors have declared an interim dividend in respect of the half-year ended July 31 at the rate of 5% per annum, less income-tax. The dividend is payable on August 31.

CONSOLIDATED ELECTRICAL.

The Consolidated Electrical Co., Ltd., has declared a dividend of 3% (7 1-5d. per share), less income-tax, on the Ordinary shares for the past year, and carried £7,385 forward.

COMPANIES REGISTERED.

ADNIL ELECTRIC CO., LTD.—Registered June 29. Capital £10,000, in £1 shares. Objects: To carry on the business of electricians, electrical and general engineers, ironmongers, makers of and dealers in electric tramcars, motor-cars, flying machines, aeroplanes, cycles, carriages and other vehicles, manufacturers of and dealers in dynamos, motors, electric light fittings, etc. Private company. Registered office, Adnil-building, Artillery-lane, E.C.

PREMIER ELECTRIC INSTITUTE, LTD.—Registered July 9. Capital £100, in £1 shares. Objects: To inaugurate an institute for selling curative electrical appliances and advising on electrical treatment, to carry on the business of manufacturers of and dealers in electrical specialities, etc. Private company. Table "A" mainly applies. Registered office, 133-5, Regent-street, W.

S. A. WARD & CO., LTD.—Registered July 8. Capital £3,000, in £1 shares (1,500 Preference). Objects: To acquire the business carried on by S. A. Ward & Co. at Broad-street, Sheffield, and to carry on the business of mechanical and electrical engineers, merchants, stores contractors, colliery and general mill furnishers, driving belt manufacturers, etc. Private company.

SYLVERLYTE (1909), LTD.—Registered July 24 by Romer & Skan, 4, Copthall-chambers, E.C. Capital £200,000, in £1 shares. Objects: To acquire any inventions relating to electric and other lamps or any lenses, reflectors or other compound parts or accessories for use in connection therewith, in particular to acquire patents Nos. 5,191 of 1904 and 10,696 of 1908, granted for the United Kingdom in respect of inventions relating to improvements in lenses and the benefit of foreign and colonial patents granted or applied for in connection therewith, also to acquire the business and assets (except cash in hand) of the Sylverlyte Electric Lamp Co., Ltd., and to carry on the business of manufacturers of and dealers in lamps, etc. Minimum cash subscription, 50,000 shares. The first directors (to number not less than three nor more than nine) are A. E. Berthoud, J. S. Burns, T. E. Dickinson, H. Harker and S. F. Rumball. Qualification, £250 shares. Remuneration, £50 each per annum. (Chairman £100) and 10% of the distributed profits, divisible. Registered office, 13, Sise-lane, Queen Victoria-street, E.C.

FIFE TRAMWAY LIGHT AND POWER CO., LTD.—Registered July 3 in Edinburgh by Guild & Shepherd, Edinburgh. Capital £200,000, in £1 shares. Objects: To acquire all or part of the share capital of the Dumfermline and District Tramways Co. and the Fife Electric Power Co., to construct or acquire light or other railways, electier or other tramways and electric lighting and power supply works, etc. The first directors (to number not less than two nor more than five) are to be afterwards appointed. Qualification, 100 shares. Remuneration as fixed by the company.

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ALBA LAMP SYNDICATE, LTD.—Registered July 29, by R. P. Hamp, 22, Southampton-street, Bloomsbury-square, W.C. Capital, £3,000, in 2,925 Preferred Ordinary shares of £1 each and 3,000 Deferred Ordinary shares of 6d. each. Objects: To acquire the benefit of and develop and turn to account a certain existing invention relating to a central reflector electric lamp. Private company. The first directors (to number not less than two nor more than seven) are: S. Fawns (chairman) and A. E. McCracken. Registered office, 149-150, Finsbury-pavement House, E.C.

PACIFIC RAILWAY CO. OF COLOMBIA.—July 30. £280,000 (£20). To acquire as a going concern the undertaking and assets and liabilities of the Compania del Ferrocarril del Pacifico (formed under the laws of the Republic of Colombia), including all concessions granted to the company by the Government of the said Republic for the construction and operation of lines of railway, to operate any of the company's railways by steam, electricity, or other power, etc. First directors (not less than three nor more than nine): C. T. Elicechea, A. J. Penney, and C. Castro. £500. £150 each per annum (£50 extra for the chairman). B. Sanin Cano, R. Parga, and L. Norzagaray are alternate directors.

LIENS REGISTERED.

HART ACCUMULATOR CO., LTD.—Mortgage, dated July 15, 1909, to secure £4,500 and 4% interest, charged on lands and premises at Stratford. Holders—G. A. Smith, H. A. Smith and F. Smith.

WOLFRAM (TUNGSTEN) METAL FILAMENT LAMPS, LTD.—Particulars of £40,000 Debentures, created April 30, 1909, filed pursuant to section 93 (3) of the Companies (Consolidation) Act, 1908, the amount of the present issue being £30,000. Property charged—The company's undertaking and property, present and future, including uncalled capital. No trustees.

RECEIVERS APPOINTED.

RENO ELECTRIC STAIRWAYS AND CONVEYORS, LTD.—M. Lancaster, of 1, Basinghall-street, E.C., as receiver and manager, by order of Court, dated July 23, 1909.

BUSINESS NOTES.

LIGHTING AND GENERAL.

BIRMINGHAM.—The City Council are seeking powers to borrow £149,350 for the electric supply undertaking, £100,000 of which is required for extension of the underground mains; £15,000 for high tension switch gear, and £2,000 for transformers. There was an increase of nearly four-and-a-half millions of units supplied to private consumers as compared with the previous year, and the undertaking was able to pay over £10,000 out of profits in relief of the rates.

ILFRACOMBE.—The Electric Light Co. wrote to say that they would provide the lamps, etc., needed at the Pavilion, for £11. The Chairman said the time was very short, and he and the Surveyor had given orders for the work. The Council unanimously confirmed the action, the lighting to go on to the end of the month with the option of continuing a week or two longer.

CARLISLE.—Mr. W. O. E. Meade-King, Inspector of the Local Government Board, held an inquiry into an application to borrow £5,750 for laying down new plant at the electricity station, which is now being run at full power. There was no opposition.

OULTON BROAD.—The General Purposes Committee reported that the Clerk had submitted copies of provisional orders and transfers received from the Urban District Councils of Leatherhead, Wembley, Sandgate, Hampton, and Cromer, and it was resolved—"That this committee having considered the information received from Urban District Councils having provisional orders for the lighting of their respective districts, apply to the Council for authority to advertise inviting tenders for the working of the electric lighting provisional order." On the motion of Mr. R. S. Stranack the report was adopted.

SOUTHAMPTON.—It has been decided to seek Parliamentary powers to carry on the work of free or assisted wiring, to instal wires, fittings, etc., and to hire out arc lamps, heating apparatus, and cookers, either at a rental, or on the deferred payment system.

SURREY COUNTY COUNCIL.—It was reported that a clause for the protection of the Council had been inserted in the Hindhead and District Electric Lighting Order, and though the placing of overhead wires had not entirely been prohibited, the placing of them would be subject to the consent of the Board of Trade and the local authority, and the Board had intimated that they would not in any case give their decision without affording the County Council an opportunity of being heard.

WOOD GREEN.—Messrs. May and Hawes, consulting engineers, have issued a report embodying a scheme for an electric supply undertaking which has been adopted by the Wood Green District Council, subject to the terms of an agreement with the North Metropolitan Power Company, for the supply of electricity in bulk. An alternating current 3-phase system is proposed. The pressure would be reduced from 10,000 to 3,000 volts at a distributing station, and thence transmitted to sub-stations or transformer pillars, the delivery pressure for lighting being at 250 volts.

TUNBRIDGE WELLS.—During the past 14 years the electrical undertaking has earned a gross profit of £59,327 on a capital outlay of £80,519 4s. 10d. The inception of the undertaking was co-incident with Mr. Boot's appointment as resident engineer, and since that date 960 consumers using an equivalent of 64,126=8 c.p. lamps have been secured (being nearly one-sixth of the total number of ratepayers). In 1907 Mr. Boot was appointed, and is still retained as Consulting Electrical Engineer to the Corporation.

BATH.—The Electricity Department shows a net loss in fixed interest and sinking fund of £384. The extra amount for interest and sinking fund amounted to £175 (interest), and £163 (sinking fund); total £338, or about £50 less than the net loss. In briefly explaining the reasons for the loss, Mr. Hatt said it was very well known throughout the whole country that the revenue of electric lighting had been disastrously affected by the introduction of metallic filament lamps, and there was a reduction in the revenue of £645. Fortunately, they had an increase in the sale of current for power purposes of £171, reducing the net loss on the current, but the fact remained that the introduction of these lamps had resulted in a loss to the undertaking of £645, but the speaker referred optimistically to the future, with the reduced cost to the consumer and the better light provided. But while the introduction of the 3,000 lamps temporarily affected the revenue, he believed they might safely say it had solved for them the problem of street lighting. They had an instance of it, for no one who had seen the lighting of the road in Bloomfield-park would hesitate to say that it was infinitely better than any street lighting by gas at present in the city. The cost of the 100 candle power metallic filament lamp was £2 15s. per annum, as compared with £2 10s. for the 60 candle power incandescent burner.

LONGTON (STAFFS).—The Council will expend £1,550 for the purposes of the electricity undertaking.

LUTON.—£269 are to be spent on extensions of the electric mains.

CALCUTTA.—The number of units delivered to consumers by the Calcutta Electric Supply Corporation, Ltd., during the four weeks ended June 25, 1909, were 689,235, compared with 561,055 units in the corresponding four weeks of 1908.

IPSWICH.—During last summer the five main boilers were fitted with the Crosthwaite Patent Grates, at a total cost of £430 19s. 7d., resulting in an economy in coal consumption, represented by about £579. A water softener, having a capacity of 400 gallons per hour, was also purchased and brought into use. A special main was laid in December, in order to supply the power for working the Dock cranes from our tramway circuit. These cranes were previously supplied from the lighting mains, but their intermittent working and the great fluctuation of current rendered it necessary to make the change. During the year negotiations were concluded with the Admiralty for supplying electric energy for operating the new wireless telegraph station. A special feeder is to be laid from the power station for this purpose, but the cost will be borne by the Admiralty. The use of electricity for lighting the streets has received consideration during the year. The free wiring system for consumers' installations which you decided to introduce in March last year has now had a full year's trial, and the fact that 69 consumers have been connected on this system warrants you in concluding that it has been successful. The total capital laid out at March 31, was £488. In October last year, following the practice adopted by many other electric supply undertakings, a scheme of hiring out arc lamps for shop lighting was introduced the hirer paying a fixed sum per annum for a definite number of hours of burning, including hire of lamps, electric energy, carbons, cleaning, etc. At March 31, 26 lamps were installed under this scheme, representing a capital outlay of £128. The working expenses amount to £9,496 and capital charges to £5,901, making a total on the expenditure side of £15,397, excluding the two special items mentioned below. The total of the revenue side is £15,391, so that, had there been no special charges such as the payment towards the cost incurred in rebuilding the boiler settings, and the instalment for liquidating the preliminary

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expenses, the two items amounting to £345, revenue would have failed to balance against expenditure by only some £6. The two special amounts mentioned, however, make the deficit on the year's working £351, which compares with a loss in the previous year of £1,789. In that year, however, we made no allowance towards preliminary expenses, consequently the net result of working this year is £1,678 better than the previous year, a result which I think you will consider very satisfaction. There has been a considerable increase in the turnover of the installation department as compared with the previous year. The installation department on the year's working shows a profit of £150. The percentage increases in the supply for private lighting and power over last year's figures, being respectively: Lighting, 16·32%; power, 28·61%. There is also an increase of 2·78% in the output for traction, which is referred to later. The number of consumers has increased by 137 during the year or 29·4% on last year's total. The department has benefited considerably through the new metal filament lamps in connection with which important improvements and developments have taken place during the year. The figures for cost of production show a satisfactory reduction, especially the cost per unit for coal.

MADRID.—The Government has decided to spend 10 million pesetas in the reorganisation of the telegraphic and telephone service. Nearly two millions will be reserved for land telegraphy, and over two millions for marine cables. *ddd* telegraphic offices are to be fitted with telephonic apparatus.

WORTHING.—A report on the trial of the Beck electric lamp for street lighting has been before the Town Council. Taking two arc lamp circuits in Chapel-road, the Beck lamps showed a saving of 19% of electric current, and the committee reported that "The illumination afforded by the Beck lamp is also much greater than that obtained from the other lamps." There is an excess in the cost of carbons, but a saving in repairs. The electrical engineer reported that no difficulty was experienced in maintaining the new lamps in an efficient condition, that they were extremely simple in construction, and that all new parts which from time to time become necessary will be inexpensive. It is proposed to replace the present lamps with the new.

BURNLEY.—The total expenditure of the Electrical Department last year was £11,680, and the total revenue £21,934. There was an increase of 119 consumers, of 34 motors connected, representing an increase of 64 b.h.p. In his report Mr. L. E. Starkie, the Borough Electrical Engineer, says: "There is no doubt that the metallic filament lamp for electric lighting will do what the incandescent mantle did for gas, that is, increased illumination at less cost. It is gratifying to know that the price of the lamps is gradually being reduced, and since lamps are now to be readily obtained to burn singly on 220 volts, electrical undertakings should eventually reap the benefit."

CAPE TOWN.—The Cape Town Corporation Electric Lighting Works on July 1 took over the responsibility of supplying energy in bulk to the Cape Government Railways, and the Table Bay Harbour Board. The supply to the Cape Town Post Office is also taken from the Corporation through the Railway switchboard. Cables have been laid in duplicate by the Corporation, both to the Railways and Docks switchboards, in order to provide against a breakdown. For the purpose of the extensions a large quantity of new plant has been erected. The engines are by Belliss & Morcom, and are directly coupled to Siemens alternators generating two-phase current at 2,200 volts. The engines are capable of giving a continuous output of 600 b.h.p., with an overload of 25% for two hours. The boilers were supplied by Babcock & Wilcox, and the condensing plant by W. H. Allen, of Bedford. There is also a "booster" (by the Phœnix Co., Bradford) for raising the pressure from 440 volts to 550 volts for working purposes at the Docks. A battery station has been erected at the Docks, and equipped by the Chloride Co. The switchboard was supplied by Siemens Brothers, and is of the remote control pattern. In addition to the two steam-driven alternators, there is a motor-generator so that when the lighting load at the Railway and Docks is small, the load can be supplied from the alternator of this motor generator; this plant was supplied by the General Electric Co., of London. The old battery station at Dorp-street has been dismantled, and a new battery shed erected and equipped, adjoining the Central Electric Light Works. The total cost of the extensions amounts to about £25,000.

FAREHAM.—The Council decided to provide new cooling apparatus and other plant at the new Electric Light Works, at an estimated cost of £182 10s.

BRADFORD.—The annual report of the Electricity Department for the year ended March 31 shows a surplus on the year's work of £2,146, compared with £,1135 in the previous year. Against this has to be set a sum of £1,491, for adjustment of liabilities on March 31, 1908, and a sum of £1,200 rebate made to the Tramways Committee in consequence of the failure of the Committee to provide sub-stations for the transforming of the high-pressure current. The works are shown to have earned from 1890 the total surplus of £78,127. The general supply of current for the year shows a decrease of £217, but this has been more than compensated for by an increase of £4,064 in the bulk supply. The cost of coal during the year was £11,910, an increase of £510 on the previous year. The total income showed an increase of £3,972 and the total expenditure an increase of £2,960.

EMDEN (Germany).—The British Vice-Consul, Mr. W. H. M. Sinclair, reports that a new undertaking has been initiated near Aurich with Government assistance. Works are being erected with a view to utilising peat, of which a vast supply is available, for the generating of electricity. The Government will, it is reported, require a supply of some 2,000,000 kws. yearly in connection with the harbour at Emden.

TRACTION.

YORK.—In connection with the electrification of the tramway, the whole of the rails are to be welded by the "Thermit" process.

DUKINFIELD.—Alderman W. E. Wood stated at Dukinfield Town Council that the Stalybridge, Hyde, Mossley, and Dukinfield Joint Tramways and Electricity Board had produced electrical current at a cheaper rate than any other undertaking in the United Kingdom. Answering Councillor Hamer as to whether the current was being sold at less than cost price, Mr. Wood explained that the policy of the Board in charging one penny to the tramways and less than one halfpenny per unit to private firms had resulted in a reduction of the loss of £5,000 in 1907 to £500 last year.

IPSWICH.—The Tramways Department report the greatest deficit which has so far resulted in the working, viz., a sum of £2,294, comparing with a loss of £1,450 last year. The increase in the loss on working is mainly accounted for by £409 less revenue, and £124 increase in cost of electric power. Another item in the increased loss is the contribution from revenue of £200 (made this year for the first time) towards the wiping out of the preliminary expenses which originally stood at £602. The only capital expenditure during the year has been £85 on a special machine for grinding rails, joints, and points. A new system of 1d. return fares was introduced in order to encourage short distance riding.

LINCOLN.—The City Council has accepted Mr. W. R. Lilly's Steep-hill tramway scheme, which will prove of great advantage to the Electrical Department and to the inhabitants.

CONTRACTS OPEN.

DUBLIN.—Ballinasloe Lunatic Asylum. Supply and erection of overhead cables. Spec., £1 1s., G. B. Meenan, 5, Charleville-road, Rathmines.

BRUSSELS.—Electric equipment of new sub-station at Ostend. October 8.

BISSONE (Italy).—Equipment, &c., of single track, 1-metre gauge electric tramway from Capolago to Bissone. (Part., from Sig. Antonio Soldini).

BONN.—Electric railway between Bonn-Beul-Siegberg and Bonn-Koenigswinter-Konneff (Electrische Bahnen der Kreise, Bonn-Stadt, Bonn-Land und des Sieges Kreises).

LEITH.—Dock Commissioners.—Crane, Est. £11,000, capable of lifting 100 tons, having a jib 60 ft. in height and a radius of 36 ft., with an auxiliary jib about 15 ft. higher, capable of lifting 20 tons.

MAASTRICHT (Holland).—Electric line from Baats to Maastricht, *viâ* Margraten, with branch fromGuelzen to Wylre. Est., £110,000. (Part., from Provincial States).

BUKAREST.—Municipal Council.—New electric tramway lines, to be constructed by a Rumanian company to be formed with a capital of £160,000, of which amount the municipality will subscribe a quarter.

LUGANO (Italy).—Tramway construction and equipment—one metre gauge electric line from Massagno to Ostarietta *viâ* Casternpino. (Part., Sig. Elvezio Crivelli).

YORK.—Corporation.—Eighteen double-deck electric tramcars and one watering car. August 27. Spec., City Electrical Engineer, Foss Island-road.—MADRID.—Electric tramways in Barcelona. (Part., August 26).

ROME.—Italian State Railways.—Six hammers electrically worked. August 18.

BATTERSEA (Metropolitan Borough of).—Electricity Department: The Council invite tenders for supplying apparatus and installing same on consumers' premises, in connection with their hire-purchase scheme, for a period of one year. Section "A"—Direct current motors and controlling gear; Section "B"—Direct current flame and enclosed arc lamps; Section "C"—Motor and arc lamp installations. Tenders will be considered for any Section, or the whole of the Sections, but not for part of a Section. Tenders, sealed and endorsed "Electricity Department, Hire-purchase Scheme, Section '—'," by Saturday, the 21st inst.

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Particulars from the Electrical Engineer, Electricity Works, Lombard-road, Battersea, on payment of a fee of 5s. for each section, which sum will be refunded on receipt of a *bona-fide* tender.

LEEDS (City of).—Electric Lighting Department. Cables: Tenders are invited for the supply of paper insulated cables, required during one, two, or three years (at the option of the Corporation to be declared on the acceptance of a tender), commencing on January 1, 1910. It is proposed to make the prices subject to a sliding scale based upon the market prices of copper and lead. The department's requirements of cable have during recent years been of the value of £8,000 to £10,000 per annum. Tenders must be in the form attached to the specification, and must reach me not later than 10 a.m. on Tuesday, September 7, 1909, in sealed envelopes endorsed "Electric Lighting—Tender for Cables." Particulars from Mr. H. Dickinson, Manager, 1, Whitehall-road, Leeds, on payment of a deposit of £1 1s., which will be returned on receipt of a *bona-fide* tender.

DUBLIN.—Tenders for one Electric Water Sprinkling Car.—The Cleansing Committee of the Corporation of Dublin are prepared to receive tenders for the supply of one electric water sprinkling car, fitted with electrically-driven air compressor or returbo pump, to sprinvle a minimum width of 10 ft., and all intermediate distances up to a maximum of 30 ft. from centre of track. This car when not in use for street sprinkling will be used for the haulage of the Corporation's refuse wagons, and should be designed accordingly. Particulars from Fred. J. Allan, Secretary, Cleansing Committee, 3, Cork-hill. Tenders, sealed and endorsed, must be addressed to the Chairman, Cleansing Committee, 3, Cork-hill, Dublin, and delivered not later than 12 o'clock noon on Tuesday, August 31, 1909. The committee do not bind themselves to accept the lowest or any tender.

CORPORATION.—The Council invite tenders for the supply at McDonald-road Electricity Supply Station of a motor alternator. The specification, form of tender, general conditions, and drawings can be abtained at the Engineer's Office, Dewar-place, Edinburgh, on and after Monday, August 9, 1909, on payment of a deposit of £2 2s., which will be refunded on receipt of a *bona-fide* tender and on the return of the specification, general conditions, and drawings. The specification, general conditions, and drawings can be seen at, but not obtained from, the office of Sir A. B. W. Kennedy, 17, Victoria-street, London, S.W. Tenders, endorsed "Tenders for Motor Alternator," must reach the Town Clerk, City-chambers, Edinburgh, not later than September 4, 1909.

RESULTS OF TENDERS.

BARNSTAPLE BOARD OF GUARDIANS.—Seven tenders were received for wiring the House for electric light: Messrs. Pullen, Bradford, £191 10s.; Edmonds, London, £186 10s.; Harris & Co., Exeter, £141; Bristol Electricity Co., £135; Baker & Co., Newport, £130; Malone, Barnstaple, £122 10s.; Rippin, Exeter, £120 1s. 10d. The Visiting Committee recommended that the tender next to the lowest—that of Mr. Malone, of Barnstaple, at £122 10s., should be accepted. There was but little difference between the last two tenders, both of which were below the estimate. Mr. Malone's tender was accepted.

CROYDON.—The following tenders were accepted: No. 1 contract, repairs shop, Mr. F. W. Honour, Warlingham, £365 10s.; No. 2 contract, mess room, lavatories, etc., Messrs. Truett & Steel, Thornton-heath, £374.

PEKING.—It is announced that the contract for the establishment of a telephone service in Peking has been awarded to the Western Electric Co., the amount of whose tender was $150,000. Tenders were submitted from practically all over the world.

PATENTS.

Alternating Current Arc Lamps.

4122.—1909. M. KÖRTING, Leutzsch, nr. Leipzig. This improvement in alternating current arc lamps is to prevent the loud chattering and humming noise arising from the short violent oscillations of the armatures of the lamp magnets. Fig. 1 is a sectional elevation, Fig, 2 is a plan. *a a* and *b b* are a pair of horse-shoe magnets, *a a* being in the main lamp circuit and *b b* in the shunt circuit. *e f* are armatures situated between the poles of the magnets and connected together by a frame *d* adapted to turn about pivots *c c*¹. The frame *d* carries means such as *h* for retaining and freeing a clock-work train *k* in the usual manner for the purpose of feeding the carbons. *g* is a ring formed of good conducting material surrounding the armature *e*. The induction currents generated in the ring *g* will damp the oscillation of the armatuer and this damping action will be very effectual when the armature moves at right angles to the lines of force and the circuit of the ring is at right angles to these lines. In a differential lamp both armatures may be provided with rings, but one only is necessary, that in the main circuit, for the damping action due to the ring comes into operation to a greater degree on the ignition of the lamp, which in this case takes place quietly and with certainty; for it is known that at the moment of ignition the shunt magnet is nearly

Fig. 1.

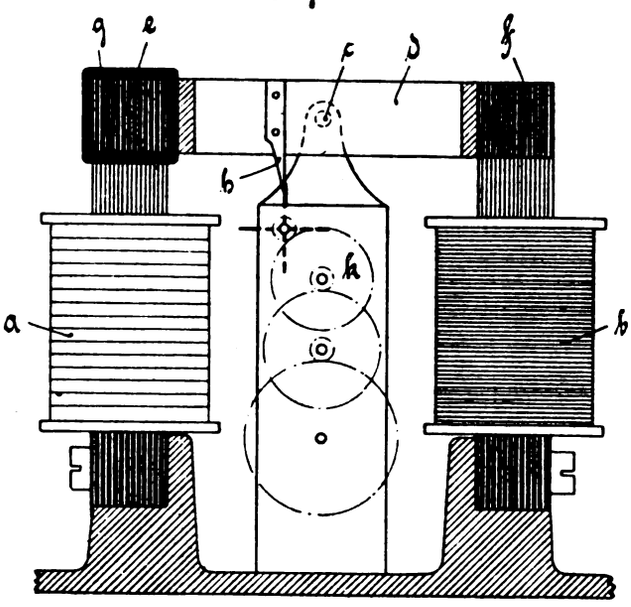
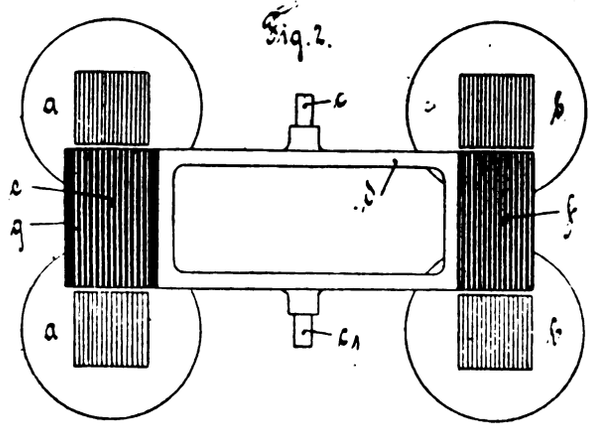


Fig. 2.



powerless, whilst the main current magnet is at its full normal strength or its strength is even intensified as the main lamp current on ignition is usually greater than normal. In place of one ring several rings may be employed or windings forming closed circuits are arranged on the armature or the frame which connects the armatures together may be made to embrace the armature and so form the ring.

Automatic Regulators.

19992.—1908. ART. BROWN, Boveri Baden, Switzerland. This is an improved method of automatically regulating direct and alternating current machines in such a manner as to produce a powerful and rapid regulation at the commencement of the process. The arrangement illustrated operates as follows: If the pressure of the generator *c* vary, then the torque exerted on the disc *b* also varies; that is to say, the disc will rotate with the spindle *a* and consequently roll along the arc of the sector *h* on the contacts *i* in such a manner that according to the variation and pressure more or less resistances are inserted. Instead of allowing the damping arrangement to influence from the commencement of the movement of the disc *b* the drive of the rolling sector *h* in order to prevent over-regulating, the spindle *a* together with the sector *h* will lead owing to the interposition of the spring *m* between the spindle and the damping device by a certain distance without damping. This will obtain until the spring *m* is tensioned to such an extent that it supplies the required torque which is wanting in the torque produced by the weight *e* on increase of pressure and in the torque produced by the electro-magnet *d* on decrease of pressure for maintaining the equilibrium. At the end of the regulating process the disc *n* gradually assumes its former position relatively to the shaft *a* by the gradual lessening of the tension of the spring. Instead of winding the electro-magnet *d* with a shunt winding as in the form described, it may be wound with other windings according to the effect or regulation it is desired to obtain; for example, it may have in

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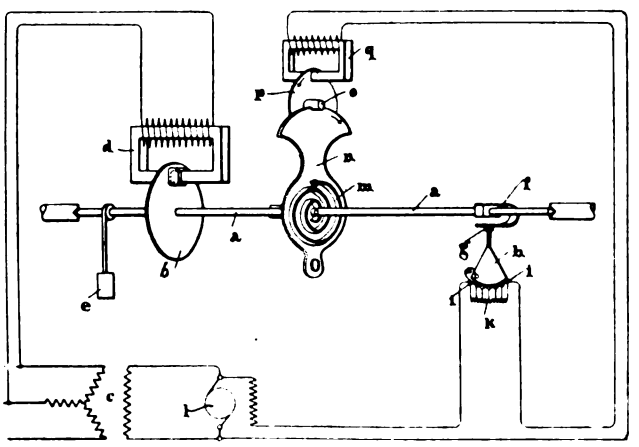
place of the shunt coil a series of coil, or it may have a shunt and a series coil arranged to aid one another or to oppose one another. In the case of the shunt coil it has been shown above that variation of voltage of the generator *c* automatically through disturbing the equilibrium of the electro-magnet *d* and the disc *b* causes alteration of the field system to compensate for the voltage variation of the generator. When *d* is wound with a coil in series with a lead of the generator *c* a similar action will occur on a change of current in that lead, the excitation adjustment, which is automatically effected, being that which is predetermined a definite change of current of the generator shall effect in the exciter circuit. When the electro-magnet is wound with two coils aiding one another, one in series and one in shunt, as referred to above, the action may be considered as follows:—If the current or the voltage alone were to change, then regulation would be effected as in the forms referred



to above. If, however, the current were to increase and the voltage to decrease these would balance, there would be no flux change of the electro-magnet, and, therefore, no action on the disc *b*; no alteration of the exciting current would, therefore, be produced. Were the current to fall and the voltage proportionally to rise, there would still be no flux variation and no alteration of the exciting circuit. Assuming now that both current and voltage decrease or increase simultaneously, there will be a double decrease or increase of flux from the electro-magnet through the disc *b*. There will, therefore be a doubly strong action impulse to vary the excitation circuit in order to combat the current and voltage variation causing the change All these alterations effecetd when the electro-magnet is wound with a series and a shunt coil acting to assist one another, tend to keep the watts of the circuit constant. It will clearly be understood, however, that the ultimate effect for a given change of voltage or current is that predetermined by the windings and the relative proportion between them on the electro-magnet *d*.

Incandescent Electric Lamps.

24211.—1908. Société Française d'Incandescence Par le Gaz, Paris. The object of the invention is the elimination of the hydrogen occluded in the filaments of incandescent lamps and their supports. The filament and its support are introduced into a furnace heated to red heat and filled with nitrogen or other inert gas. This exhausts the hydrogen, the presence of which is prejudicial to the life of the filament.

Electric Cooking and Heating Apparatus.

2251.—1908. E. Coiseur, Brussels. The apparatus has elongated heating tubes made of crystal and containing metallised filaments of such a length and cross section that for a given voltage the filaments are brought to a red heat and not beyond, in which state they give the maximum heat output.

Manufacture of Filaments for Incandescent Electric Lamps.

23726.—1908. British Thomson Houston Co., & H. H. Needham, Cannon Street, E.C. The invention provides for the use of an amalgam binding material for tungsten filaments whereby finer filaments can be made. The binder may be composed as follows: 40% cadmium, 40% mercury, and 20% bismuth. About 20% tungsten is used with this mixture; more or less according to the degree of fineness required.

Electrolytes for Electrolytic Cells.

15792.—1908. General Electric Co., Schenectady, U.S.A. The electrolyte is composed of 10% tetraborate of ammonium, 10% concentrated glycerine, and 80% water. It is claimed that this electrolyte will ensure the efficient operation of the cell whether used as a rectifier or current valve or as a static electrical condenser at relatively high voltages with moderate temperature rise and without appreciable deterioration of the electrodes or the electrolyte itself.

Electrical Ignition Systems of Internal Combustion Engines.

19883.—1908. J. D. Bell, Coventry. An intermittent current is sent from the battery through the induction coil in the magneto. To ensure the armature being correctly magnetised as regards its position in relation to the field magnets a commutator is used which ensures the current from the battery correctly magnetising the armature. Thus the current, instead of causing the magnets to deteriorate, increases their power.

Electrodes and Resistances for Electric Furnaces, Radiators and Lamps.

13734.—1908. G. Cornaro, Turin. This invention provides a process for graduating the conductivity of electrodes and resistances formed of an agglomerate containing metallic salts in a finely divided state so as to enable them to be used either for apparatus for transforming electricity into heat or for arc lamps and Crookes or Geissler tubes. This graduation is obtained by first compressing the agglomerate more or less, then submitting it to baking under a temperature which does not attain the point of fusion of the metals employed, and submitting the electrodes or resistances thus formed to fresh pressure and repeating alternately the baking and compressing until the desired resistance is obtained.

Automatic Electro Magnetic Switch for Overhead Traction.

14463.—1908. W. Barraclough, Brighouse. The invention comprises a new electro magnetic switch for disconnecting the current to the wires in the event of breakage or other distrubance in the continuity of the system. The two wires or conductors in each section at the extremities furthest from the source of supply are coupled together in order that the feed and return flow may commence and terminate at the same end of the respective section. The current from the supply flows through the feed wire to the switch and from the switch through a feed wire to the conductor to the further end of the section, and then through the connection to the other conductor and returns to the feed end again. The current is conducted from thence to a magnet located underground. A wire leads from the feed side of the switch to a solenoid, the core of which is attached to a pivoted lever weighted at one end and connected at the other end to the switch. The core tends to draw down the lever. The lever carries an armature which, while the current is flowing through the magnet, is attracted and held thereby against the action of the solenoid and maintains the lever in normal position. If one of the conductors breaks the flow of the magnet is interrupted, the armature and lever are released, the unweighted end of the lever is drawn down by the solenoid, and the current to the section is cut off.

Protective Devices for Electric Distribution Systems.

22135.—1908. General Electric Co., Schenectady, U.S.A. The device consists of a vessel provided with a cover of insultaing material, from which tubes of insulating material project downwards into the vessel. Metallic anodes extend through the tubes, and at the upper end of the anodes are spark gap electrodes. The vessel contains a volume of electrolyte anodes in operative system to the electrolyte and connected with the line conductors of the system. The contrivance is designed to protect alternating current systems from the destructive effects of lightning.

Dynamometer.

3849.—1909. A. E. S. Craig & Acer, Ltd., Hanwell. Instead of employing a friction band that is rigidly attached to travelling links so as to form a cradle apart from the main lever for engaging with a segment of the wheel to be tested, a flexible friction band hinged at each end to a pair of chains is used. The chains pass over pulleys secured to the main frame. With this arrangement the main lever itself forms the cradle, thus enabling the toothed racks and pinions previously employed to be dispensed with.

Electric Arc Lamps.

9516.—1909. H. P. Bleckly & W. Brown, Victoria-street, S.W. The invention consists in the employment of a subsidairy cut out coil which is arranged in parallel with the shunt coil. The subsidiary cut coil has a movable core, which bears at its lower end a carbon contact and thus maintains the circuit closed through the shunt coil. The circuit through the subsidiary cut-out coil is normally open, but closed when the shunt coil reaches its highest position through the movable carbon contact touching the fixed carbon contact.

Stranded Electric Cables.

20447.—1908. C. J. Beaver, E. A. Claremont, Chester. The outer strands are of aluminium, which is less destructive to the india-rubber insulation covering than copper strands. The inner strands are of copper. These do not come into contact in any way with the india-rubber covering. Cables composed of copper and aluminium wires are much less expensive than those composed wholly of aluminium.

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LONDON, AUGUST 20, 1909.

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NOTES.

COTTAGE INDUSTRIES.

An excellent example of what electricity can do in providing power within the domestic circle is shown by our article on the cottage ribbon industry of Zurich. In its old form the industry was being crushed out of existence. Hand labour had to give way before the machines of large factories. Then electricity came to the rescue, bringing power in a clean, easily controlled form, to operate the small looms, and so the cottagers were enabled to continue their work and compete with the factories. The figures given are not as complete as we could desire, but they are eminently satisfactory so far as they go. It is, perhaps, an open question whether home work in cottages and tenements should be encouraged. Certainly, home work often gives rise to great hardships; on the other hand, it has its own advantages, and, in any case, electrical power mitigates much of the evil existing under old conditions. Then, again, the Swiss experience is capable of wider application, showing how easily power generated at a distance, may be used for domestic purposes.

ELECTRICALLY PROPELLED SHIPS.

The subject of electrically propelled ships still continues to flurry the old-fashioned marine engineer, who is not at all inclined to admit the possibility of so thorough a change as is now foreshadowed. This discussion is likely to receive a fresh impetus, for Mr. MacLaren lectures on "The Extended Use of Electrical Power Transmission on Board Ships," at the Imperial International Exhibition, Shepherd's Bush, on the 4th ult., and on the same day Mr. William P. Durtnall, M.I.M.E., a pioneer in this matter, will lecture on electrically propelled ships before the London Association of Foremen Engineers and Draughtsmen, at the Cannon Street Hotel, when he will show most of the systems introduced since he took up the subject some years ago. This will take place in the evening and will be all the more interesting by reason of the lantern slides wherewith he will illustrate his address. Mr. MacLaren is also a strong advocate of polyphase alternating current machines for this purpose. These papers ought to bring forth some notable speakers.

ELECTRICAL MACHINERY FOR TRANSVAAL.

An interesting recommendation has been submitted to the Transvaal Power Commission by the Transvaal Institute of Mechanical Engineers. The witnesses on behalf of the Institute urged that in the establishment of any power schemes the rights of British manufacturers should be safeguarded in the supply of the necessary machinery, and that no special rights, power or facilities should be granted to any company which does not comply with this condition. They added that as a safeguard they deemed the most effective method to be the appointment of a Government representative on the board of directors of any power company which acquire special rights from the Government. No doubt the suggestion that a Government representative should sit on the Board of any power company is rather too drastic to be tamely accepted, but the principle underlying the idea is one of which we may unreservedly approve. There has certainly been a tendency for continental financiers in the Transvaal to unduly favour foreign contractors.

COPPER AND ELECTRICAL PROSPERITY.

There is jubilation in the copper market, and in the commercial world generally, for the metal is rising in price, which some brokers put down to a shortage of supply, but most attribute to a brisker demand. Undoubtedly, electrical manufacturers are beginning to experience a revival of trade, and are now again becoming extensive purchasers of copper. To them the rise in price of the metal does not bear quite such a cheering aspect as it does to investors and speculators. As far as it is a barometer of rising prosperity, it is welcome enough, but the industry in the past has been badly victimised by copper market manipulators, and the sudden rise in response to a little activity in buying cannot but be looked upon with suspicion. To the industry, therefore, any possibility of relief from copper monopolists will prove welcome. Some such hope is held forth in the article on aluminium cables, appearing in another column, and will prove particularly interesting. Careful experimentation with aluminium has been going on for some years now, and the outlook, as far as its service to the electrical industry is concerned, is most encouraging.

MAINTENANCE CONTRACTS.

It has been suggested that central stations should adopt a maintenance contract system. It is a plan which in America has promoted the extension of electricity for lighting purposes and among small users of power. Under such contracts the consumer is entitled to a weekly inspection of his lamps and other apparatus. The central station is bound to keep them in proper working order, clean them, and carry out any repairs, though, of course, a clause would be necessary to protect the supplier from damage as the result of the consumers' negligence. This system has the same advantage as that of the household wiring policy already in vogue here with successful results. It relieves the consumer of much trouble, and assures him of smooth working for a stated price, and by removing a source of uncertain expense, proves a great inducement to extensive use. This, no doubt, opens up an alluring prospect, for it would mean a remunerative branch of the enterprise for the central stations, bringing with it an increased demand for electricity, would open up a new field of employment for young electricians and would satisfy customers, who would reap the benefit of their fittings being constantly kept in good order. The maintenance contract system is open to practically all supply companies, but under existing laws municipal undertakings would mostly be debarred from directly adopting such a course. With them an intervening company would have to be established, which would mean loss of profit and a possible element of friction. In any case, the suggestion, which is a modification of that discussed in our issue of July 16th (page 57), is worth consideration.

THE ART OF ILLUMINATION.

Inidrectly, the adoption of a maintenance contract system would bring about other benefits. It would force upon us the close study of the art of illumination. At present, generally speaking, the aim is to secure the maximum brilliancy of light from a lamp and the consumption of a given amount of electricity. The new metal filament lamps have been a triumph of ingenuity in this respect. But brilliancy is not everything in illumination, indoor or outdoor. We must study distribution to secure effectiveness and comfort. This means taking local conditions into

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consideration, and adapting the form, number, grouping, and screening of lamps to suit the particular needs. The wise use of frosted glass and shades is of utmost importance, all the more so now that we have the intensely brilliant metal filaments. We require floods of light, but distributed in such a way that they do not prove a source of discomfort by neglecting to take into account the line of vision. All these points would have to be taken up if central stations entered extensively in the supply and maintenance business. In the long run, this would lead to increased output, for with better use would come greater demand. The same principle of study of local needs and advice would have to be brought into play in the selection and placing of small power-using appliances. In this the central stations would be following the example of the gas companies, who have found the supplying of gas stoves, fires, irons and other apparatus remunerative in itself, and a splendid lever for increasing use of gas.

THE TRAINING OF ENGINEERS.

Now, this prospect of opening up a new field for employment is alluring. It would mean, of course, specialisation to a large extent, but specialisation is inevitable, though it should be based on a broad foundation. Of late, we have had much discussion as regards the training of engineers. Dr. C. P. Steinmetz, in America, speaking before the Institute of Electrical Engineers, pleaded for a study of the classics as a necessary preliminary to professional training. Unquestionably, the study of the classics provides a splendid exercise for the mind, and, if carried far enough (which, however, is rarely the case), broadens the mental outlook. Our own old University, which only comparatively recently turned their attention to the exact sciences, hold this view. There is much to be said for it, but it is not really essential. Certainly, with a few brilliant exceptions, our most noted engineers have been possessors of but scant Latin and far less Greek. In these days of strenuous effort and multiplication of professional duties, specialisation in training must come early. Even in our own deviation of engineering, the electrician soon has to devote his attention to some particular branch, and cultivate that assiduously if success is to be achieved.

LIVE WIRE FATALITIES.

While it is undesirable to make too much of the death of the two unfortunate men, David Thomas and Owen Davies, at the Cribburr Fawr Colliery, near Porthcawl, yet the circumstances under which the fatality occurred must not pass unnoted. It appears clear that the two men were descending the slant and on leaving the tram they slipped. They appear to have made a grab upwards to try and save themselves, and their hands came in contact with the unprotected cable, laid along the roof of the drift, one being instantly electrocuted and the other dying soon after. Deplorable as the accident was, it does not do to give way to the exaggerated fears that arise when accidents occur through the introduction of some innovation. After all, the accidents, fatal or otherwise, that can be attributed to the use of electricity in mines are very few compared to those positively due to other causes. Nevertheless, this question of insulation is one that will have to be studied in connection with local needs. Certainly both Mr. R. A. S. Redmayne, H. M. Chief Inspector of Mines, and Mr. R. D. Bain, Inspector of Mines, suspect that the explosion in the West Stanley Colliery last February, when 168 lives were lost, was due to a fault in the insulation of a cable following on the collapse of a roof, thereby igniting first gas, which in turn exploded the dense clouds of coal dust. It is impossible to guard against all accidents, but with practice, dangers should be minimised, and certainly the use of unprotected wires should be discarded wherever circumstances will permit this being done.

AN ELECTRICAL BAROMETER.

A method of enabling the indications of an ordinary mercury barometer to be read with far greater accuracy than has hitherto been possible has been invented by P. B. Goldschmidt. In his barometer a V-shaped carbon filament passes through the Torricellian vacuum, the bend dipping into the mercury. The two ends of the filament pass through the glass of the barometer tube at different points and are connected, one with the cathode, the other with the anode of a battery, a galvanometer being in the circuit. It is obvious that if the barometer rises the current has a less length of carbon filament to traverse than before, and the galvanometer shows an increased current, the reverse effect occurring if the barometer falls, the bend of the filament being so placed, of course, that the mercury never falls out of contact with it.

To eliminate the effect of changes of temperature on the height of the mercury column, a thermometer, provided with a carbon filament in exactly the same way as the barometer, is included in the circuit. At each reading a known resistance is added to the circuit sufficient to bring the galvanometer to the null point. From this resistance the height of the barometer can be determined within the tenth of a milimetre.

Goldschmidt's barometer has revealed a long suspected phenomenon which the ordinary barometer cannot detect viz., that the atmospheric pressure is continually varying, and is hardly ever the same for five minutes at a time

RAILROAD ELECTRIFICATION IN CANADA.

From Moncton, New Brunswick, reports come that the electrification of the Grand Trunk Pacific, or National Transcontinental Railway, from the St. Lawrence River to Moncton, is now under serious consideration by the railway Company, the Dominion Government, and the New Brunswick Cabinet. Mr. Steeves sends the following details :

Electrical engineers who have given the subject consideration, declare the conditions to be entirely favourable. The distance between the St. Lawrence and Moncton is about 460 miles, and for a considerable part of the distance the road passes through dense forests of spruce and fir in lower Quebec and northern New Brunswick, as well as through the rich farming country along the upper St. John valley. What has given impulse to the new power plan is that at Grand Falls on the St. John River, 170 miles from the St. Lawrence and 160 miles from Moncton, is located waterpower sufficient to develop a current for the working of the whole road. At this point the river has a natural fall of about 130 ft., and a flow that electrical experts estimate will be sufficient to furnish from 100,000 to 125,000 h.p. continuously by the utilisation of comparatively inexpensive means of storage and conservation. As the requirements of the road are estimated at not more than 40,000 h.p. there is every reason to believe that the supply will be more than equal to the needs.

GREAT NORTHERN AND TRAM COMPETITION.

The Great Northern Railway has suffered from tram competition both in London and Yorks. So said Lord Allerton, who presided, on the 10th, at the half-yearly ordinary general meeting of the company. In Yorkshire they had closed one passenger station. Strange to say, they had carried 20,000 more pigs this year. Their earnings had improved to 1¼d. per passenger mile.

More and more people were travelling third class. That was due to cheaper fares, and to the constantly increasing luxury which railway companies provided for their third-class passengers. He thought that with regard to the suburbs there should be third-class trains. The first-class carriages were very expensive to construct and to haul, and he was sure that something would have to be done. Motor-cars, they believed, were taking away some of the traffic which they were losing.

The attitude of the Great Northern was to develop its outer suburban traffic with quick-service trains. He was very sceptical about any power on the part of steam railways to compete effectively in short distances, as from station to station, served by electric trams. The company's energies were better spent in developing their outer suburban traffic than in playing the game of either breaking the tramway companies, or breaking themselves.

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ELECTRICITY AND THE COTTAGE WEAVING INDUSTRY.

Hand loom weaving was a picturesque cottage industry in the days not long since past. Here and there it may survive. Generally, however, in the fight between machine and hand labour, which in silk weaving began about forty years ago, the victory has been gained by water and steam.

But before the old home industry is entirely a thing of the past, electricity has come to its aid, and is now actually reviving on the Continent. According to a communication to a Zurich newspaper, ribbon weaving has already availed itself of electric power. Five years ago, the Posamenterverband Baselland was founded for improving trade conditions. The first object of this union was to introduce the use of electric power. Contracts were made with electric power supply companies, and many places undertook to supply the distributing mains for a high tension current and a transforming station at their own cost. The introduction of electric power into houses, the delivery and erection of motors, and the installation of electric lighting systems were also undertaken. These responsibilities required considerable capital. For example, the Runeberg association incurred the following expenses:

For 3·6 miles high tension main	£480
,, transformer and distributing wires	320
,, 80 motors for 140 looms, including erection and gearing	880

A ribbon loom requires a ¼ h.p. motor. The association levies for motor, power, etc., an inclusive annual fee of £2 7s. 6d. per loom, and for a 10-candle lamp 8s., for a 16-candle lamp 12s. 6d. These prices permit them to pretty well write off their business capital. The looms belong, for the most part, to the manufacturers. The interest which the manufacturer has in getting a return for the capital invested in the loom affords the workman his best security for regular employment. Both employers and workpeople are satisfied with the results of electric driving. The output is greater, so that orders can be more quickly executed, wages have risen, physical over-exertion is put an end to, and female labour, the most suitable for weaving, is thereby enabled to recover its proper position. The use of electric power again enables household to compete with factory work, and makes it remunerative and life-supporting.

In cloth weaving, the conditions are somewhat different from those governing ribbon weaving. The hand-driven loom was a machine, and nothing had to be done but to change the driving power, but hand looms cannot be converted into power looms for fabric weaving, and a new kind of loom is wanted. Moreover, the cloth loom runs faster than the ribbon loom, and the consequent vibration, noise and danger to children made it unsuitable for use in dwelling rooms in the opinion of many persons. This view has now been shown by experience tobe wrong. Thanks to the initiative of a Zurich firm, there are to-day nearly 100 piece looms at work in private houses in the Bernese Jura, so that this kind of loom also must be allowed to be suitable for household use.

The publication of this important fact has excited great interest in many places where hand weaving is in a parlous state, even threatening to become extinct. Municipal bodies are enquiring as to how they may be able to introduce mechanical silk weaving into the homes in their districts. Three points have to be considered:

1. What will be the cost of the installation and who will be responsible for it?

2. What are the profits obtainable?

3. How is the work to be obtained?

The fabric loom is driven in the same way as the ribbon loom. What is required is to bring the power up to the house, introduce it into the workroom, and to instal the motor loom and lighting apparatus. To judge by experience already acquired, the current may be brought up to the house by the power-supply station by the local authorities, or by a specially formed local association, the workman paying the cost of wiring inside the house, and a rent for light and power. The workman's employer provides loom and motor. The local authorities or association make the contract for the power supply, provide the labour for erection and installation, and either collect the rents from the workpeople for the power supplies, or guarantee that they shall be paid direct.

The cost of the installation so far as the inside of the house is concerned may be reckoned as follows:

Wiring and erecting motor and lights	£2	16	0
New loom with warping machine £24 to	28	0	0
¼ h.p. motor	6	0	0
Carriage and erection of the loom	1	4	0

The running expenses per loom per year will be about as follows:

Power and light	£2	16	0
Overseers' expenses	2	16	0
Interest, depreciation and upkeep of loom and motor	4	0	0
Total	£9	12	0

Of this amount the workman has to pay about £3, his employer the remaining £6 12s.

We now come to the question of profit. This cannot be stated in figures, as it depends upon so many factors. It depends upon the wages paid to the workman and on his skill, on the competency of the overseer, and the loom being kept regularly at work. In general, however, it may be said with reference to this point that with the help of electric power the ribbon weaver working at home is able to compete with factory work and yet get his just dues, and the same should be the case with fabric weaving. There is this circumstance in favour of cottage weaving, that factory hours are always being cut down more and more. As house industry dispenses with weaving sheds and special power and heating and lighting plant, very little capital is wanted, and running expenses are low.

Another point in favour of home industry is the invention of a new beaming machine which can be attached to the loom and beams direct from the hank. This enables the weaver to earn the wages of a weaver, a warper and a winder all at once. The cleaning of the fabric after weaving, which gives considerable labour, especially as a power loom has thrice the output of a hand loom, as well as any warping that may be required, can be done by the weaver's family.

In spite of all these advantages, power home weaving must be done well and industriously if it is to pay either the workman or his employer. The daily running expenses of about 7½d. are somewhat heavy, and must be divided over as many yards of stuff as possible. If there are two looms in one room, they can be attended to by one person as in a factory, and he or she has, of course, higher wages than for working only one. If the looms are double width, there is a still further gain to the attendant, but few houses could find room for a pair of them. Much advantage may be gained if two or three neighbours will work together on some well-considered system. It is also of importance that the looms under the supervision of the same overseer should be as close together as possible. The same man may have to look after as many as thirty, but the number depends upon the character of the work done. The further they are apart the more time will the overseer waste in going his rounds. If they are close together he will waste little or none.

In seeking for work, negotiations with manufacturers should be entrusted to the local authorities or to a local committee. Places already well known to manufacturers for hand weaving will rarely find any difficulty in extending their orders and connections when they have put themselves in a position to increase their output. The people of the Jura had no difficulty whatever. It may be mentioned that factories are now replacing narrow looms by wide ones, and the discarded narrow looms can usually be had cheap for household use.

It is to the interest of manufacturers to encourage home weaving. The introduction of electricity seems eminently calculated not only to check the decay of cottage weaving, but to make it more prosperous than it has ever been, and it is to be hoped that the co-operation of manufacturers and municipalities will lead to this desirable result.

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THE CORROSION OF METALS UNDERGROUND BY ELECTROLYSIS.*

BY A. A. KNUDSON, E.E.

The object of this paper is to set forth somewhat briefly the present status of electrolytic action upon subsurface metals due to railway currents, and to illustrate with some items gleaned from practice the movements and effects of such currents.

Attention will first be given to some features pertaining to the *cause* of railway currents flowing into and following underground pipes and other metals, and afterwards consideration to some of the destructive *effects* from this cause.

A glance at the construction of the single trolley system will first be made in order to fully appreciate the results of such construction upon underground metals.

It is fairly well known that the single overhead wire reinforced by copper feeders carries the current to the cars, thence through the motors and wheels to the *rails* which are employed to return this current to the power house. As is well known, the rails are buried to their top surface in the soil, and therefore this side of the circuit is permanently "grounded." Here is where the trouble from electrolysis comes in, for in the same soil in the average city and town, a few feet below the surface there is a gridiron of water-mains and a gridiron of gas mains, besides other metallic conductors. Under the law of divided circuits these underground mains represent other paths by which a portion of this current is bound to flow and, therefore, it divides itself among them all, some passing by the way of the rails and their auxiliary feeders when they are provided, and some by the way of mains, in the inverse ratio of their several resistances in accordance with this law, the damp soil acting as the conducting medium between the rails and mains. Where the current *passes out* of these mains to the soil on its way to some neighbouring main, or to some water-course leading to the power house, or again to the rails in the vicinity of a power house, electrolytic action, commonly called electrolysis, takes place, resulting in the destructive effects which are now quite familiar.

The condition *of the track circuit* has much to do with the proportion of current that may leave it and pass into the mains. With heavy 90 and 100 lb. rails well bonded, and with auxiliary copper feeders a much less amount will pass off to other paths than if the rails are light and poorly bonded, with no feeders. The former construction generally found in the central or busy parts of a city, is while the latter usually prevails on the more distant sections or suburbs. If the entire track circuit in a city were constructed as in the former case, it would not mean perfect immunity from electrolysis, as some current even then would pass by way of other indirect paths underground.

We shall endeavour to illustrate with views divided in two groups both the *cause* and *effect* of electrolytic action; the first group represents the cause, and some of the peculiar current movements underground will also be referred to, while the second group will refer to effects or damage to mains and other metals.

Cause of Electrolysis.

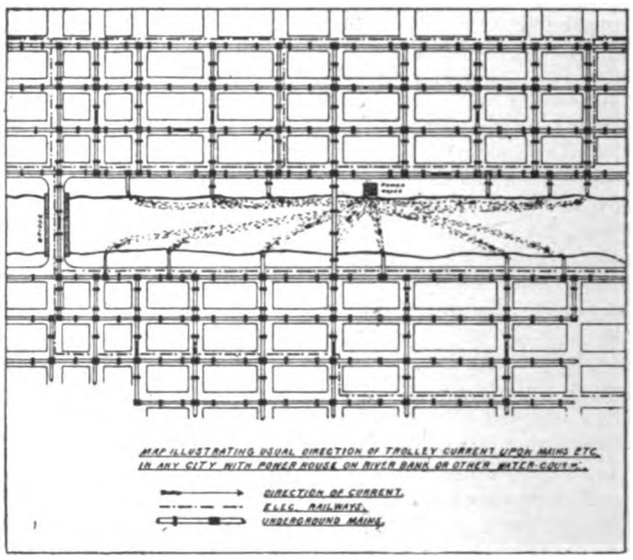
Fig. 1 is a typical map, and illustrates the usual flow of current upon mains in any city where the single trolley system is in operation; with the power house located upon the bank of a river or other water-course.

Such an arrangement is quite common, and as the effect is much the same among them all so far as the direction of currents are concerned, we have chosen this method of illustrating a number of cases.

It will be noticed that not only do these currents flow across the river to the power house, but also along the banks of the side upon which it is located.

A water or gas main as indicated at *A*, passing across a river bed, is one path for a returning current often found. Such pipe is quite likely to be damaged by electrolysis, particularly if in salt water, as when it conveys current some is sure to leave it and pass into the mud bottom or river, thence to the power house by way of the pipes used for condensing. This *back door* entrance in many cases is a matter of much concern to railway companies, passing, as it does, into the intake pipes, thence through steam and condensing apparatus, resulting in electrolytic injury and often necessitating extensive repairs. This effect may be fairly termed the "boomerang" of the single trolley system.

Fig. 1

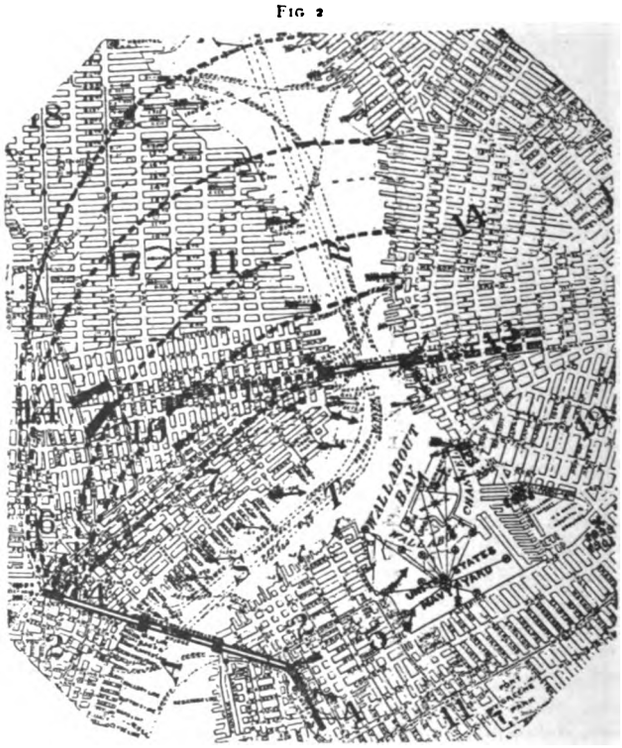

MAP ILLUSTRATING USUAL DIRECTION OF TROLLEY CURRENT UPON MAINS ETC.
IN ANY CITY WITH POWER HOUSE ON RIVER BANK OR OTHER WATER-COURSE.
DIRECTION OF CURRENT.
ELEC. RAILWAYS.
UNDERGROUND MAINS.

It has been found that a considerable proportion of trolley current will seek a river or other near by water-course in preference to following an underground main or even the railway track return whenever the conditions offer an opportunity.

New York City.—The next illustration (Fig. 2) of straying currents is a section of New York City showing the flow to be over the Brooklyn Bridge to Manhattan Borough, thence through the underground metals to and over the new or Williamsburg bridge, thence over that bridge and returning to the power house in Brooklyn at Kent Avenue through underground mains in Brooklyn.

Before the new bridge was built this current spread as far north as 23rd-Street, about two miles, before entirely

Fig. 2



crossing, as shown by the lines and arrows. Now, however, the new bridge, with its mass of metal, is acting as a "short circuit," and most of the current re-crosses the river through it.

One test for current flow was made upon the Brooklyn

* Paper read before the Electrical Section of the Franklin Institute.

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side of the new bridge upon a 6-inch water pipe coming down from the structure, and a maximum of nearly 70 amperes was found passing through it directly into the water mains, and thence towards the Brooklyn Power House. This, however, was only one path; there are many others, such as the metal foundations of the pillars where the current may pass out into the soil and cause electrolytic action. In this same section of New York is located the U. S. Navy Yard, where considerable damage by electrolysis has occurred to the pipes underground.

A method employed by the officers in charge, in keeping track of the direction and force of these currents, is through potential measurements between different points of the Yard.

Navy Yard.—Wires are run from a central station to 12 or 13 different points connecting with the water pipes at each place. By this arrangement voltmeter readings can be taken between any two of these points, and in this way some knowledge of their direction and force is had.

Several potential tests have been made about the bridges in New York. One taken during a so-called "rush hour" between 5 and 7 p.m., between a pillar of the New York and Brooklyn bridge structure on the Manhattan side and a water main, brought out the change in strength of the railway current which is governed by the changes in traffic is reflected between other metals underground. The bridge was positive to the mains, showing currents coming over from Brooklyn and passing into them as well as other metals. Beginning at 2 volts a little after 5 o'clock, the rise was quite rapid until 3.6 volts was reached several times betwen 6 and 6.35, after which it began to fall off, when at 7 o'clock, after most of the crowd had been carried home, it was back to 2.4. This rise and fall of potential, therefore, corresponds to traffic changes on the cars, and is one means of establishing when necessary the identity and source of these currents.

A more complete method for observing the roaming of trolley currents through other peoples' property and the damage caused, is by *current measurements* upon the mains. This is often conveniently ascertained by the drop of potential test in a given number of feet upon a known size of pipe, the resistance of which has been previously determined, and by the application of Ohm's law the flow of current in amperes is found.

In many cases permanent stations are now installed upon important mains by screwing into them brass plugs, usually 10 ft. apart, to which are attached insulated wires; these are led to the surface of the street and the ends secured in a box. By this arrangement periodical tests are made, and a record kept of the current in amperes, which is found by millivoltmeter readings in the manner stated. Sometimes when found desirable these current measurements are taken every few minutes throughout the 24 hours.

The periodical tests, which are carefully compiled in tables, are kept as records for future use, so in case it is found that important mains have been badly depreciated by electrolysis by currents flowing through them, a city or water company would be in a position to fix the responsibility.

Another effect of the movements of underground current is its transfer from one pipe to another underground. This occurred in an 8-inch water main, and two 6-inch wrought-iron pipes used for conveying oil to the seaboard passing over the top of the main at right angles about 3 ft. apart. The water main for about two lengths (25 ft.) was nearly ruined by electrolysis at this point; it was found positive to the oil pipes, at times to 6 volts, and was in continually wet soil, the conditions all being favourable for electrolysis.

Tests upon the street, however, failed to show this action at all, the main was negative to the rails, and had it not been uncovered its condition would not have been known until it had burst. This is but one case of many that are never discovered until a leak is reported; the usual condition, however, is where a current passes from one water main to another or between a water main and a gas main underground.

There are two distinct phases of electrolytic action upon underground mains; one is the *lateral* effect, where the current in passing out from the body of a main causes pitting and disintegration of the iron, the other is the effect of current flowing *through* a main, causing damage at the joints.

First, as to the lateral effect. In cast-iron mains soft spots or furrows form, which are filled with carbon similar to an artificial graphite. In steel or wrought iron the effect is a shredded appearance with but little carbon.

One such case led to a burst, causing the waste of a large amount of water, which ran off into a canal near by, and did not show on the surface of the street. No one connected with the Water Department can tell how long this water was flowing to waste: the break was discovered by accident, a heavy truck wheel breaking through the ground, which had been hollowed by the force of water flowing away. This pipe was positive to the trolley rails to nearly 6 volts, and also plus to a gas pipe in the same street and the water of the canal, indicating current flowing from it in three different directions.

We will now pass to the other phase of electrolytic action, namely, corrosion of the *joints of mains*, particularly water pipe joints.

A 16-inch water main at Peoria, Illinois was injured by electrolysis upon the *inside* of the joint. We are informed by Mr. D. H. Maury, consulting engineer in charge of the Water Company, who made this discovery, that of the 1,000 feet of this pipe removed from the ground every joint showed more or less of this action; at some places near the end of the pipe the metal was softened or eaten away for more than an inch. The electrolytic action also took place upon the *outside* of the main close to the lead packing of the joint; this is indicated by the row of nails driven in on the softened iron, showing the shunting effect of the current; this pipe was taken up owing to a change in pumping works, a new one having been built. We are also informed that at no other place upon this pipe except at the spigot ends were there any signs of electrolysis, the direction of current through the main being from spigot to bell.

A 6-inch pipe from New Bedford, Massachusetts, had previously lain in the river; it has a ball-and-socket joint, and was in preparation for further use. We discovered during an investigation in that city that a number of the ends were badly softened and much weakened by electrolysis, the nails driven in at some of the soft places show where they were damaged; when the attention of the Superintendent was called to this damage, he promptly condemned several lengths as being unfit for further use. A 6-inch gas main at Norristown, Pa., was badly pitted upon the spigot side of the joint; one of them was 3-16 inch in depth.

We will now give our attention briefly to electrolytic action upon *water meters*.

This part of the subject, so far as we know, has not before been touched upon. It shows, however, that there are other metals underground besides pipes that are affected by electrolysis; and not the least important among them is water meters.

Two recent meter examinations made by the writer in two different cities revealed the fact that in a number of cases meters were injured by electrolysis; this is owing

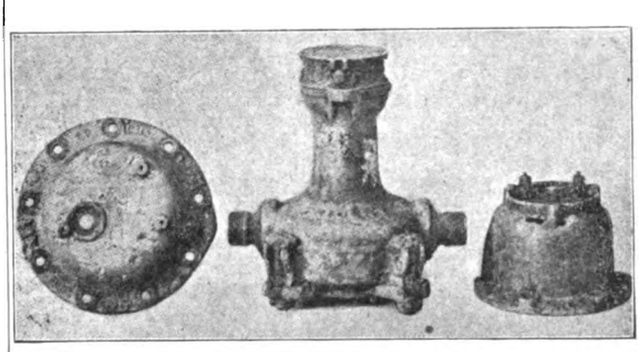

FIG. 3.

principally to their location. In many cases, to prevent freezing, meters are placed in pits 3 to 4 feet below the surface of the ground, the bottom and sides of the pits boarded up and provided with wooden covering. Some of

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these are placed under the docks along a river front, and many in the cellars of dwellings and stores.

It will be readily seen that in the latter case the meter pit is practically a cess pool, as it is the lowest part of a cellar and collects the drainage of whatever liquids may be upon the cellar bottom, the quality of which will usually make a good electrolyte (and the same will apply to meter pits under stables, in such case there is a large percentage of ammonia in the solution), and it is well known that this ingredient materially helps electrolytic action.

Fig. 3 is a photograph of the upper parts of two meters and the whole of a third, all showing the effect of electrolysis and the very evident cause of their removal.

At all of the places where meters had been similarly damaged in this investigation, in making tests it was found that those which took their place *positive* to the soil or gas pipe, were the ones damaged. With the usual trolley current variation, such tests were usually made with a millivoltimeter, the readings taken between the meter and an iron bar driven down in the wet soil alongside of the pit, the variations in most cases running from 20 to at times as high as 250 and 300 millivolts. These samples were taken from a number similarly affected.

A 4-inch meter which was found to be practically destroyed by electrolysis. It was placed in a pit at a ferry house where tide water had access. The potential measurements showed the pipes which had connected with the meter to be positive to near-by trolley rails from 5 to 7 volts. This meter was in use six years and eight months; the under side was softened nearly through the iron, as shown where it has been cut away, and a knife-blade pushed in up to the handle. The fish-trap connected to it had several holes in it. The actual loss in weight of iron through electrolysis was carefully ascertained, and found to be just 15 *pounds*.

In another city, where a meter smaller than the above was placed in a pit at a dock and subject to tide water, it was found when the pit was pumped out and an examination made, that the service pipe *on both sides* of the meter had burst owing to electrolysis, the larger leak on the consumer's side explained the cause of abnormally high meter readings, as well as the vigorous protests on the part of the consumer when bills were rendered.

The meter was also somewhat damaged. It was found positive to the river, the same as in other cases along the docks. The power house was upon the opposite side of the river, and this current leaving pipes and meters was flowing *acro s*, as has been illustrated in the map (Fig. 1.)

It may seem strange that no better setting of water meters is made than in the places referred to. In many cases, however, where the ground is low, it is practically impossible to keep them dry more than one month in the year, those near tide water being partially or wholly submerged every day in the year. In some cities a better method is used for setting meters, such as placing them in a water-tight iron box below the side-walk in the street, and from the best accounts obtainable freezing is avoided as well as electrolysis.

There is one other view (Fig. 4) which may be interesting in illustrating the effect of electrolytic action upon the partially exposed iron or steel work of bridges, and showing the distinction between ordinary corrosion and electrolytic action. This does not, of course, refer to underground foundations or cable anchorages, but to the metal work of the shore spans or trusses where the heavy planks of the roadway rest against or nearly against them. Between the planks and the metal is usually lodged the sweepings of the bridge, which consists almost entirely of animal refuse; this will, and does cause corrosion where there is no current present, but when current is flowing from the iron to the surrounding soil it passes through this material and to the planks which are often wet and damp. In this particular case, which was of a bridge at Providence, Rhode Island, each of the four shore ends of the trusses was carefully tested. At three of them no sign of current could be found, and a removal of the planks disclosed but little corrosion; at the fourth, however, a difference of a potential of from 4 to 6 one-hundredths of a volt was found with the truss positive to the soil.

As will be seen, part of the iron plate of the truss which lay next to the planks was quite badly corroded, the iron which was originally ⅜ inch thick, was reduced for a considerable space to about the thickness of paper, and pentrated in three places. The distinction, therefore, between ordinary corrosion of metals and corrosion caused by electrolytic action, we regard as quite marked.*

It seems proper that something should be said as to the situation in this city of Philadelphia regarding electrolysis. It has often been asserted that no electrolysis exists here, the reason given owing to the compulsory requirements of an excellent Electrical Bureau. Track returns of heavy copper auxiliaries have been established as well as efficient rail bonding, probably far exceeding in extent and completeness the track returns of any city in this country. If excellent construction were a guarantee against electrolysis, then there should certainly be none here; but as a result of a few tests which we have made for the purpose of getting some idea of the situation, we are prepared to say that electrolytic action *is* going on at both water and gas mains in certain quarters of the city, as we will undertake to show.

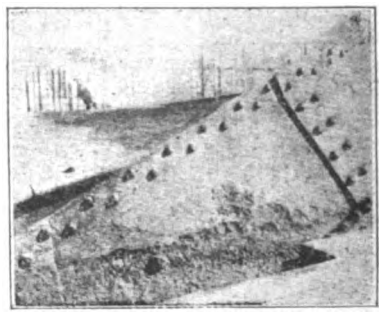

FIG. 4.

A measurement for current flow upon a 30-inch cast-iron gas main in the subway, on the south side of Market-Street, revealed a flow of trolley current west reading at times as high as 12.5 amperes.

In the vicinity of the power house on the west side of the river towards which this current was flowing the potential difference was too high to be measured with the instrument we had at the time, as its limit was but one volt, the needle, however, went off scale hard, and did not show even a minimum reading. The mains are positive to the rails, and it is safe to say that the reading would not be less than two volts, and may reach from four to five volts.

Tests between the water mains and rails in the same vicinity were from 0.3 to 0.7 of a volt, mains positive. From these tests we conclude there may be electrolytic action upon the water mains if they are located in wet soil where the resistance is sufficiently low for some current to pass, but this is not usual with such low difference of potential. There was no opportunity to make a current measurement upon the water mains in this part of the city.

In regard to the gas mains, however, from the current flow discovered on the main in the subway and the tests near the power house, we believe they are being damaged by electrolysis in this vicinity.

Some further tests were made in another part of the city, upon water mains that were found accessible, the most important one being the one in Greenmount Cemetery. Not far from the Bristol-Street entrance there is a 48-inch main resting upon a wooden trestle, as it crosses a small valley. Railway current was discovered flowing through this main north, from 20 to 50 amperes. When a current of electricity is found flowing through an important main, if only 5 or 10 amperes, it is well to learn, if possible, where it is coming out, because at such points electrolysis takes place. Such point has been discovered in this case. About ½ mile north of the test in the cemetery this main crosses Wyoming Avenue, upon which is a double-track trolley road. The main was found highly positive to these tracks, indicating this to be the point of delivery for this current, and as the power house is a short distance west,

* Since this paper was delivered this bridge has been replaced by a new one. The underground chords when uncovered were found badly corroded and weakened from electrolysis.

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it is most natural for this current to pass out of the main to these tracks, and thence to power house.

A number of precedents in similar cases in our own experience justified our prediction, made to the General Superintendent of the Water Bureau that this main was being damaged by electrolysis under these tracks, and it was but a question of time, if these conditions continue, when it would be in grave danger of bursting.

He informed us if such a thing should happen it would cut off the water supply of a large section of the city until it could again be repaired. Another effect would be the the heavy cost of damage to property through the sudden letting loose of a huge mass of water, as well as the heavy cost of repairs. One experience of this kind has recently been had in this city, the details of which are well known, and a repetition of such an accident would, of course, be very undesirable. We are informed that the cause of this break, however, was a defect in the iron of the pipe.

Since we reported these conditions, two weeks ago, changes made have considerably improved the situation, as further measurements made only to-day show. For instance, instead of 40 to 50 amperes of current discovered flowing *north*, there is now but 5 to 15 amperes, and it is flowing in the reverse direction, *south*. Instead of the main being highly positive to the rails on Wyoming Avenue, as found at that time, it is now negative to the rails, from 3 to 4 volts. Just how much this main is damaged by electrolysis under these tracks depends somewhat on the length of time these conditions were in force before the change was made. It would be interesting to know, also, where the average current of 10 amperes now flowing south through it is coming out, but lack of time and severe weather have prevented further investigation.

One method used in some cities for relieving mains from electrolysis at badly affected places, is to bond them to the rails or railway return. This we have always opposed for the reason that more current flow is invited upon them and electrolytic action takes place at the joints, mostly inside, if a water main, illustrations of which we have shown in several views.

We do not believe it to be a good policy where the future is considered to allow either the water or gas piping system in any city to be practically converted into a railway return by bonding, and if we understand the situation correctly, that is the view taken by the Managers of the Electrical Bureau in Philadelphia.

We have only touched briefly upon various points as to *cause* and *effect* of electrolysis upon underground metals; we will now turn our attention, in conclusion, to a few remarks as to the prospect of *remedy*.

Under the present system of operating street cars with its "grounded" track return, there can be no other result under the law of divided circuits, but that more or less railway current will pass to and through underground metals, causing electrolysis among them in a greater or less degree according to local conditions. This diversion of current from rails to mains is restrained in some cases by liberal use of copper in the auxiliaries, but even then there is sure to be escape at some parts of the system, practical illustrations of which have just been shown.

The late I. H. Farnham, one of the first investigators in electrolysis, stated in a paper read before the Institute of Electrical Engineers in New York in 1894, that: "In some cities where electrolysis is in progress to-day, the return copper nearly equals that of the trolley and feed-wire system. We cannot force a current to take one path exclusively when others are open to it." This statement was made 10 years ago; since then there have been many electric railway lines built, but, excepting the double underground trolley in New York and Washington, there has been no other system brought into general use than the present single trolley.

The present status, therefore, as to the *cause* and *effect* of electrolysis does not differ much from the conditions as they existed 10 years ago, except there is a tendency for better construction on the part of the railways, which modifies the effects but does not cure the trouble.

In the evolution of the electric railway it is impossible to say if the next step is to be a method which will or will not cause electrolysis. The double trolley has been largely advocated, and both the overhead and underground methods have been in practical use for years.

An improved storage battery has been looked to as a possibility. A modification of the gasoline engine, as used in automobiles, is another possibility. Any of these methods will, of course, avoid electrolysis. The latest, however, which is attracting considerable attention as a possibility is the alternating current method.

We are not prepared to say what the effect of alternating currents will be. In one case a laboratory experiment showed that the metal was removed from each electrode and deposited between them. If this is to be the result in practice, then not much help can be expected from this direction; but it is to be hoped that some system will be evolved that can be operated without a "ground," and will result in finally avoiding electrolysis or corrosion to underground metals.

THE CONTRACTOR AND THE CENTRAL STATION.

At the recent convention at Toledo, Ohio, of the National Electrical Contractors' Association, one of the most striking addresses was that delivered by Mr. William H. Blood, jun., who is President of the National Conference on Standard Electrical Rules. After a reference to the triumvirate of Roman history, he said: "To-day, the triumvirate of the electric lighting industry consists of the code, the contractor and the company. No one of these interests rules alone, yet each has its individual duty to perform, and together the three interests control the situation. No one of these has unlimited power, but each is a check on the others, and all are automatically controlled by financial limitations.

"If the company's lighting rates are too high, the prospective customer declines to use electricity and turns to gas or oil. This prevents the company from exercising unlimited authority. If the contractor attempts to make undue profit, or insists upon too costly construction, the prospective customer again refuses to use electricity and the contractor's business is thereby curtailed. If the code requirements are unnecessarily severe, this has the same result of decreasing the use of the electric current.

"Were I commissioned to pick out a symbolf or the electric lighting industry, I should not hesitate for a moment in a choice. I should select a chain composed of three large links, representing the code, the contractor and the company, respectively, and each of these three firmly fastened together by three smaller links, all three representing the necessary bond which we call 'confidence.' For the continued success of the electric lighting industry, these little links of confidence are essential. Each of the three interests is dependent upon the others and through these bonds of confidence is firmly tied to the others.

"Standard rules and uniform interpretations of them do much to facilitate the business of the contractor. With an increase of wiring installations the company sells more current, and to secure more customers is an essential part of the company's business. The company cannot afford to have cheap or unsafe work done, nor can it permit the expense of getting ready to use the current to be so great that it will scare off prospective customers. A wiring job which costs $2 per outlet produces as much revenue for the electric lighting company as one which costs $4 or $5 per outlet, and a $50 wiring job may appeal to a customer, whereas perhaps a $100 installation would not be considered but would drive the customer to use gas or oil. It would be shortsighted for a contractor to insist upon the expensive work when the cheaper form of installation would be fully as satisfactory. A conduit job is desirable for some installations, but from the electric lighting company's standpoint a knob-and-tube job properly installed generally gives as large an income, and, costing about one-half as much, appeals to the customer, whereas the conduit job would not.

"If a number of contractors should get together and arbitrarily fix the price of wiring installations at a high rate during the time of active building operations in a given city, you can readily see that a permanent injury would be done the lighting company, for the new buildings would go up piped for gas, with the electric wires left out. If the contractor charged but a reasonable profit, however, or the company did the wiring substantially at cost, gas pipes would be omitted, and by having the wires once installed the lighting company would be assured of a continuous revenue. No one questions the right of the contractor to a fair profit, or wants to see him do business at cost, and if he will pursue the policy of fair charges, coupled with honest and intelligent workmanship, the electric lighting company will not be forced to enter into competition with him. The electric lighting company must, however, for its own salvation, see that all new buildings are wired, and to do this the price must be reasonable and the work honest."

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ALUMINIUM ELECTRIC WIRES.

The introduction of electric wires of aluminium may be regarded as assured within the near future in view of the fact that the metal is now being produced more and more cheaply. From a practical electrical standpoint, aluminium is already hardly of less importance than copper as a conductor. From the purely commercial standpoint it may soon be in an even better position than copper, as it is cheaper. It is better, too, than copper for wires when exposed to atmospheric influences.

The most striking advantage of aluminium over copper is its specific gravity. While that of copper is 8·9, that of aluminium is 2·7 only. On the other hand, it has not yet been found possible to make aluminium wires much lighter than copper wires, as the difference in specific gravities would suggest, because the superior conductivity of copper must be borne in mind. At 15° C., a hard copper wire one metre in length and of one square millimetre section, has a resistance of 0·0175 ohm, while the resistance of an exactly similar wire of aluminium is 0.03 ohm under the same conditions. Hence, to give the aluminium wire the same electric conductivity as the copper wire, its transverse section must be greater than that of the latter in the proportion of 0·03 to 0·0175, *i.e.*, of 12 to 7.

Even this necessity of having the aluminium wire thicker than the copper wire by no means cancels the advantage possessed by the aluminium in respect of its lower specific gravity, for the thicker aluminium wire is still lighter than the thinner copper wire. Hence less metal is required for wires, when aluminium is employed than when copper is used, and the price of aluminium being less than that of copper, weight for weight, the advantage due to the lower specific gravity of the aluminium is very real although not quite so great as it would be if the two metals were equal in conducting power.

Seeing that for conductors of equal length and conducting power the aluminium wire is stouter than the copper wire, there is no fear of the former metal being wanting in strength, for, roughly, copper has about twice the tensile strength of aluminium, and, as just shown, the aluminium wire must have about double the section of the copper wire to have the same conductivity. Besides the aluminium wire being lighter than its equivalent (as a conductor) of copper wire, it has less stress to incur than the latter in respect of its own weight. Hence an aluminium wire does not require, as a rule, to be supported at more points than a copper one. If, to make things quite sure, a few more supports are used, the extra number is so small that the additional expense involved in using them may be neglected.

It is now obvious that there need be no hesitation in using aluminium wires instead of copper, or in replacing copper wires past service by aluminium, instead of by new copper ones. All that has to be done is to have the aluminium wires of the proper transverse section. The only practical difficulty consists in joining up different lengths of aluminium wire. The problem of soldering aluminium has yet to be fully solved, but for making these junctions other means than soldering are at our disposal. Metal unions render excellent service, the two ends to be joined being fixed inside the union tube, itself, of course, a conductor, in close contact with each other and with the tube. But the diameter of these unions must not be too great. There are plenty of reliable short union tubes on the market.

Electric cables are very advantageously made with aluminium wire. The fact that they have to have a larger diameter than those made with copper wire in respect of the smaller conductivity of aluminium already insisted upon sufficiently, is compensated for, over and over again, by the greater flexibility and extensibility of aluminium, whereby there is far less chance of breakage in a cable with it than with copper. Copper wire will not stretch more than about 3% in length before breaking, while the average corresponding percentage for aluminium is half as great again.

In spite of all this, hard drawn copper wire will never cease to be indispensable to the electrician, for aluminium is rapidly attacked by alkalies and alkaline chlorides. Hence it will never replace copper for use in chemical factories, or in the open air on the sea-coast, where the air is constantly laden with particles of salt from the spray of the waves. Ordinary atmospheric influences it resists in a perfectly satisfactory manner.

TELEGRAPH SYSTEMS IN THE UNITED STATES.

The statistics for the telegraph industry of the United States, taken as a part of the third census of the electrical industries of the United States, for 1907, have been compiled by Chief Statistician Steuart, and will be issued in bulletin form by United States Census Director E. Dana Durand in a short time.

Conspicuous among the facts exhibited are the stupendous single wire mileage of the commercial telephone and telegraph systems, the millions of messages annually carried over the wires, the almost incredible growth of the telephone system as compared with the telegraph, the large capitalisation of the companies concerned, and the enormous sums expended by them; and the difficult development of the wireless system.

The first table relates to the telegraph systems, and is a summary, by classes. The total number of systems is given as 1,813, of which 25 are commercial land line and ocean cable, 6 wireless, and 625 railroad telegraph systems, the remainder not being involved in the topics treated herein. The 25 commercial land line and ocean cable systems operated 1,577,961 miles of single wire, employed an average of 28,034 persons, paid $17,808,249 in salaries and wages, expended $41,879,613, earned $51,583,868 and sent 103,794,076 messages. The 625 railroad telegraph systems operated 860,342 miles of single wire, employed an average of 68,197 telegraph operators and dispatchers, expended $37,242,479 (income not stated, as there is no direct financial income from their own use of the service), sent 264,512,816 messages, of which 5,923,483 were of a commercial nature, the income for which is reported by the commercial systems.

Another table shows that there was a grand total of 15,072,220 miles of single wire in the telegraph and telephone service. Of this, the telephone systems controlled 12,999,369 miles, of which there were on pole or roof lines 5,092,223, in overhead cables 2,917,114, in subways or conduits 4,969,302, and in submarine cables 20,730 miles. Of the grand total stated, the telegraph systems, exclusive of Government telegraph systems, used 2,072,851 miles, of which there were on pole or roof lines 1,958,336 miles, in overhead cables 41,886, in subways or conduits 65,247, and in submarine cables 7,382 miles. These figures emphasise the economic importance of the telegraph and the telephone.

A comparative summary deals with the telephone and commercial telegraph systems, not including railroad lines and the wireless, giving the grand total as 22,996 companies, of which there are 22,971 telepohne systems, which include 17,702 independent farmer or rural lines, and 25 commercial telegraph systems, not including the wireless. The grand total of single wire mileage was 14,570,142, of which the telephone systems controlled 12,999,369 miles, which include 486,294 miles of wire on independent farmer or rural lines, while the telegraph systems used 1,570,773 miles, exclusive of 7,188 miles of leased wire.

The grand total of ocean cable was 46,301 nautical miles, all controlled by the commercial telegraph systems.

The grand total of salaried officials, clerks, etc., was 29,470, of whom 25,298 were employed by the telephone systems and 4172 by the commercial telegraph. The telephone officials, etc., received in salaries $19,298,423 and the telegraph clerks $2,794,937. The total of 142,733 wage-earners is divided, 118,871 belonging to the telephone systems and receiving in wages $48,980,704, while the 23,862 telegraph wage-earners were paid $15,013,312.

The grand total of capital stock and bonds outstanding, par value, was $1,034,909,579, of which $814,616,004 were credited to the telephone systems and $220,293,575 to the telegraph companies.

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The grand total income was $236,045,615, of which the tehephone concerns earned $184,461,747, expending $140,802,305, and the telegraph system earned $51,583,868, expending $41,879,613. Of the whole number of systems in operation, the telephone formed 99·9 per cent.

In taking up consideration of the joint subject of commercial telegraphs and ocean cable systems, the bulletin points out the impossibility of segregating the statistics. A comparative summary is given of the three census periods 1880, 1902, and 1907, and it is explained that in 1880 there were 77 companies reported, but that number decreased later by consolidations among themselves. In 1902 there were 25 companies considered. The same number is found for 1907. Taking the details for the last census period, it is shown that 1,577,961 miles of single wire were operated; 46,301 nautical miles of ocean cable; 103,794,076 messages transmitted, which include 5,869, 317 cable messages; 29,110 telegraph offices operated; total income $51,583,868 of which, $45,255,187 was from telegraph traffic, and $6,328,681 from all other sources. The total expense was $41,879,613, including $34,057,298 for operation and maintenance, salaries, wages, and legal expenses. The capitalization in the form of capital stock was, authorized, par value, $161,603,900, of which there was outstanding, par value, $155,089,575. Dividends on stock amounted to $7,477,083. The average total number of employees is given as 28,034, and salaries and wages $17,808,249.

The bulletin notes the decrease since 1880 in the number of separate companies, and adds that, on the other hand, there has been a very large increase in business and equipment. The increase in the number of salaried employees and wage-earners in 1907 as compared with 1902 was but 407, or 1·5 per cent. As compared with 1880, the number was 13,106, or 87·8 per cent. increase. In 1907 the amount paid in salaries and wages was 18·4 per cent greater than in 1902, and 264·5 per cent. greater than the 1880 figure.

Attention is drawn by the bulletin to the fact that, with but one important exception, the entire commercial telegraph and cable industry of the country is operated as incorporated concerns. It is shown that of the total authorized issue of stocks and bonds in 1907, capital stock constituted 66·1 per cent and bonds 33·9 per cent. At the end of 1907 the total authorized issue of stock, outstanding, was 96 per cent., and 78·6 per cent. of the bonds were outstanding. On the bonds an average rate 4·1 per cent. was paid in 1907. Of the 24 incorporated companies for 1907, only 11 paid dividends on their capital stock. The same number declared dividends for 1902. The total receipts of the telegraph companies for 1907 exceeded those for 1902 by $10,653,830.

The bulletin then goes into a comprehensive analysis of the income, operating expenses, assets and liabilities, and other details, giving the apparent reason for increases or decreases in totals for 1907 as compared with 1902 and 1880.

The commercial telegraph systems controlled ocean cables, having a length of 46,301 nautical miles in 1907, as compared with 16,677 in 1902, an increase of 29,624 nautical miles, or 177·6 per cent. It is pointed out that this large increase is largely due to the fact that the Pacific cable and the New York-Habana cable were laid during the interval between the two censuses.

There were six commercial wireless telegraph systems, having 122 tower stations in 1907, situated at most of the large ports on the Atlantic and Pacific oceans, the Gulf of Mexico, the Great Lakes, and in Hawaii. Wireless messages to the number of 163,617 were sent between these ports in 1907. These six companies had an authorized capitalization in the form of stock with a par value of $39,450,000, of which $32,726,242 was the value of outstanding stock. The year's income was $122,154, and the expenses $169,782, of which $87,571 was expended in the salaries and wages of 182 employees.

It is pointed out that the Federal Government has realised the value of wireless telegraphy, and the Bureau of Equipment in the Navy Department, at the end of the fiscal year 1907, had installed wireless telegraph apparatus on 73 naval vessels and at 44 shore stations. During that period the shore stations sent 26,933 messages, containing 541,919 words, and received 34,073 messages, amounting to 675,607 words. Cape Cod, Mass., led all stations in this respect, sending 2,673 messages, and Cavite, in the Philippine Islands, came next, sending 2,025 messages. Of the number of stations receiving messages, Dry Tortugas, Fla., had 2,703; Newport, R. I., 2,701; Marc Island, Cal., 2,334; Cape Cod, Mass., 2,304; Norfolk, Va., 2,171 and Cavite, P. I., 2,013. The shore stations are open to the public for messages, and these are also received from or put on the telephone or telegraph land lines.

It is shown that in 1907 the railroad systems in the United States operated 807,824 miles of telegraph wire, 52,518 miles of telephone wire, and employed 68,197 telegraph oeprators and dispatchers, who received $37,242,479 in salaries and wages. These systems reported 33,441 telegraph offices and 30,115 telephones; transmitted 5,923,483 commercial messages and 258,589,333 messages in connection with the dispatching of trains and other railroad business. The bulletin states the presumption that the telephone will come into more general use for train dispatching, as during 1908 two conventions of railway telegraph superintendents heard reports that the telephone would appear to be as safe as, if not safer than, the use of the telegraph, and that the telephone actually expedited train movements because of its greater speed and flexibility. Referring to the electric interurban roads, the bulletin notes that they early recognised the advantages of the telephone for dispatching purposes.

ELECTRIC TRACTION AND FRENCH RAILWAYS.

The Western Railways of France have obtained authority from the Government to electrify their lines. A beginning is to be made with the lines which run from the St. Lazare Station in Paris to Argenteuil and Saint-Germain-en-Laye. Special tracks will be laid, so that the service can be effected without any interference with the steam-driven trains. Sub-stations will be erected which will supply continuous current at 600 volts. It is anticipated that from 12 to 20 trains, composed of a *maximum* of six double carriages 20 mètres long, can be run per hour. The permanent way, equipment of line, etc., will cost £1,160,000; the rolling stock and converter stations, £800,000; interest on capital and other expenditure bringing the total amount to £2,280,000 for the 33·5 kilomètres of line to be constructed.

ELECTRICITY IN NEW SOUTH WALES COAL MINES.

(Concluded.)

The quotation made by Mr. Hall was embodied in the code of rules which the Electrical Committee furnished in their report, and the substitution of the words "where General Rule No. 8 applies" for "where safety-lamps are used"; was the subject of a considerable amount of thought and discussion by that body. It is unfortunate that the result of the arbitration did not allow the words "where safety-lamps are used" to remain, and on this point it is very satisfactory to know that such a high authority as Mr. Hall is in agreement with the Electrical Committee and the officers of the Mines Department.

Although it may be admitted that the form in which the rule was left by the arbitrators is an improvement on the indefiniteness of the British rules, where the expression "where General Rule 8 applies" exists, it is, in my opinion, not so clear as the alteration suggested by the Electrical Committee and endorsed by the officers of the Department. Yet, although the rule, as it now exists, is somewhat indefinite, it is hoped that the managers will not attempt to place unenclosed electrical machinery in places which may give rise to danger; indeed, I confidently anticipate that none will take undue advantage of a rule which certainly lacks clearness of expression, but the intention of which is unmistakeable.

Particulars are given in the following table of all the electrical installations in the coal and shale mines of the State to the time of writing.

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Electrical Appliances at Mines under the Coal Mines Regulations Act, 1902.

Name of Colliery.	District.	Generating Plant.			Lighting.		Motors.					Electric Blasting.	Electric Signals.	Telephones.
		Rated current K.W.	Current D.C. or alternating	Pressure Volts.	Lamps on Surface.	Lamps in Mine	Coal-cutters.	Haulage.	Pumps.	Fans.	Other uses.			
					Northern District									
Abermain	Maitland	180	D.C.	250	145 arcs 5	35	13	Nil.	5	1	Nil.	Nil.	Yes.	Yes.
Aberdare	,,	485	D.C.	250–500	165	100	14	1	5	Nil.	,,	Yes.	,,	,,
,, Extended.	,,	200	D.C.	250–280	100	Nil.	3	Nil.	3	1	,,	,,	,,	,,
Burwood Extended.	Newcastle	100	D.C.	250–275	19	5	3	,,	Nil.	Nil.	15 H.P. Motor.	,,	,,	No.
Burwood	,,	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	,,	,,	,,	Nil.	,,	,,	,,
Brown's	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	No.	,,
Co-operative	,,	,,	D.C.	220	4	4	,,	,,	1	,,	,,	No.	Yes.	Yes.
Duckenfield	,,	,,	Nil.	Nil.	Nil.	Nil.	,,	,,	Nil.	,,	,,	Yes.	No.	No.
Dudley	,,	7½	D.C.	220	60	,,	,,	,,	,,	,,	,,	,,	,,	,,
East Greta	Maitland	14	D.C.	240	97	24	,,	,,	,,	1	2	,,	Yes.	Yes.
Gunnedah	Gunnedah	100	0D.C.	250	12	5	2	,,	,,	Nil.	Nil.	No.	No.	,,
Hebburn	Maitland	280	D.C.	250–275	198	36	15	,,	1	,,	1	Yes.	Yes.	,,
Heddon Greta	,,	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	,,	Nil.	,,	Nil.	,,	,,	,,
Hetton	Newcastle	100	D.C.	570	80	29	,,	,,	3	,,	,,	No.	,,	,,
Killingworth	,,	60	D.C.	250	34	78	,,	1	2	,,	,,	Yes.	,,	,,
Lambton B.	,,	Nil.	Nil.	Nil.	Nil.	Nil.	,,	Nil.	Nil.	,,	,,	,,	No.	No.
Maryland	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	No.	Yes.	,,
Neath	Maitland	6½	D.C.	220	39	,,	,,	,,	,,	,,	,,	Yes.	No.	Yes.
N.C.M. Co., A	Newcastle	50½	D.C.	560	116	52	3	,,	3	,,	,,	No.	Yes.	,,
,, B	,,	5 D.C. 10 D.C.		110 110	.. 78	.. 49	.. Nil.	.. Nil.	.. Nil.	.. Nil.	.. Nil.	.. No.	.. Yes.	.. Yes.
Northern Extended.	,,	60	D.C.	280	6	20	3	1	2	,,	,,	,,	,,	,,
Northumberland	,,	20	D.C.	250	6	1	2	Nil.	1	,,	,,	,,	No.	,,
Pacific	,,	50	D.C.	280	16	Nil.	4	,,	Nil.	,,	,,	,,	Yes.	,,
Pelaw Main	Maitland	6	D.C.	220	110	,,	Nil.	,,	,,	,,	,,	Yes.	,,	,,
Rhondda	Newcastle	62	D.C.	250	16	,,	3	,,	,,	,,	,,	No.	,,	,,
Seaham	,,	Nil.	Nil.	Nil.	Nil.	,,	Nil.	,,	,,	,,	,,	Yes.	,,	,,
Seaham No. 2	,,	5·75	D.C.	125	40	10	,,	,,	,,	,,	,,	,,	No.	,,
Shortland	,,	Nil.	Nil.	Nil.	Nil.	Nil.	,,	,,	,,	,,	,,	No.	Yes.	No.
South Greta	Maitland	14 70 45	D.C.	220–250	29 144	2	2	1	2	2	1	Yes.	,,	Yes.
Stanford-Merthyr	,,	200	D.C.	250	144	74	Nil.	6	5	5	3	No.	,,	,,
Teralba	Newcastle	5½	D.C.	50	12	Nil.	,,	Nil.	Nil.	Nil.	Nil.	Yes.	No.	No.
Wallarah	,,	300	D.C.	250	9	3	8	,,	3	,,	2	No.	Yes.	Yes.
Wallsend	,,	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	,,	Nil.	,,	Nil.	,,	,,	,,
Waratah	,,	7½	D.C.	250	..	18	,,	,,	1	,,	,,	,,	,,	,,
West Wallsend	,,	3·15	D.C.	105	28	38	,,	,,	Nil.	1	,,	Yes.	,,	,,
					Southern District.									
Bulli	Southern	7½	D.C.	250	7	2	..	..	..	1	..	Yes.	Yes.	No.
Bellambi	,,	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	,,	,,	Yes.
Coal Cliff	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	No.	,,	,,
imal-Balgownie	,,	7	D.C.	220	30	31	,,	,,	2	,,	,,	Yes.	,,	,,
Metropolitan	,,	10	D.C.	250	84	111	,,	,,	Nil.	1	,,	,,	,,	
Mount Kembla	,,	77 220	D.C. A.C.	220 2,200	20	31	4	1	4	Nil.	,,	,,	,,	,,
Mount Pleasant	,,	20	D.C.	500	45	50	Nil.	1	1	,,	,,	,,	,,	,,
North Bulli	,,	95	D.C.	250–280	15	72	4	Nil.	4	,,	3	,,	,,	,,
Osborne-Wallsend	,,	Nil. 105 350	Nil. A.C. A.C.	Nil. 2,300 2,300	Nil.	Nil.	Nil.	,,	Nil.	,,	Nil.	,,	,,	,,
South Bulli	,,	3 5 B.H.P.	D.C. D.C.	220 250	59	52	1	4	2	2	2*	,,	,,	,,
South Clifton	,,	5·5	D.C.	220	50	35	Nil.	Nil.	1	Nil.	2	,,	,,	,,
Sydney Harbour	,,	25·75	D.C.	230	63	Nil.	,,	,,	Nil.	,,	3	Nil.	Nil.	Nil.
					Western District.									
Commonwealth Oil Corporation	Western	33½ 24 20 24	D.C.	250	10	7	Nil.	Nil.	2	..	4	No.	Yes.	Yes.
Hermitage	,,	1·75	D.C.	220	18	Nil.	,,	,,	Nil.	Nil.	Nil.	,,	,,	,,
Lithgow Valley	,,	6·75	D.C.	400	14	4	,,	,,	2	,,	1	,,	,,	,,
Oakey Park	,,	Nil.	Nil.	Nil.	Nil.	Nil.	,,	,,	Nil.	,,	Nil.	,,	,,	,,
Vale of Clwydd	,,	28	D.C.	560	5	5	2	,,	,,	,,	,,	,,	,,	,,
Zig Zag	,,	2	D.C.	200	25	12	Nil.	,,	,,	,,	,,	,,	,,	,,

* For compressing air for coal-cutting plant.

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PRINCIPLES OF FAULT LOCATION.

BY JULIUS BERNSTEIN.*

In presenting this paper on fault location my remarks, which are based upon the methods of telephone practice, will be confined to the use of those testing instruments which are based upon the principle of the Wheatstone bridge, inasmuch as practically all faults can be located by the "loop" methods, which are particular cases of the Wheatstone bridge.

The system of conductors called the Wheatstone bridge is the most common of the several arrangements for measuring resistances, and is represented by the familiar conventional diagram shown in Fig. 1. The current from the battery is made to branch into two paths at *c* and unite at *d*, so that part of the current flows through the points *e* and *f*. *A*, *B*, *X*, and *R*, are known as the arms of the bridge, although in practice *A* and *B* are termed the "bridge arms" or "ratio arms," *R*, the "rheostat," and *X*, the "unknown resistance." When the galvanometer shows no deflection, it becomes evident that the two points *e* and *f* are at equi-potential; since current flow can only be the result of potential difference.

The bridge is said to be balanced, and the resistances in the arms will then have relation to each other as expressed in the simple proportion:

$$\frac{A}{B} = \frac{X}{R} \text{ or } A \times R = B \times X.$$

From the foregoing simple proportions, it is apparent that, by knowing the values of three arms of the bridge, the fourth can be quickly calculated, or

$$X = \frac{A}{A} R$$

It is to be noted that any resistances in the galvanometer *r* or battery *r'* circuits do not affect the values or ratios or the bridge arms. It is also to be noted that the

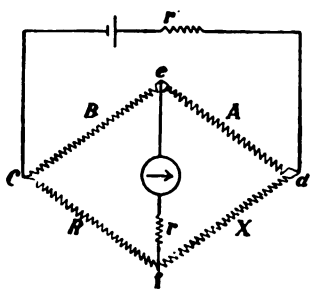

Fig. 1. Diagram of Wheatstone Bridge Connections.

position of the galvanometer and battery may be interchanged without in any way affecting the law of the bridge.

The Wheatstone bridge would have a restricted range of measurement if the arms were equal. It will be evident that the adjustable resistance will represent the total amount of the unknown resistance that can be measured under conditions of equal bridge arms. By altering the ratio of the arms of the bridge we can measure very high or very low resistances. This is accomplished in an actual bridge by placing in the arms *A* and *B* resistances having values of at least 1, 10, 100, 1,000 ohms, and at times 10,000 ohms.

If the unknown resistance is equal to the ratio $\frac{A}{B}$ multiplied by the resistance in the rheostat to balance, it is evident that when measuring small resistances, maximum accuracy will be had by making *A* small and *B* large, as this will mean a division for the value of the rheostat. If, for instance, we make *A* 1 ohm, and *B* 1,000 ohms, and the rheostat value was 67, the unknown resistance would be 0·067 ohm. If we were concerned with measuring a large resistance, we would place a larger value in *A* and a small one in *B*. If *A* were made 1,000 ohms, and *B* 1 ohm, and the rheostat value was 67, the unknown resistance would be 67,000 ohms.

* Abstract of paper read at the convention of American Municipal Electricians.

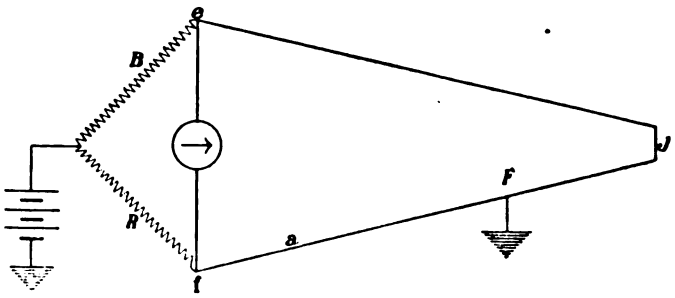

Fig. 2. Diagram of Connections for Murray Loop.

Having thus familiarised ourselves with the basic principles of the Wheatstone bridge, we will turn our attention to a modification of the Wheatstone bridge, called the slide-wire bridge.

Referring again to Fig. 1, we can reason that it is not necessary to know the actual values of the resistances in arms *A* and *B* to determine *X*, if we know their ratio. Our assumption is that when the bridge is balanced, the voltage drop over *A* equals that over *X*, and the drop over *B* equals that over *R*, consequently if the parts *A* and *B* consist of a straight wire with provision so that one terminal of the galvanometer can be moved along it for a balance, then the proportional parts of the wire on each side of the balance point can be used for the ratio $\frac{A}{B}$.

It can be looked upon as being a Wheatstone bridge, in which the bridge arms are varied to obtain a balance, and the rheostat has one fixed value for any particular measurement. Since the value of the unknown resistance is determined in terms of the rheostat by the ratio of the bridge arms to each other, it is immaterial whether we express the ratio in ohms, or in length of wire.

The term "portable testing set" is usually understood to mean some form of Wheatstone bridge, complete with galvanometer and battery, mounted in a carrying case, and arranged for the various tests to which a bridge can be put. There are two types in general use, namely, the plug and dial. In the plug type the resistances are inserted in the circuit by manipulating plugs, and in the latter switches or dials are utilised.

Before considering any diagrams, some general remarks will be in order. The term fault is intended to cover every variety of damage by which the electrical efficiency of a line is affected. Defects which impair the mechanical condition of the line, without affecting it electrically, do not come under the heading. An aerial wire may be penetrated by rust, or a cable sheath may be damaged,

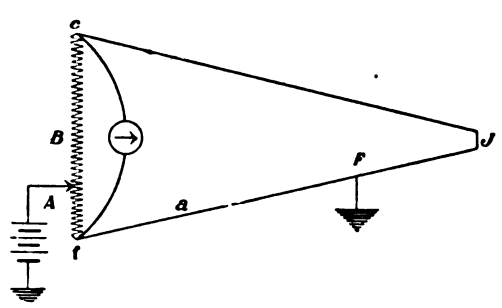

Fig. 3. Circuit Similar to Slide-Wire Bridge.

without a trace of change in the electrical condition of the line.

The different kinds of faults may be distinguished by the following classification:

Grounds are defective insulation, to ground or to a cable sheath.

Crosses are defective insulation between wires.

Opens are breaks in the conductor, so that two parts are entirely separated electrically.

Inductive crosses result from the transposition of single sides of adjacent pairs.

In speaking of crosses or grounds, it is well to use the modifiers "total" or "dead" and "partial," as a dead ground and a partial cross.

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The first step in fault testing is to ascertain the nature of the fault and to give some particular study to the line in trouble by reviewing your knowledge of the line conditions. Having decided whether it is an open, a cross, or a ground, the next procedure is to make a location. The Wheatstone bridge is employed for locating a cross or ground by the "loop tests," and so called because it is necessary to have a complete circuit from one binding post of the instrument through the faulty section of the line and back to the other binding post of the instrument. The circuit is called the loop. The different sections forming the loop need not be of the same sectional area; it is only necessary that there be two independent paths of good insulation from the testing point to the fault. The simplest way to get this loop is to use the mate of the faulty wire, if the wires are in a cable; or, if the wire is an aerial or single conductor in a cable, then we must use an external conductor for a return.

Referring now to Fig. 2, which represents the connections for the Murray loop, at first inspection we will see an arrangement of conductors exactly like that of the Wheatstone bridge. The wire $f\,T$ has a fault at F, and is looped to a good wire at J. The loop is connected to the testing set at e and f. The resistances B and R are in the instrument, and form two arms of the bridge, while the section $f\,F$ of the faulty wire, and the remaining portion of the loop $F\,e$, form the other two arms of the bridge. The galvanometer and battery are connected as shown. The current from the battery flows through the earth from the point of grounding at the testing set to the fault. This connection is independent of the resistances forming the bridge, as far as its own resistance is concerned. The earth has a negligible resistance, and while the fault will generally have some resistance, unless it be a dead ground or cross, its resistance corresponds to r' of Fig. 1. Calling a the resistance of the wire from f to F, or the resistance from the instrument to the fault, and r the total resistance of the loop, from the law of the Wheatstone bridge we have:

$$\frac{B}{R} = \frac{r-a}{a} \text{ and } a = \frac{Rr}{B+R}$$

From the last equation, the distance to the fault may be readily calculated when the values of B and R and the resistances per unit length of the loop wires are known.

Since in uniform wires the resistance is proportional to the length, these equations may also be written, when all the wire of the loop is of one size:

$$\frac{B}{R} = \frac{L-d}{d} \text{ and } d = \frac{RL}{B+R}$$

where L is the total length of the loop, and d is the distance to the fault. This formula should always be used when it is applicable, as it is the most accurate as well as the most convenient. In using the previous formula, in order to calculate the distance to the fault, the resistance of the wire per 1,000 feet must be determined from a wire table. A slight variation from gage or a difference of temperature from that assumed may cause a considerable error. Errors from these sources are very largely eliminated when the distance to the fault is determined as a fraction of the length of the loop.

In using a bridge for locating by the Murray loop, it is customary to use a 10,000-ohm coil for arm B, and vary the rheostat until a balance is obtained. This operation, while quite simple, can be made more rapid when using testing sets built upon the slide-wire principle. In using an instrument of this kind, there are limitations in its range, but in its own field of usefulness it is to be strongly recommended.

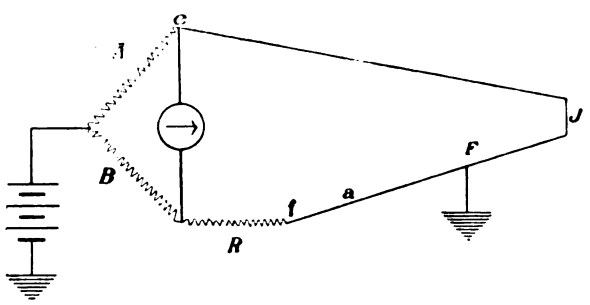

Fig. 4. Diagram of Connections for Varley Loop.

Referring to Fig. 3, a circuit will be noted arranged similar to that of the slide-wire bridge. A contact can be moved along a uniform resistance, and the ratio is that of the two parts of wire on each side of the contact. Let r equal the total resistance of the loop, and a the resistance from the instrument to the fault then the formula for solving becomes quite simple, and is:

$$\frac{A}{B} = \frac{a}{r-a} \text{ from which } a = \frac{Ar}{1{,}000}$$

Another way of analysing this case is to note the symmetry of the arrangement as indicated in Fig. 3.

It is apparent that if the bridge is balanced with the contact half way between e and f, then the arm $f\,J$ must equal $e\,J$, since A and B are equal, which implies from the law of the bridge that the other two arms must have the same ratio to each other. As the arm B increases and A decreases, so does the distance or resistance from e to F increase, and the distance or resistance $f\,F$ decrease. Since in uniform wires the resistance is proportional to the length, this formula may be written:

$$\frac{A}{1{,}000-A} = \frac{d}{L-d} \text{ and } d = \frac{A}{1{,}000} L$$

where L is the total length of the loop, and d is the distance to the fault from f. The last formula is the most convenient, but it is only applicable when the wires have the same resistance per unit length.

The Varley loop test differs from the Murray in having a portion of the loop made up of resistance in the testing set, as shown in Fig. 4. The Varley test can be most usefully applied in those types of bridges which permit of making the ratio of A to B unity, or 10, 100, 1,000, etc. In these cases the ratio of A to B is fixed, and R is varied until a balance is effected. Calling r the resistance of the faulty wire $f\,J$ plus that of the wire $e\,J$ and a, the resistance from f to the fault, we have:

$$\frac{A}{B} = \frac{r-a}{R+a} \text{ and } a = \frac{Br-AR}{A+B}$$

The formula for the Varley loop admits of several modifications, which will not be given at this time, for lack of space.

If the fault in a grounded or crossed conductor were always of practically infinitely low resistance—that is to say, if it were a "dead" ground or short-circuit—its location could easily be detected by measuring the resistance from the point of test, and back again through the ground, or through the other conductor affected by a regular resistance test. Unfortunately, however, it is seldom the case that this condition exists, and tests giving result independent of the resistance of the return circuits and at the point of trouble are, therefore, necessary.

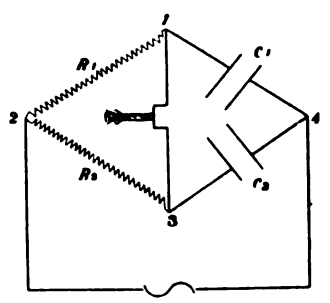

Fig. 5. Testing Capacity to Locate Break.

The loop tests fulfil these requirements. The only effect a high resistance will have upon our test will be to reduce the electromotive force of the battery, so that in very high resistance faults it becomes necessary to employ 50 and 100 cells, so as to impress the electromotive force through the fault, so that the galvanometer will have sufficient sensibility.

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When a conductor is actually broken, and there is no return circuit from the break, a new set of conditions must be considered. In locating the break, we depend upon the fact that every conductor, whether it is in a cable in the

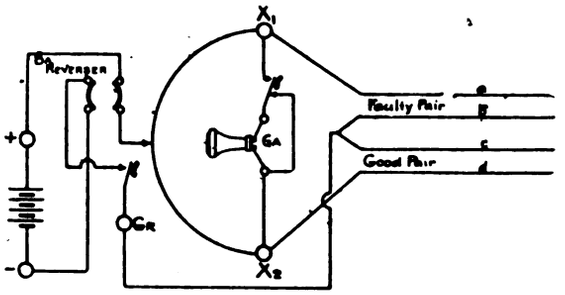

Fig. 6. Testing Capacity, with Telephone Receiver.

earth or submerged in water, or is an air wire, possesses "capacity," and is, in fact, a condenser. The conductor itself forms one plate, the insulation from the point of test to the break of the dielectric, while the other plate is the earth, water or lead sheath.

This capacity is generally proportional to the length of the conductor, so if we know its capacity per unit length, and measure the capacity up to the break, we can calculate the length of the conductor to the break. This method is open to the objection that the capacity cannot always be relied upon as uniform throughout the length of the wire, variations of 10 per cent. or more often occurring. In measuring the capacity by this test, the deflection method is used, in which the cable is charged to a certain potential, and the discharge is then read by means of a deflecting galvanometer. The deflection, however, is liable to be augmented through the action of what is called "electrical absorption," which produces return currents after the true discharge of the condenser capacity is over. This phenomenon takes place to greater or less extent with all cables, and increases with rise of temperature.

A method which largely removes the above objections, and at the same time can be performed by a simple bridge arrangement, with the addition of a telephone receiver and reversed battery current, is to compare the capacity of the open wire, from the point of test to the open, with the capacity of the good mate of known length.

Referring to Fig. 5, if the capacities of C_1 and C_2 (represented by the conventional symbol of parallel lines) are the capacities of an open wire and its good mate, respectively, we can balance the two capacities against R_1 and R_2 in the other two arms of a Wheatstone bridge. Instead of a galvanometer and battery, a telephone and a source of alternating current are shown in Fig. 6. When the resistances are adjusted so that no sound is heard in the telephone, then the points 1 and 3 are equal in potential. The cable capacities represented by C_1 and C_2 are then charged to the same difference of potential and contain quantities of electricity proportional to their capacities; but the quantities flowing into the condensers in the same time are inversely proportional to the resistances R_1 and R_2; therefore,

$$\frac{R_2}{R_1} = \frac{C_1}{C_2}$$

Since the good and bad wires are under similar conditions, their lengths may be taken as proportional to their capacities. Hence, if L_1 and L_2 represent the lengths of the bad and good wires, then

$$\frac{R_2}{R_1} = \frac{L_1}{L_2} \text{ or } L_1 = \frac{R_2}{R_1} L_2$$

The question of allowance for lead wires does not enter, unless the leads are very long or a wire in a cable is used for a wire leading to the faulty cable.

In the use of testing apparatus, it is of primary importance that good electrical connections be made throughout the circuit. Attention must be paid to the cleanliness and the firm binding of all wires and leads. If, for instance, the assistant does not make a good connection in joining the good and faulty wires, but introduces a resistance of one-fourth ohm., where the wire is No. 22 B. & S. copper, the location will be 16 ft. in error. Proper care, therefore, will be immunity from many troublesome derangements and failures, the causes of which are usually discovered after much loss of time and labour.

A source of inconvenience and error lies in the fact that at the fault there may exist an electromotive force due in some instances to the contact potential difference between the faulty conductor and that on which it is grounded. Not infrequently stray currents are flowing on your wires from light and power circuits, or are induced from such circuits. These currents are generally irregular, and cause irregular deflections of the galvanometer. Where they occur, the battery should be made as large as possible, so that the galvanometer deflections due to the test current may be larger than those due to the stray current. If this precaution does not make it possible to make sufficiently accurate location, it may be necessary to make use of another loop or postpone the test until conditions are more favourable.

A disappearing ground is occasionally encountered while trying to locate a fault. This is generally caused by the battery current from the testing set turning a slight moisture ground into gas. Sometimes, by waiting for a short time, the ground will reappear. By employing more battery, so as to get a higher voltage, and taking a quick reading, it is sometimes possible to catch a location. It may be advisable in these cases to interchange the galvanometer and battery. When this is done the galvanometer current only flows through the fault, and it is much less likely to dissipate it than the battery current.

Sometimes the ground can be increased or permanently burned out by applying a ringing generator to the faulty wire. Before doing this, disconnect the testing apparatus.

If these methods are unsuccessful, it is best to leave the trouble until it becomes worse. A ground that is sufficient to make a line noisy, can, as a rule, be located.

All fault locations by loop methods are based on the assumption that the wires have a uniform resistance per unit length. This is never exactly true, and is sometimes very far from true. Unless the wire inequalities balance each other, which they do in many cases, the calculated location will be in error exactly in proportion to the inequalities. Among the causes of inequalities are introduced resistances such as poorly soldered sleeves, slight variations in gage, and inequalities in the temperature of different parts of the line. It is generally impossible to correct for these inequalities. In the cases of long lines, where there are considerable inequalities in temperature, the resulting resistance variations may be calculated and allowed for.

Another cause of inequality is unequal twisting of a wire in a cable. For this reason the loop should be made, whenever possible, by connecting the faulty wire to its mate, as the two will then be subject to the same conditions of twist, temperature, etc.

On lines where a source of trouble is suspected as being due to poor joints, it is well to measure the resistance of the line from point to point, and compare the results with the correct resistance per unit length.

It sometimes happens that the testing instrument cannot be placed directly at the cable ends, and it then becomes necessary to employ leading wires between the testing set and cable. When such is the case, it is simplest to use the leading wires of the same size as the faulty wire. Then the length of these leads must be added to L, the combined length of the good and the bad wires, and from the calculated distance to the fault must be substracted the length of the leading wire connected to the faulty wire. If the leading wires are different in size from the cable wires, multiply the length of each of the former by its rated resistance per 1,000 ft. and divide the product by the rated resistance per 1,000 ft. of the size of wire in the cable. The values thus found represent the equivalent length of cable wire having a resistance equal to each leading wire.

If the resistance of each leading wire is known the equivalent length of the faulty wire having a resistance

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equal to each leading wire is found by dividing their respective resistances by the rated resistance per 1,000 ft. of the faulty wire, multiplying the quotient by 1,000.

Occasionally it may be necessary to employ fixed leading wires whose separate resistances are unknown. The individual resistances of the wires may be obtained most easily by connecting them at the distant end and measuring the resistance of the loop. Then ground the connection and apply either the Murray or Varley loop test. This will give the proportion of the total loop resistance in each wire.

Of importance equally as great as that of locating a fault after its occurrence, is to make systematic tests upon one's lines, so as to foretell the occurrence of such defects. The use of high-class insulated wires, both for overhead and underground cables, has increased to such an extent in recent years, that I feel we are not realising the importance of making systematic tests in order to maintain as high an efficiency as we should. This necessity of testing is especially true in the case of those who have charge of so vital a system as police and fire circuits.

ELECTRICAL REFRIGERATION FOR BUTCHER SHOPS.

In view of the heat wave we have been passing through, an article on refrigeration by Mr. R. L. Lloyd in the New York *Electrical World* appears very opportune, especially as butchers and dairymen might be induced to take up the idea over here. The machine described by Mr. Lloyd is a 7 in. × 14 in. compressor, with a 72 in. flywheel, running at 72 r.p.m. Under this speed the machine develops about seven tons of refrigeration. At a higher speed it is capable of eight tons. The motor is a 15 h.p. Westinghouse machine.

Two boxes are cooled by direct expansion. Both have brine tanks for storage and auxiliary cooling. In the store where the cuts are kept for retailing, the box is 10 ft. × 10 ft. × 8 ft. high, and the brine tank 20 in. × 24 in. and 9 ft. 6 in. long, containing about 200 gal. of brine which is maintained at a temperature of nearly 40°. The refrigerating pipes are controlled by an individual valve which allows a wide range of regulation; but too low a temperature is not desired. Fruit and vegetables are also stored in the refrigerator.

A larger box in the rear, near the slaughter house, is 10 ft. × 11 ft. × 20 ft. The high ceiling is necessary to keep the hanging beeves clear of the floor. There are two brine tanks here ranged one above the other on one side. They are each 18 in. × 24 in. × 11 ft., and hold 205 gal. of brine. The temperature in the box is maintained at from 30° deg. to 32°, which is sufficient to keep the meat in prime condition. There are usually 8 or 10 beeves and 10 or 12 mutton hanging. Killing is done two or three times a week, depending on the season and the meat supply. Seven or eight cattle and 20 sheep or lambs is the average weekly work. If an opportunity is offered to make a profitable purchase of cattle, it is a very easy matter to get the whole lot quickly hung up in cold storage. Under former conditions this was not feasible, and the cattle had to be kept on the hoof and fed, a method which inevitably resulted in a shrinkage of weight. To maintain the above-mentioned temperature the refriegrating machine is operated only a small portion of the day, as shown by the following record:

May	70 hours	July ..	111 hours	September	96 hours
June ...	80 „	August .	118 „	October ..	85 „

The kw. hours consumed during these six months totalled 7,251, while for the other six months of the year only 2,058 kw. hours were used. The consumption during February was one-tenth that during August. City water is used for condensing, and this helps to account for this wide difference in the two months.

Besides the greatly improved hygienic conditions and better keeping of his product, the result of this investment is decidedly advantageous. Before the installation of the refrigerating machine and larger box, the yearly expenses were as follows:

	£	s.	d.
Ice	80	0	0
Feed for cattle at £1 per week	52	0	0
Shrinkage in weight at £2 per week ..	104	0	0
Total	£236	0	0

The change represents an investment of £650.

	£	s.	d.
Electrical energy	£103	12	0
Interest at 5 %, depreciation at 6% ..	77	0	0
Ammonia and repairs	15	0	0
Total	£195	12	0

a clear gain of about £3 8s. per month, or nearly 6 % more on the investment.

A smaller installation in a purely retail meat shop may also be cited. The plant consists of a " baby " compressor, and is operated by a 3 h.p. motor. The machine is set up in the basement under the meat box, which is on the floor above. This box is 9 ft. × 6 ft. × 11 ft. high, and holds at times as much as six sides of beef, four or five calves, and a dozen lambs, a total of a ton and a half of meat. A direct expansion system is used with a brine tank auxiliary for storage. This tank takes the place of the ice bunker in an ordinary meat box, and will hold the temperature down low during non-operative hours of the machine. With a temperature of 34° when shutting off at night, a rise of only 4° will be experienced by morning. In addition to the main box, the counter cases in the store and a corned-beef tank are also cooled.

In the cold months of the year, four hours' operation of the compressor per day is sufficient. In summer it is necessary to run the refrigerating machine about nine hours, while during January and February the machine is not used at all unless an unusually hot spell occurs. When ice was used, the yearly bill was £85. The bill for electricity for the first year was £50, and for the *second* £41 8s. The installation cost less than £200. Adding interest and depreciation charges at 11 % to the bill for electricity, makes the total operating cost £64 per year, a saving of 24, % to say nothing of the added advantages of a lower and drier temperature more constantly supplied, and an improved display counter.

DEARER RUBBER.

The slight reduction in the price of rubber is not likely to last. Mr. Spencer Brett, of the well-known firm of brokers, Messrs. Gow, Wilson, & Stanton, Ltd., speaking to a Press representative, said that the fall is merely the result of the holiday season, which has created a temporary falling-off in the demand.

" Prices for the best Para rubber have dropped from 8s. 5d. to 8s. a pound," he said, " but the reduction is quite a temporary one. It is possible that the price will not only go up again to the 8s. 5d. rate, but even higher. The state of the market is very uncertain, and one cannot say what the conditions will be in the near future. Supplies are not coming in any faster, despite the fact that so many new companies have been floated since the boom commenced. Nine new companies have been formed, representing a capital of £750,000. They are, of course, getting to work to produce rubber as fast as they can, but it will be some considerable time before the effect of their enterprise is felt on the market. The first month of this year's crop is only 100 tons in excess of the corresponding month of last year, which is, of course, quite inadequate to deal with the great demand from motor tyre manufacturers and makers of electrical goods, which require a large amount of rubber in their construction."

There is a suggestion that the increase in the price of motor tyres will debar many people of moderate means from buying cars. Tyres, of course, are the heaviest expenditure in connection with the upkeep of a car. Tyres for the small types of cars average £4 4s. each, while those for the big cars run as high as £9 16s. each, the average life of a tyre being from three to four thousand miles. Prices have just been increased a further 10 per cent., and the effect of the increase is keenly felt in the trade.

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THE

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Municipal Central-Station Engineers and Tramway Managers are invited to send advance notes of new work being undertaken by them, and of successful results obtained from the undertakings under their charge.

Secretaries and Managers of Companies are asked to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers.

Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

Contractors can make use of our columns to obtain the names of the makers of any specialities they require in their business.

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CONTENTS.

	PAGE
Notes	205
Electricity and the Cottage Weaving Industry	207
The Corrosion of Metals Underground by Electrolysis	208
The Contractor and the Central Station	211
Aluminium Electric Wires	212
Telegraph Systems in the United States	212
Electric Traction and French Railways	213
Electricity in New South Wales Coal Mines	213
Principles of Fault Location	215
Electrical Refrigeration for Butcher Shops	218
Dearer Rubber	218
Furnace Practice	219
Correspondence	220
Economy in Stage Lamps	221
"Tantalum" Lamps, Posters and Show-cards	221
The "Peckham" System	221
Obituary	222
Domestic Electricity	222
American Notes	223
Motormen's Working Hours	223
Some Contracts	223
A Popular Electrical Laboratory	225
Personal	227
Preston Semi-Convertible Car	227
More Mining Notes	229
Post Office Telephones Responsibility	229
Electric Lighting for Motor Cars	229
Electricity in American Mines	230
Technical Problems, with Solutions by Practical Men	233
Water Turbines	235
Companies' Meetings and Reports	236
Companies Registered	237
Liens Registered	238
Contracts Open	238
Results of Tenders	238
Lighting & General Notes	238
Traction Notes	240
Patents	241
Interesting Ceremony at Caldy	242
Companies' Stock and Share List	242
Traffic Returns	244

FURNACE PRACTICE.

Are we destined to see the blast furnace replaced by the electric furnace in the production of steel, if not of pig-iron? It seems more than possible in Germany, and perhaps America, where, however, manufacturers enjoy the benefits of cheap power from hydro-electric central stations. What can be done where cheap power is available is well brought out in a recent report to hand from the United States consul in the Cologne district. He mentions that several German firms are now using electric furnaces on a large scale, and gives particulars of one case within his own district. It appears that less than two years ago this firm, said to be one of the most important in the Empire, decided to give up its crucible furnaces for one electric furnace to produce cast steel for gears, and malleable cast steel for motor and machine parts. The idea was mainly to secure economy in production, but also to gain in efficiency. The plant discarded consisted of 32 furnaces, each containing six crucibles, with a capacity of 77 lbs. per furnace, or a total of 2,464 lbs. The new equipment was a single electric furnace of 250 h.p., with a capacity of 2,205 lbs. The electricity was taken from a large central station furnishing a three-phase current of 5,200 volts, supplied direct through a substation where the current was transformed into a three-phase current of 110 volts. The process has now been carried on uninterruptedly for over 18 months, a duplicate furnace having been laid down in case of breakdowns, etc. The normal steel produced contains ·06% of phosphorus, ·03% of sulphur, and from ·08 to ·18% of carbon; but tool steel, containing from ·7 to 1·3% of carbon, and also occasionally additions of nickel, chromium, and tungsten, has been produced. The procedure is not the direct reduction of ores, but the fusion of ordinary slugs, cuttings, and other waste iron of comparatively low price. The fusion and refining takes five hours, and consumes some 900 KW.

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hours for 2,205 lbs. of cast steel, the entire charge being poured in at once. The furnaces are of iron plates, lined with heavy magnesite bricks. The carbon electrodes enter by three openings in the sides, terminating slightly above the level of the metal when molten; in this way the heat produced by the ore is almost completely absorbed by the metal, only a small percentage being radiated to and deflected from the dome. When in full use the magnesite lining lasts for from 20 to 25 days, giving an output of some 70 metric tons. The relining takes 5 days, but there is no loss of time, as then the duplicate furnace is brought into play. It must be remembered that the cost of current is exceedingly low, being produced in bulk with cheap motive power. The price is 4½ pfennings, or rather less than ½d. per KW. hour. The cost of production is calculated as follows: Renewals and sinking fund, 4s. 8d.; metals (including chromium, etc.), £3 4s.; electric current, £2 2s., magnesite bricks, 11s. 5d.; labour, 9s. 5d.; electrodes, 2s. 5d.; water for cooling purposes, 6d.; or an average of a little over £6 14s. per metric ton of 2,205 lbs. This is found to be considerably cheaper than the old furnace procedure, and to give better and more uniform results. It was found that a cheaper class of raw material could be used; and that the large masses at one charge were easily dealt with, thus reducing labour and conducing to greater uniformity; moreover, the molten metal can be withdrawn at a much higher temperature. In this particular case the mixing and handling generally is done mechanically; a 5 H.P. dynamo being used to operate the machinery. It is important to remember that the furnaces have been found to answer well for production of malleable steel as well as for hard tool steel, and also for alloys. Experiments, we believe, are being made in the production of pig-iron. Of course, the great advantage which the German and Swedish manufacturers' possess is the extensive use of water power for the generation of the electric current, which at once brings down the cost. With us we could not hope to produce electricity in bulk hydraulically in the iron smelting districts. But other economies are possible. For instance, in the production of a ton of pig-iron, on an average gases representing rather over 200 units of heat are allowed to go to waste. Many attempts have been made to use this waste heat for the generation of electricity, and although little has come of experimentation, so far, there is hope of economy in this direction. The electric furnace for steel, and possibly for iron production, is not only possible, but advantageous; its wide adoption is merely a matter of reducing cost of current.

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "THE EDITOR, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE JAPAN-BRITISH EXHIBITION (1910).

Letter from H.R.H. the Duke of Connaught.

SIR,—Under the auspices of the Imperial Government of Japan, and with the cordial approval of the British Government, arrangements have been completed for a great Japan-British Exhibition to be held next year at the White City, Shepherd's Bush. In view of the alliance between Great Britain and Japan, no conjunction could be happier. His Majesty the King, with characteristic solicitude for everything that makes for the extension of British Trade and with keen appreciation of our Allies in the Far East, sent to Prince Arthur of Connaught, the Chairman at the Inaugural Banquet of the Exhibition, the following message:—

> "I understand you will preside this evening at a dinner given in connection with the proposed Anglo-Japanese Exhibition next year. International Exhibitions in these days largely depend on private support, and I hope therefore that the Japanese and British people will come forward to promote an undertaking which has for its object an increase in the commercial prosperity of both countries, and the uniting still closer of the bonds of fellowship which already exist between them."

His Imperial Majesty, the Emperor of Japan, also sent a telegram as follows:—

> "I take advantage of the occasion to tender my congratulations to your Royal Highness and to those who join you in celebrating the inception of the Anglo-Japanese Exhibition, and to express my sincere wishes for the complete success of the undertaking."

His Excellency the Japanese Ambassador on this occasion said that he felt confident that the Exhibition would confirm the friendly sentiments and would greatly help the commercial relations between the two countries, and spoke of the intense interest taken in the Exhibition by the people of Japan and of the large sum of money voted for it by the Imperial Diet.

The Lord Mayor of London pledged his official and personal support, and expressed the conviction that nowhere would more real interest be taken in the Exhibition than in the Ancient City of London. The full support of the London Chamber of Commerce and of the Associated Chambers of Commerce of the United Kingdom is also assured.

As Hon. President and President of the Exhibition, we venture to ask the courtesy of your space in order to invite universal support for this specially important demonstration. The value of the traditional art of Japan and the influence it has exercised on the fine and industrial arts of the world cannot be over-estimated, and on the occasion of this Exhibition the nobles of Japan will pour out, from the treasures they have accumulated for centuries, works of art never before seen in this country and only by a favoured few in Japan.

The Committee joins us in appealing to possessors of the treasures of British Art to make a like revelation of those priceless works, many of which are but little known to the general public, so as to equal, and if possible eclipse, the magnificent display of art at the Franco-British Exhibition.

The unique character of the Exhibition is sure to attract multitudes of people, not only from Japan and the United Kingdom, and the Colonies and Dependencies, but from every European country and from America, and cannot fail to increase the commerce of the two nations and to create new commercial channels between them and the rest of the world.

We therefore trust that the manufacturers and producers of this country, as well as those of the rest of the British Empire, will rise to the occasion by displaying the best of their respective productions in arts and industries, so as to make a representation worthy of this great opportunity.

The Exhibition will have the advantage of the beautiful buildings, already known to millions of people, which made the White City so famous in connection with the Franco-British Exhibition, and it only remains for the British Empire to provide a collection of exhibits which will worthily compare with those already promised by Japan, and to translate into reality the hope expressed by His Majesty the King that increased commercial prosperity and closer bonds of fellowship will result.

We have the honour to be, Sir,

ARTHUR,
Hon. President Japan-British Exhibition.
NORFOLK,
President.

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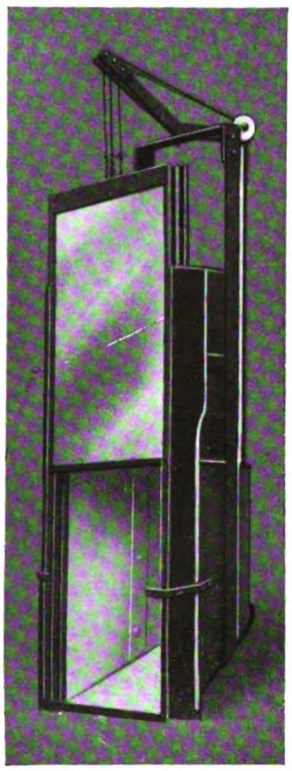
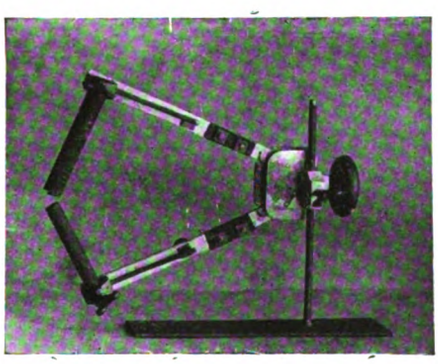
PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

Economy in Stage Lamps.



The introduction by Messrs. T. Francis & Sons (41, Hampden-street, Bolton) of their patent hand-feed arc for stage and photographic purposes and a special proscenium lamp places on the market two most useful and ingenious inventions. The Francis hand-feed arc is the latest in utility combined with cheapness in manufacture. Neatly made in aluminium or brass, its special features are the entire absence of worms, wheels, and delicate rack work, thus rendering it practically unbreakable. Two bell crank levers are fitted in a box, a feeding screw is introduced at the back, which forces the levers carrying carbons apart against the tension of a spiral spring. The spring closes the carbons when the screw is withdrawn. The inner arms are so interlocked that the weight of the top arm tending to drop is counterbalanced by the weight of the bottom one. A stage arc usually has a short life on account of its being knocked about in the semi-darkness, which is damaging to worms and wheels. The new invention has a promising future, and the firm are doing very good business with it.



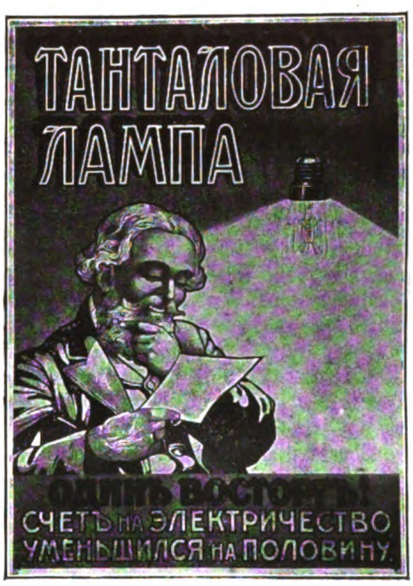
The proscenium arc, so-called from the position on a stage where it is intended to be fixed, is a 10 amp. 12 hour shunt arc, fitted in the firm's special box and provided with coloured mediums in such a manner that the switchboard attendant can attend to any number of them, no limelight men being necessary. They give an exceedingly powerful light, the colour effects being splendid.

NEW BUSINESS.

The Acme Electrical Co. have commenced business at 248, Stanley-road, Bootle, Liverpool. The firm's operations deal with electric light, heating, cooking and power. A free information bureau has been opened.

"TANTALUM" LAMPS, POSTERS AND SHOW-CARDS.

The "Satisfied Consumer" design of posters and show-cards used for advertising "Tantalum" lamps (Siemens Brothers Dynamo Works, Ltd., Tyssen-street, Dalston, London, N.E.) are now widely known and seem to enjoy universal popularity. The design has not only appealed to the electrical trade in this country, but has found a ready acceptance on the Continent. It has also been translated into Russian, German, Spanish and Portuguese, in order



that the same idea may be brought before the public mind of those countries. It will be readily understood, however, that for different countries, an alteration in the design is necessary, to bring it into line with the prevailing types of the country represented. We reproduce for the benefit of our readers the Russian version of the "Satisfied Consumer," and it will be noticed that the design is similar to the English one, but is made to appeal to the Russian idea of "satisfaction."

THE "PECKHAM" SYSTEM.

The "Peckham" system of pendulum and radial gears and trucks for electric and steam railway cars (the Peckham Truck Co., Queen Anne's-chambers, Westminster, London, S.W.) is becoming increasingly popular as its merits are understood. The system comprises pendulum and radial geared trucks suitable for any and all lengths and styles of car bodies, from a 16 ft. double-decked tramway car to a 70 ft. high speed electric or steam railway car. It is claimed to overcome all of the defects in existing car gears and trucks, and prevent hot axle bearings, shocks, noise, side swings and gallopings of car bodies, grinding of wheel flanges and corrugation of rails and reduce consumption of power and cost of maintenance of equipment and permanent way. The report of Mr. Henry M. Sayers. M.I.E.E., strikingly attests to the value of the system. Over 3,000 Peckham trucks are in use in Great Britain.

ECONOMY IN ELECTRIC LIGHTING.

The claim is made that by adopting the latest system of Messrs. Drake & Gorham (66, Victoria-street, London, S.W., and at Manchester and Glasgow) the cost of new electric lighting installations can be reduced by one-half and the running expense by two-thirds. Existing installations may be remodelled on the firm's plan so as to effect a saving of from 30 to 50% in the working costs.

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OBITUARY.

Mr. M. Wilson, Senr.

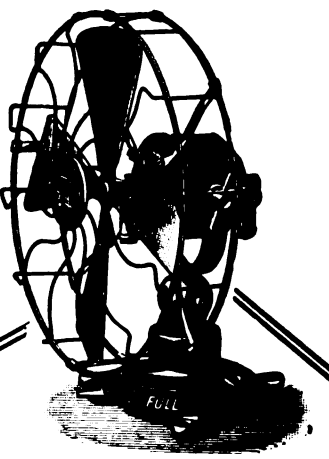
Those who have had dealings with the Electrical Standards Laboratory of the Board of Trade, will learn with regret of the death, after only one day's illness, of Mr. M. Wilson, Senr. He had served in the R.E. as sapper for over 21 years, and held for seven or eight years the office of storekeeper whilst acting as Laboratory Assistant at the Chatham School of Military Engineering, under Major P. Cardew. He held the office of Assistant Electrician and Mechanic to the Board of Trade Electrical Standards Laboratory since its inception in 1890, and the wide range of practical knowledge which he brought to bear on his duties made his services highly appreciated by all with whom he came into contact.

Mr. Hugh Erat Harrison.

We very much regret to announce that Mr. Hugh Erat Harrison, B.Sc. (London), A.M. Inst., C.E., M.I.E.E., F.C.S., the Principal of the Electrical Standardising, Testing and Training Institution, died on August 12. Mr. Hugh Erat Harrison was born at Westminster on April 23, 1859, and was educated at University College School. He matriculated in 1876, and entered University College, where he gained a Cloth Workers' Exhibition in Chemistry and Physics in 1877. He studied for a short time in Paris, and subsequently took his degree in 1880 with Honours in Experimental Physics. In the following year he entered the service of the Anglo-American Brush Co., and subsequently became Managing Engineer of the Sheffield Branch of the Hammond Electric Light & Power Co., Ltd. In 1882 Mr. Harrison organised and became principal of this company's Electrical Engineering College in Red Lion Square, London, and when it was closed in 1885 he became a partner in the firm of Phillips, Harrison & Hart. On retiring from this firm, he was appointed Clerk to the Research Committee of the Institution of Mechanical Engineers, but it was in 1889 that he carried out the work with which his memory will be associated, viz., the organisation and foundation of The Electrical Standardising, Testing & Training Institution, Faraday House, London, of which he was Principal at the time of his death. He organised the Testing Department and superintended its work, and in connection with this he was appointed Board of Trade Electric Inspector for Croydon, Tunbridge Wells, Ealing, Wimbledon, Chatham, Godalming and Clacton. From 1887–1901 he was Assistant Examiner in Magnetism and Electricity to the Board of Education, and he was one of the delegates sent by the Institution of Electrical Engineers to attend the International Electrical Congress, held at St. Louis in 1904. Mr. Harrison specialised very considerably in alternate current work. He has twice been elected a Member of the Council of the Institution of Electrical Engineers. He was unmarried. A man of wide reading, with a well-balanced mind and singularly clear judgment; he was, however, reserved almost to shyness, and shrank instinctively from anything approaching publicity. The funeral took place at Golder's Green on Tuesday.

DOMESTIC ELECTRICITY.

In another column we refer to the success with which gas companies have pushed the sale and hire of gas consuming appliances, and the excellent use of attractive show-rooms. An instance of this on the part of an electricity company is referred to in the pages of an American contemporary. It appears that the Indianapolis Heat & Light Co. has fitted up on the fourth floor of its office building a fully equipped and beautifully furnished five-room cottage in which is shown how a family can live by electricity. In the reception room there are electric lamps, electric fans, and an electric grate which heats the room. The parlour contains an electric piano which pounds out music when the button is touched. The dining-room contains any amount of electric apparatus, such as chafing dishes, coffee percolators, toasters and similar contrivances. The kitchen is equipped entirely with electrical apparatus for cooking, baking, washing machine, wringers, ice-cream freezer, irons and other devices. The sewing machine in the dining-room is run by electricity. The display is attracting much attention.



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AMERICAN NOTES.

(From Our Correspondent.)

NEW YORK.

The electrical outlook was never more promising than it is at the present time. In every direction all over the States business is booming, big installations are under construction, and heavy and remunerative contracts are in course of execution.

The Northern California Power Co. is building a 24,000 h.p. hydro-electric plant in the Battle Creek County, and the plant will soon be ready to commence operation with the 6,000 h.p. unit.

A single boiler of unusual size, 2,274 h.p., has been placed in the Delray power station of the Detroit Edison Co. It is a Stirling special, and has a 150-in. × 11-ft. grate, and is served with bituminous coal by four Roney stokers installed underneath the one boiler. This installation is in the first section of the Detroit Edison Co.'s No. 2 power house at Delray, in the construction of which allowance has been made for extending the outfit with similar units as the station's lighting load increases.

Leading capitalists of Ansonville, North Carolina, are promoting a project looking forward to the development of an electrical power site on Rocky River, near Wadesboro, North Carolina. A dam will be built to cost $400,000, and a power house which will have an initial equipment rated at 7,000 h.p. The line of the new Southbound Railway passes within one mile of the proposed power plant site, and the promoters expect to see a new town and manufacturing centre established. With the cheap power generated at the plant, it is believed that large cotton mills can be operated at a good profit.

Electrical energy obtained from the plant of the Carolina Power & Light Co., at Buchhorn Falls, is now being used for driving the cotton mills at Sanford. A total of 11,000 spindles and 400 looms, which were formerly run by a 450 h.p. engine supplied by steam from four 100 h.p. boilers, are now driven by electric motors.

At the Bernon Mills of the Manville Co., Georgiaville, Rhode Island, a 300 kw. Westinghouse-Parsons low-pressure turbine is being installed to take steam at atmospheric pressure from the exhaust of a Corliss engine, driving a three-phase, 60-cycle, 600 volt alternator to supply additional energy for lamps and motors in the mills. The turbine is operated without superheating, and exhausts into a condenser maintaining a vacuum of 27 in.

The largest electrical sign in the South has recently been set up in Montgomery, Ala. It is 85 ft. long by 75 ft. deep, and was constructed by the Montgomery Light and Water Power Co. in order to boom the town.

An electric service has been installed on the Pittsburg and Castle Shannon Railroad by the Pittsburg Railways Co., and the old steam road, which has been in operation for 40 years, has passed out of existence. The Pittsburg Railways Co. has put in a standard gauge line and an equipment of the latest standard electric cars.

The Meriden, Middletown and Guilford Electric Railway Co. has been formally organized. This road will have a tributary population of 300,000, as it furnishes a direct trolley line from Hartford, Meriden, Middletown, New Britain and other places to the shore and a trolley in Guilford.

Official statistics relating to Boston developments show that since January, 1906, the total boiler capacity in the electrical installations in the city has increased from 115,854 h.p. to 146,762 h.p., and the rated horse-power of engines from 142,931 to 236,400. The number of motors has increased, including the Boston Elevated, from 13,724 to 18,351, and the motor capacity from 192,493 h.p. to 326,652 h.p. The increase in motor horse-power on the Boston Elevated system was from 153,860 h.p. in 1906 to 271,204 h.p. in 1909, and on the Edison system the motor capacity increased from 28,030 h.p. in 1906 to 38,625 h.p. in 1909.

MOTORMEN'S WORKING HOURS.

The Tramways and Light Railways Association publish in their official circular correspondence which has taken place between the Amalgamated Association of Tramway and Vehicle Workers and the Board of Trade.

Writing to the Right Hon. Winston Churchill, M.P., Mr. C. Jackson, General Secretary of the Association, said:

"At the Annual Conference of the above Association, held in Bradford on May 26 and 27, 1909, the subject of the hours of labour worked by motormen and conductors employed upon electric cars, and the equipment of the cars was considered, when the following resolutions were passed, which I was instructed to forward for the consideration of your department, with the hope that you might be able to see your way to carry out the suggestions contained therein.

(*a*) That this Conference of Tramway and Vehicle Workers requests the Board of Trade to insist that all motormen and conductors shall have a clear break of eight hours between the time of finishing one day's labour and commencing another day, and that no day's labour should be spread over a longer period than twelve hours.

(*b*) That in the opinion of this Conference it is necessary that a more efficient system of the inspection of the rolling stock and the equipment of the tramways undertakings of the United Kingdom should be made by the Board of Trade, both in the interests of the men and the public at large.

"In reference to the first resolution, I have no hesitation in saying that if your department were to insist upon a return being made to them by the tramway authorities of the conditions under which the day's labour was performed, they would find that there are a large number of men who at times are called upon to work twelve and thirteen hours at a stretch, and the spread-over time reaches close upon sixteen hours.

"In support of the resolution dealing with the inspection of the rolling stock and equipment, may I quote the Bournemouth accident and the Glasgow accident; also the accident which took place last week between Dudley and Wolverhampton, where a passenger was electrocuted owing to a leakage of current, and the case of Clark *v.* The West Ham Corporation, which was again a serious accident caused through a defective car, in the way of a leakage of current."

To this the Railway Department of the Board replied:

"As regards the point raised in the second resolution, the Board are of opinion that the responsibility for the maintenance of the car equipment, etc., must rest with the companies or municipalities concerned, and that there is no necessity for periodical inspection on behalf of the Board of Trade, but they would be glad to receive any observations which your Association may desire to offer on the subject of the hours of work of tramway motormen and conductors."

SOME CONTRACTS.

The Mirrlees Watson Co., Ltd., have recently received orders for a number of Condensing Plants, among which are the following:—

A. Williams, Mexico.—Three Sets of Barometric Condensing Plants, 38,500 lbs. steam per hour.

Clifton & Kersley Coal Co., Ltd.—Barometric Condensing Plant, 30,000 lbs. of steam per hour.

Baldwins Ltd., Port Talbot.—Surface Condensing Plant, 30,070 lbs. of steam per hour.

Broken Hill, N.S. Wales.—Low Level Jet Condensing Plant, 10,000 lbs. of steam per hour.

For Great Boulder Prop. Mines, Ltd.—Surface Condensing Plant, 21,100 lbs. of steam per hour.

Chas. Walmsley & Co., Ltd., Bury.—Surface Condensing Plant, 15,600 lbs. of steam per hour.

P. J Mitchell, London, for Whitehaven Coal Co.—Surface Condensing Plant, 13,000 lbs. of steam per hour (Condenser only.)

The Linde British Refrigeration Co., Ltd.—Surface Condensing Plant, 8,000 lbs. of steam per hour.

Bolckow Vaughan & Co., Ltd., Middlesbrough, for South Bank Turbo Plant.—Surface Condensing Plant, 43,000 lbs. steam per hour (repeat order).

Okura & Co., London, for Formosa.—Barometric Condensing Plant, 36,250 lbs. of steam per hour.

The South Metropolitan Electric Light and Power Company, Limited, inform us that the Transfer Books and Register of Members of the Company will be closed from the 18th to the 31st August, 1909 (both days inclusive), for the preparation of Warrants for Interim Dividends payable on the 31st inst., on the 7 per cent. Cumulative First Preference Shares, and 6 per cent. Cumulative Second Preference Shares for the half-year ended 30th June, 1909.

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City and Guilds of London Institute.

SESSION 1909–1910.

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City and Guilds Central Technical College.

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Chemistry	R. MELDOLA, F.R.S., F.I.C.

JOHN WATNEY, Hon. Secretary

City and Guilds of London Institute,
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UNIVERSITY OF DURHAM.

ARMSTRONG COLLEGE, NEWCASTLE-ON-TYNE.

PRINCIPAL—SIR ISAMBARD OWEN, D.C.L., M.D.

SESSION OF 1909/10 (COMMENCING SEPTEMBER 27th, 1909).

DEPARTMENTS of MECHANICAL, MARINE, CIVIL, and ELECTRICAL ENGINEERING, NAVAL ARCHITECTURE, MINING, METALLURGY AGRICULTURE, and of PURE SCIENCE and LETTERS.

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FULL DAY COURSES in the Theory and Practice of the above Subjects will commence on MONDAY, 4th October, 1909. ENTRANCE EXAMINATION on WEDNESDAY and THURSDAY, 29th and 30th September. These Courses include periods spent in Commercial Workshops, and extend over four years. They also prepare for the degree of B.Sc. in Engineering at the University of London. Fees £15, or £11 per annum.

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SESSION 1909–10.

DAY CLASSES BEGIN TUESDAY, 28TH SEPTEMBER.
EVENING CLASSES BEGIN THURSDAY, 23RD SEPTEMBER.

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UNIVERSITY COLLEGE.

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SESSION 1909-10.

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Electrical Engineering	J. A. FLEMING, D.Sc., F.R.S.
Electrical Design	H. M. HOBART, M.Inst.C.E. (Vice-Dean).
Municipal Engineering	OSBERT CHADWICK, M.Inst.C.E., M.Inst. M.E., C.H.G. R. E. MIDDLETON, M.Inst.C.E.
Civil Engineering	H. DEANS, M.Inst.C.E. (Railway Engineering). A. T. WALMISLEY, M.Inst.C.E. (Waterways, Harbours and Docks). W. N. BLAIR, M.Inst.C.E. (Roads, Street Paving, Tramways).
Surveying	M. T. ORMSBY, M.Inst.C.E., I. E. SPRAGUE, A.M.I.C.E.
Physics	F. T. TROUTON, M.A., F.R.S.
General and Physical Chemistry	SIR WILLIAM RAMSAY, K.C.B., F.R.S. N. T. M. WILSMORE, D.Sc.
Applied Mathematics	KARL PEARSON, M.A., F.R.S.
Economic Geology	E. J. GARWOOD, M.A.
Mathematics	M. J. M. HILL, M.A., D.Sc., F.R.S.
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Secretary.

University College, London (Gower Street).

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(UNIVERSITY OF LONDON.)

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PROFESSORS—

Engineering	DAVID S. CAPPER, M.A., M.Inst.C.E., M.I.M.E. H. M. WAYNFORTH, A.M.Inst.C.E., A.M.I.M.E. M. CURRY, M. Inst. C.E.
Electrical Engineering ..	E. WILSON, M.I.E.E.
Natural Philosophy ..	C. G. BARKLA, D.Sc.
Architecture	R. ELSEY SMITH, A.R.I.B.A.
Chemistry	J. M. THOMSON, F.R.S., F.I.C. H. JACKSON, F.I.C. P. A. KIRKALDY, F.I.C., F.C.S.
Mathematics	S. A. F. WHITE, M.A. J. B. DALE, M.A.
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THE NEXT SESSION BEGINS ON OCTOBER 5th, 1909, on which day the ENTRANCE EXAMINATION will be held at 10 a.m. and 2 p.m.

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NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

PATENTS.

THE PROPRIETOR of the PATENT Nos. 11,933 of 1900 19,899 of 1905, 26,808 of 1905, for "Improvements relating to the Regulation of Electric Motors," "Improvements relating to Alternating-current Electric Motors," and "Improvements relating to Alternating-current Electric Motors," is desirous of entering into arrangements by way of licence and otherwise, on reasonable terms, for the purpose of exploiting the same, and ensuring their full development and practical working in this country.

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TO MAKERS AND USERS OF TELEGRAPHIC APPARATUS.—The OWNERS of the Patents Nos. 8,180/97, for "Improvements in and pertaining to Printing Telegraphs, Typewriters and the like"; 21,548/96, for "Improvements in and connected with Apparatus for Punching Strips of Paper and like material suitable for use in Telegraph Transmitters and for like purposes"; 14,637/00, for "Improvements in and connected with Apparatus for Punching Strips of Paper and like material suitable for use in Telegraphic Transmitters, and for like purposes, the same being particularly adapted for the preparation of Telegraphic Messages for Automatic Transmission over Single or Duplexed Circuits, which may be received in Morse or other Telegraphic Codes or Typeprinted Characters arranged in page form"; 20,682/02, for "Improvements in and connected with Apparatus for Printing Telegraphs"; 20,683/02, for "Improvements in Page Printing Telegraphs"; and 20,684/02 for "Improvements in Perforating Machines for preparing Telegraphic Messages for Automatic Transmission, applicable also to other analogous Apparatus," desire to negotiate with interested parties with the view of granting licences under them on reasonable terms.

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TO ELECTRIC LIGHT ENGINEERS.—The OWNERS of the Patent No. 23,501, 1899, relating to "Improvments in Vacuum Tube Lighting," and the Patent No. 12,582, 1902, relating to "An Improved System of Electric Lighting," desire to negotiate with Electric Light Engineers with the view of granting licences under them on reasonable terms.—For information apply to MESSRS. LLOYD WISE AND CO., Chartered Patent Agents and Consulting Engineers, 46, Lincoln's-inn-fields, London, W.C.

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A POPULAR ELECTRICAL LABORATORY.

A popular electrical laboratory has been founded in Brussels by Dr. Goldschmidt which is likely to prove of considerable service in bringing home to the layman not only some of the marvels, but the everyday utility of electricity. It is not a mere assemblage of electrical discoveries and inventions, though that would have stimulated the curiosity of many intelligent visitors; but it shows what science does, says the *Morning Post*, in giving some particulars of the new institution. It enables the visitor actually to handle apparatus and make experiments for himself. Thus on the first floor of the laboratory are the fundamental experiments of magnetism and electricity—magnets, electro-magnets, electric motors in action; the Wimshurst machine; electric discharges in Crookes tubes. Each piece of apparatus is isolated in a glass case, leaving free only the part which has to be handled in order to set the experiment in motion.

In adjoining rooms are gathered respectively the instruments of precision, for testing or for measurement, the operation of which needs knowledge of the elements of the science. Here are photometers, Wheatstone bridges, galvanometers, wattmeters, ammeters, and devices which will enable visitors to make the essential measurements relative to motors and dynamos. The visitor is here in a laboratory where measurements and tests are carried on by competent persons attached to the Office of Control of Electric Installations, whose headquarters are under the same roof. Most visitors, even if capable of following and understanding these tests, would not be able to make them; but a trained student who wished to handle the apparatus would be encouraged to do so, under the superintendence of the expert official. There are projection lanterns in an adjoining lecture hall, to exhibit details of apparatus and its applications; four small laboratories for research work: a library; and a mechanical workshop where the construction of electrical apparatus is publicly carried on.

ENGINEERING AT UNIVERSITY COLLEGE, LONDON.

Professor J. D. Cormack has been elected Dean, and Professor J. A. Fleming, Vice-Dean, of the University College Faculty of Engineering for the Session 1909-10. The Chadwick Scholarship and Medal has been awarded to F. L. Thompson. A. M. Sims has been declared *proxime accessit*, and has been awarded a silver medal. The Session will begin on Monday, October 4th. Special and Post-graduate Courses have been arranged to meet the needs of the following classes of students: (*a*) Post-graduates and Engineers in practice; (*b*) others whose qualifications are, in the opinion of the lecturer, such as to enable them to follow the Courses. Each Course will include lectures and exercises, and the numbers admitted will be strictly limited. Among the special Courses for next Session are: "Electrical Design," by Mr. H. M. Hobart; "Steam Turbines," by Mr. W. J. Goudie and Mr. E. G. Izod; "Railway Engineering," by Mr. H. Deans (of the Great Western Railway).

ELECTRIC PUMPING IN MINES.

We hear from a New Zealand correspondent that a sudden rush of water in the 5th level of the Crown Mines, situated at Karankahake, in the Hauraki district, made it impossible to explore the reef below the place where a run of valuable ore was found. The directors thereupon made inquiry as to the cost of installing an electric pumping plant, and as a result the necessary machinery has now been purchased. Electrical energy is to be generated by a 550 kw. three-phase alternator, and transmitted over bare cables to the mine, where motors will be erected in the main incline shaft for driving duplex pumps. The plant will be capable of pumping, in two stages, 1,135 gallons of water per minute from a depth of 1,000 ft. The use of bare cables seems a mistaken policy of economy, which may lead to serious trouble, otherwise the method adopted is to be commended.

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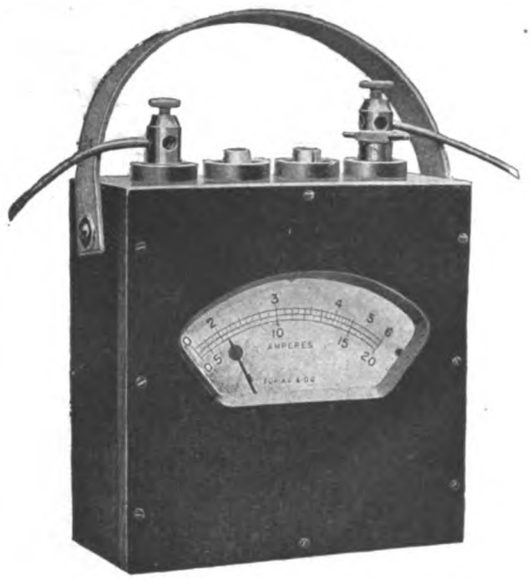

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At the official trial of the first Motor Fire Engine supplied to the Glasgow Fire Department the Hatfield Pump on same worked on a suction lift of 27 ft. At the trial of two similar pumps supplied subsequently the water was picked up instantly and delivered at the nozzle in 10 secs. from starting the motor.

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PERSONAL.

An interesting little ceremony took place recently at the Electricity Works of the Bradford Corporation, when Mr. Chas. W. Salt, Chief Assistant to Mr. Thomas Roles, City Electrical Engineer and Manager, was presented by the staff and employés with a handsome brass-mounted oak clock and a calabash pipe on the occasion of his marriage with Miss Ida Potts, of Bradford. Mr. Roles, who made the presentation on behalf of the subscribers, spoke of the high esteem in which Mr. Salt was held in the department, and several members of the staff cordially endorsed his remarks. Mr. Salt responded.

We are requested to notify that Mr. H. Jackson is no longer representing Messrs. A. P. Lundberg & Sons, of the Pioneer Electrical Works, Liverpool-road, Islington, London, N.

Mr. J. E. Sayers, M.I.E.E., of Messrs. Sayers & Caldwell, of Glasgow, was married on the 7th inst. to Miss Margaret Wilson, daughter of the late Mr. T. C. Robertson, C.A., Glasgow, and Mrs. Robertson, of Chatsworth, Busby.

Mr. Turpin has been elected by the Chippenham Town Council to represent the Council on the Board of Directors of the Chippenham Electric Lighting Co.

A scheme for the re-arrangement of the technical staff at the generating station has been submitted by the Electricity Committee to the Wolverhampton Town Council and approved. It was reported that Mr. H. A. Howie, who for the past 11 years occupied the position of Deputy Electrical Engineer, had obtained the appointment of deputy to the Chief Electrical Engineer to the Sheffield Corporation, and had resigned his position. The Council now agreed to divide the work of supervision into separate departments, each in charge of a man with special qualifications. One of the chief points urged in favour of the scheme was that it would tend to the reduction of costs, and promote the younger men whose merit deserved recognition. Mr. Ernest Stubbs was promoted Technical and General Assistant, his salary being increased from £97 10s. to £160 per annum; Mr. J. S. Dadley, Station Superintendent, was appointed Maintenance Engineer at his existing salary (£156); Mr. C. Bellhouse's salary was increased by £21 to £125 on appointment as Boilerhouse Superintendent; and Mr. E. Forder was appointed Engine-room Superintendent at £120, an increase of £16.

Mr. A. T. Gregory, a workshop foreman in the Engineering Department of the East Indian Railway, has got out a patent for an improved chair with attachments which is designed to prevent the creep of rails, and seems worthy of a trial.

In celebration of the recent marriage of Mr. Harold Dickinson, the Manager of the Leeds Corporation Electric Lighting Department, a social gathering of the officers and workpeople, together with their wives and lady friends, was held at the Grand Central Hotel. Mr. Dickinson was presented with a grandfather clock and silver tea and coffee service, and other articles subscribed for by the entire staff, numbering 237 persons. During the evening musical selections were rendered by: Mrs. Jackson, Miss Maud Baxter, Miss A. Masterman, West Leeds Quartette, Mr. Geo. Smith, Mr. J. C. Pearson, Mr. S. H. Smith, Mr. Wm. Browning, Mr. A. Tetley, Karl Christo, and Mr. H. Harrison, accompanist.

Mr. James Veit has been appointed Secretary, and Mr. F. B. Pell, Sales Manager, of Ship Carbons Limited, 67, Aldersgate-street, London, E.C.

PRESTON SEMI-CONVERTIBLE CAR.

Already the appearance of the new Preston semi-convertible car has attracted considerable attention in the tramway world. Many tramway engineers and managers have inspected the car and expressed themselves highly pleased with the design. The car is constructed on lines, which not only make it semi-convertible, but an ordinary drop-sash car as well. Among other advantages urged for this car, which has been fully patented at home, and abroad are its strength and simplicity of construction. There is nothing to guide the sash but the post, and consequently no rattling takes place. The roof is not affected in any way, and can be of any height, width, or shape. Another feature is the high window opening, without any complicated devices for opening the windows. The car is so constructed that its re-erection in foreign parts can be done with the minimum amount of labour. Although the type of car is in many respects not suitable for the conditions at home, the double window arrangement can be readily adapted for single-deck or top-seat cars of the ordinary English design. For certain tramways, especially at seaside resorts, they hold that this double window arrangement has much to commend it, and its adoption should add considerably to the takings in the hot weather, when people have an aversion to riding in the closed portion of the car. Some large orders have been received, including a number from South America, and a big demand is expected. It is anticipated by the makers, the United Electric Car Co., Ltd., Preston, Lancashire, that the new car will become the standard car, not only for South America, but for all countries where a genuinely reliable semi-convertible car is needed.

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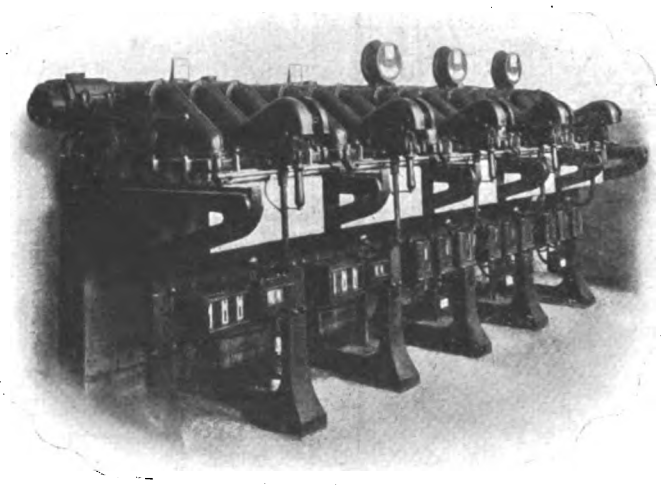

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MORE MINING NOTES.

Reverting once more to the annual report of H.M. Inspectors in connection with coal mining, we may give some important statistics relating to the use of coal cutting machines, in the operation of which electricity divides honours with compressed air. In the East Scotland district there were in use 195 coal cutting machines driven by electricity, and 93 by compressed air. The West Scotland district had 146 and 76; Newcastle district, 42 and 145; Durham district, 72 and 103; Yorkshire and Lincolnshire district, 111 and 159; Manchester and Ireland, 17 (one in Ireland) and 81; Liverpool and North Wales district, 18 and 113; Midland district, 91 and 82; Stafford district, 19 and 34; Cardiff district, 4 and 12; Swansea district, 10 and 5; Southern district, 12 and 19.

Another instructive group of notes refers to a different class of accidents to those dealt with in our last number. Reporting on the East Scotland district, the Inspector states that of 35 explosions one was caused by sparking from the commutator of an electric motor, while three fatal accidents were caused by coal cutting machines. An ignition of gas in a West Scotland district pit worked with safety lamps was attributed to an electric bar coal cutting machine emitting sparks of electricity or by sparks of fire from the cutting tool igniting a feeder. Referring to two non-fatal explosions in fiery mines in the Yorkshire and Lincolnshire district, the Inspector (Mr. W. H. Pickering) says that in one instance a charge missed fire and then a second charge was fired by electric battery. There was only a slight report, but immediately afterwards a flame rushed up the gate-road and burned a collier who was 24 yards from the shot. It was afterwards found that the second charge had exploded and expanded itself in a break in the stone, but the first charge was not detonated. The other case was the ignition of gas in an engine-room of an inlake haulage road, by a flash from the starting switch of an electric motor. Mr. Henry Hall, in his report on the Liverpool and North Wales district, states that the present output will be more easily attained, when the new Act for an eight hours' day comes into operation, at collieries where mechanical coal-cutters have already been installed than at those dependent on manual labour alone. With the machines the undercutting can all be done in the night, ready for the beginning of the eight hours' day, and this undercutting represents about a third of the total labour involved in coal getting. There were two accidents in the Midland district, two fatal accidents on the surface, said to be due to the use of electricity. In one case the deceased, a fitter's labourer, had no knowledge of the use of electricity, and at the time of the accident was assisting to clean and repair a locomotive in the engine shed. Deceased took hold of the brass fitting of the incandescent lamp holder, and immediately called for help, when a fellow workman ran and snatched the cable and lamp from his hand. Upon examination of the lampholder the porcelain inside was found broken, and a wire of the cable would touch the brass work when moved about. This would allow an electric current to pass round the exterior brass work when moved about, and so communicate the current to any person who handled it. A test was made to ascertain the strength of current which would go through deceased's body, when it was found to be 150 volts, a remarkably small voltage to kill a healthy person almost instantly. In another case the deceased was a Bachelor of Science. He was in the employ of the British Westinghouse Electrical Manufacturing Co., but had been sent to the colliery to work under the instruction of the colliery electrician in the erection of additional switchgear at the back of a large switchboard. On the day of the accident the deceased had been working in a cubicle which was dead to all current, but for some reason he unlocked the door of the next cubicle and with one hand (burned on the back) on a bare part, his head (nose) came in contact with another bare part. The electrical current passed through his body and he appears to have been instantly killed. On examination of the cubice it was found that the three safety plugs had not been removed, probably due to momentary forgetfulness on the part of deceased, or haste to get away, as it was Christmas Eve, or it may be that he was simply threading through the cubicle the wires to connect to the Tirrill regulator, and he thought he could pass them through without cutting out the cubicle. In this case the plant was of the best description, and every precaution up to the time of the accident appeared to have been provided, and yet we have a fatality to an educated man who fully understood the dangers, but who neglected to secure his own safety, and probably trusted to his scientific knowledge to do a trivial operation without taking advantage of the appliance erected for safety when the generators were at work. There are two points in connection with this accident which Mr. Stokes (the Inspector for the district) desires to bring before the makers of such switchboards, and the responsible colliery officials having charge of electrical plant, viz.:—(1) The cubicle should be so arranged that the opening of the door will cut off all current and render all parts inside dead. In the above case this was carried out half way, and there is no reason why the opening of the door should not be made to cut off all current. It is a simple mechanical arrangement of switches. (2) That each cubicle shall have a separate key, and that no one shall be allowed to have any key without the authority of the electrician in charge, and then only to such cubicles that require attention. The electrical and mechanical arrangements present no difficulties, and the design of the switchboard of the future to secure safety from accidental shock is largely a mechanical question of contrivance.

POST OFFICE TELEPHONES RESPONSIBILITY.

In the City of London Court, before Judge Lumley Smith, K.C., the Postmaster-General sued Mr. William H. Russell, trading as John Russell, Devonshire-mansions, Haverstock-hill, to recover 15s. 7d. for the rent of an extension telephone line. The defendant had several other lines, about which there was no dispute. Defendant's manager, Stevens, said that the extension line was absolutely useless from beginning to end. They never could get connected, although he tried to do so over fifty times. At last they asked the Postmaster-General to take the machine away, and wrote and said no sensible man would ask them to pay rent for the extension. Mr. W. Brignall, for Sir Robert Hunter, the solicitor to the Post Office, said that the extension worked all right at first, but there was no responsibility of the Postmaster-General to maintain it or keep it efficient. If there was any error or fault on the part of the engineers, the Crown was not responsible, as they were not liable for the faults of any of their servants. Stevens said they never had any use out of the extension. Judge Lumley Smith said that the contract was a very tight one, and he had had similar complaints before. Defendant probably did not read the conditions under which he was bound. The fact that the extension was out of order was no answer to the present claim, and the contract precluded the defendant claiming damages. Defendant had trusted to the good feelings of the Postmaster-General that he would do his best to keep the extension in order. That was all. Judgment for the plaintiff, with costs.

ELECTRIC LIGHTING FOR MOTOR CARS.

Electric lighting installations for motor cars are being offered in a compact and serviceable form by the United Motor Industries (46, Poland-street, London, W.). The outfit, which is styled the Eyquem Electric Lighting Set, comprises a dynamo, driven off the engine in any suitable position, a set of Castle accumulators of 12 volts tension, a combined voltmeter and ampéremeter, two parabolic head lights, two side lights, a tail light, a roof light for an enclosed car, an electric signal for the driver, a lubricator and pressure gauge light, a Wagnor horn and a cigar lighter. By means of the controlling switches on the dashboard the head lights or any other can be cut off as desired, and the whole apparatus needs but little attention. The dynamo requires ¼ h.p. to drive it, and weighs 22 lbs., while the accumulator turns the scale at 30 lbs.

NEW CATALOGUES, ETC.

"CRANE MOTORS AND CONTROLLERS."—New edition of pamphlet by Dick, Kerr & Co., Ltd., Abchurch-yard, Cannon-street, London, E.C.

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ELECTRICITY IN AMERICAN MINES.*

BY GEO. R. WOOD.

Assuming that the coal vein lies almost horizontally, with an average dip of, say, 1·5 to 4 or 5 per cent., the main headings or tunnels are driven to the raise where possible, so that grades will favour the loads. At intervals of about 1,200 ft., cross-headings or flats are driven at right angles to the mains, and from these, parallel to the mains, are driven room-headings or entries, from 300 to 600 ft. apart. The rooms or chambers from which most of the coal is taken are turned from these entries, and are started in about the same width—10 ft.—as the entries. When in about 20 ft. they are widened out to full width—from 20 to 30 ft. These rooms are driven on about 40-ft. centres, leaving a pillar of coal between them from 10 to 20 ft. thick, to support the roof.

The thickness of coal in the Pittsburgh seam runs from 5 to 7 ft., in the Connellsville basin from 6 to 9 ft., and in central Pennsylvania from 3 to 5 ft. In a completely equipped electrical mine, the coal is undercut by electrical machines, hauled from rooms to cross-headings by small gathering locomotives, and from cross-headings to main tunnels and thence to the tipple by larger locomotives. Electric pumps of various sizes handle the water; electric motors drive the fans which ventilate the mines; and car-hauls, crushers, elevators, and the like, where used, are also driven by motors.

Electrical mine locomotives and machines have been in use for more than 20 years. Originally very crude and expensive to operate, they are now highly developed and satisfactory pieces of apparatus. Some of the first locomotives were made of street-car trucks weighted down. Many were of the single-motor type, with connecting rods or with chain drive. The motors were not enclosed, and the trolley was of the pantagraph type. For a long time the equipment was inadequate, largely on account of the narrow gauge as compared with street-railway work, and also because each locomotive was proportioned for particular service, which afterwards increased as the haul was extended. The equipment was based on about 5·5 h.p. per ton, which will stand an intermittent service fairly well, but is not sufficient for long hauls or on heavy grades where sand is used.

Modern locomotives have usually two series motors, with a total capacity of about 10 h.p. per ton of locomotive weight. These motors are rated at 75 degrees cent. rise in 1 hr., or in some cases are rated for 40-min. service. A rheostatic controller with grid resistance is used, and motors are operated in parallel on heavy pulls and in series for switching. The change is made by a four-point reversing cylinder. In a new controller for heavy work, each point on the controlling cylinder has a double-contact finger and a separate blow-out coil. Arc head-lights are largely used.

In many mines it is desired to gather the wagons from rooms to cross-headings by motors. For this service small locomotives weighing from 4 to 6·5 tons are used, and since it is not desirable to have trolley wire in the rooms, these locomotives are provided with cable reels. These reels are arranged automatically to reel out cable when running into rooms, and reel it up again on coming out. The cable is hooked over the entry trolley and supplies current to the locomotives. The reel may be driven by a sprocket chain, through a friction clutch, from the axle of the locomotive or from the shaft of one motor. The reel may also be operated by a coil spring, if the cable be not too long or by a small series motor connected permanently in circuit. Where grades are very heavy against the load, a wire-rope reel, with a small independent motor, is sometimes provided. In this case, the locomotive remains at the top of the grade, lowers the empty car by gravity and hauls up the loaded wagon by the wire rope.

Mainline four-wheel locomotives are not often made heavier than 14 tons, on account of the heavy rail required. When more power is needed, six-wheel, three-motor locomotives are used, of from 15 to 20 tons weight, or two four-wheel locomotives are coupled together with a single four-motor controller, and with the brake rigging operated from one lever. These tandem locomotives are sometimes so arranged as to be easily disconnected and worked separately when desired.

Electric coal-cutters were first of the "cutter-bar" type, in which the "bits" or small chisels were staggered around the surface of a horizontal cylinder, which was rotated and forced under the coal, making an undercut of a width and height equal to the length and diameter, respectively, of the cylinder cutter head. The next type was the chain-breast machine, which is very largely in use at present. This type comprises a stationary rectangular frame and a movable frame, carrying the motor, gearing and cutter head, travelling within the stationary frame. The cutter head is the base of a long isosceles triangle, around which the chain is driven by a sprocket at the apex. This chain carries a number of cutters or bits, about one-third being uppers, one-third lowers, and one-third centres. The chain is fed forward into and under the coal by a rack-and-pinion feed, the cut being about 4 or 5 in. high and 44 in. wide. Both types of machines, after making a cut to the desired depth, are shifted sideways; the operation is repeated until the face of the room is undercut completely across, after which the coal is blasted down.

A new type of machine is an electrically driven puncher. This puncher consists of a vertical motor with gearing, and a cylinder and two pistons, one of which is driven by the motor, the other carrying the cutting-tool or pick. The rear piston, driven by the motor, compresses air on its backward stroke and the front piston, carrying the tool, is forced back by atmospheric pressure. At a certain point the rear piston passes a port which admits the compressed air between the two pistons. As the front piston is free to move, it is driven forward, causing the tool to strike the coal with great force. Should the pick not strike the coal, the blow is absorbed by an air cushion at the front of the cylinder. This machine is mounted on a pair of wheels, like the air puncher, and is operated in substantially the same way.

Another type of under-cutting machine is similar to the chain-breast machine, except that after making the first undercut, instead of withdrawing, moving sideways, and repeating the forward cut, this machine remains under the coal and is drawn sideways across the room, cutting as it goes. This type is especially adapted for cutting wide rooms or long faces, and is called a "long-wall" machine.

Machines have also been designed to cut and load the coal, without blasting. One of these is made up of two discs or cutting wheels about 4 ft. in diameter carrying bits in the periphery, mounted side by side and rotated in opposite directions. These are fed into the coal and undercut it, carrying the cuttings to the centre, where a conveyor chain picks them up and feeds them back into a car. At the same time, two puncher machines, mounted above the wheels and one at each side, on swivels, are used to break down the coal as it is undercut, the cutter wheels throwing the coal to the centre whence it is carried back by the conveyor. This machine as first designed is operated by compressed air.

Another machine has a double cutter head, like two standard chain machines, one above the other. The double head is swung in a vertical plane, describing an arc of about 180 degrees, like a steam shovel, except that the cutting is done on the downward stroke. This machine cuts the entire vein into fine slack, which is preferable for coking.

Electric mine pumping does not differ essentially from power pumping on the surface, except that the water is usually acid, and that grit and fine coal must often be handled. In the geared-type plunger pumps, the valve lift is increased to allow the passage of fine coal, etc., and the cylinders, plungers, valve seats and stuffing boxes are made of acid-resisting material. In some extreme cases cement-lined pumps with wooden plungers are used, or the entire pump is wood-lined. Where the water is not too strongly acid, and other conditions are favourable, turbine pumps are used, eliminating valves, packing, gears, etc. Rotary pumps of new design are also coming into use where the water does not contain much grit.

* A paper read before the Pittsburgh Section of the American Institute of Electrical Engineers.

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One of the first electrical mining plants in the Pittsburgh district was that at Grindstone, near Brownsville, Pa. The generator was a bipolar machine of about 60 kw., driven by a Corliss engine through a countershaft. It is still in daily operation. Cutter-bar mining machines were operated.

The two largest plants at that period were those at Essen, near Carnegie, and Scott Haven, above McKeesport, both of which are now operated by the Pittsburgh Coal Company. The Essen plant supplied two mines, and consisted of three bipolar, 250-volt, 150-kw. generators, belt-driven. A number of mining locomotives were used, these having but one motor, carried lengthwise in the locomotive frame, with bevel gears at each end. On account of this positive connection to all driven wheels, and also on account of the steel-tired wheels, these locomotives had a very high draw-bar pull, but they were expensive to operate on account of the difficulty of holding the bevel gearing in line.

The Scott Haven plant, installed in 1895, supplied four mines, and consisted of four-belted, 550-volt, 100-kw., four-pole generators. The switchboard was a skeleton oak frame, with round copper bus-bars, the switches being front-connected. On account of the high potential, a metallic circuit was provided for the mining machines as being safer for the men, but this circuit quickly became grounded in the mines. All the apparatus was later put on a grounded circuit with rail return.

The locomotives in the Scott Haven plant were of the two-motor type and mechanically of modern design. The motors were of about 23-h.p. rating on 10-ton locomotives. The armatures were cross-connected and were very difficult to rewind. These motors were replaced in 1898 by 35-h.p. motors for narrow gauge use, originally designed, the author believes, for the Boston Elevated Railway. One of these locomotives has still in service the motor installed in 1898, the armature never having been taken out.

The installation at Scott Haven included some of the earliest motor-driven fans and pumps. Practically all of these are still in use.

One of the first direct-connected plants was installed in 1897 at Moon Run, about 5 miles West of McKees Rocks. This plant was first used for haulage alone, and included one 165-kw., 250-volt generator, driven at 240 rev. per min. by a centre-crank engine. Another unit was installed later with a side-crank engine, but before this was in place the centre-crank engine shaft broke in the disc. It was operated for several weeks after breaking in two, until the other unit could be started.

One of the first alternating-current central plants for coal-mining purposes was installed in 1902 at Gary, W. Va. This plant first contained two 400-kw., 6,600-volt, 25-cycle generators, driven by twin simple engines with independent governors. The exciting equipment consisted of one 25-kw. vertical engine-driven unit and one 25-kw. generator direct-driven by a 40-h.p. induction motor at 720 rev. per min. All oil switches were in brick cells back of the switchboard, with remote manual control, the feeder switches being of the automatic overload release type with time limit relay. The generator switches were non-automatic.

The longest transmission was originally 3 miles. Three sub-stations were built, each containing one 150-kw., 275-volt converter with step-down transformers and the usual switchboard equipment. Each sub-station also contained step-down transformers for induction motors at tipples, etc. Direct current from the converters was used for haulage only, supplying main-line and gathering locomotives of the cable-reel type, and the larry equipments for the coke ovens. These larry equipments included one motor with a reversing controller, resistance and trolley, and the motors were duplicates of those on the smaller locomotives. Each larry could haul one trailer.

Induction motors are used on single-stage, two-stage, four-stage and five-stage turbine pumps, for coke oven supply; on crushers in sizes of 75, 200, 300 and 400 h.p. at the tipples; on mine fans, for which purpose two-speed, changeable-pole, 100-h.p. and 150-h.p. motors are used; for driving deep-well pumps and small compressors for air lift, with silent-chain drive; and for driving picking tables, car hauls, conveyors, etc., at tipples.

This plant was later increased by adding two 750-kw., 6,600-volt generators, driven by cross-compound Corliss engines at 125 rev. per min. At the same time the original twin simple engines on the smaller units were changed to cross-compound, giving better regulation and economy. Within the past year one 1,000-kw. steam turbine on 140 lb. pressure has been added, also one 1,000-kw. low-pressure turbine, using exhaust steam from the engines. Condenser equipment, including three large cooling towers, has been provided for the turbines.

Nine sub-stations are now in operation, and three 500-kw. step-up transformers, 6,600 to 22,000 volts, have been installed for supplying mines to be opened about 12 or 15 miles distant.

A very economical plant has been installed near Fairchance, Pa., utilising in the boilers the waste heat from the coke ovens. A large flue is built back of 100 bank ovens, with smaller flues connecting each oven, and a boiler plant is located at the centre of each section of 50 ovens. Thus each boiler plant draws from 25 ovens each way, making a travel of about 350 ft. for the hot gases. The engine room is half way between the boiler plants, and contains four 400-kw., 2,300-volt, 25-cycles, three-phase generators, driven by cross-compound engines. By means of five sub-stations this plant now supplies seven works, operating locomotives, larry equipments, car hauls, conveyors, fans, pumps and coke-drawing machines. Up to the present time it has been found necessary to operate but one boiler plant, but extensions are under way which will absorb the entire capacity of the plant, one of the additions being a 1,000-cu. ft., 1,000-lb. motor-driven compressor for supplying air locomotives in a gaseous mine. When the demand for power increases, it is expected to install a low-pressure turbine with condensers, which would give about 1,000-kw. additional when operating three engine units.

At Ellsworth, Pa., it was expected ultimately to install an alternating-current central station, and belt-driven synchronous converters were installed for temporary use as three-wire direct-current generators. A neutral was obtained from the collector rings through the secondaries of small 200-volt transformers, and this neutral was permanently grounded to the mine tracks. Locomotives, machines, and pumps were operated at 275 volts between either main lead and the track, the load being balanced as nearly as possible, while outside motors, on fans, etc., are connected across 550 volts. It was found that straight star connections to the neutral from the collector ring through transformers would not work, as the converters bucked badly until interconnections were made to neutralise the flux in the transformers due to unbalanced direct current. It was also clearly demonstrated that the old style converters are much better adapted for use as direct-current generators than the modern design. The first ones installed were built 7 or 8 years ago and operated well with proper attention. One or two new ones could not be operated successfully at more than one-half rated capacity.

Three-wire, direct-current plants are also in operation in West Virginia, using railway type generators, with derived neutral through balancing transformers. One of these plants, at Minden, W. Va., operates three 300-kw., 600-300-volt generators, driven by cross-compound engines, and supplies four mines. The apparatus in use includes 20 locomotives, 16 machines, 21 pumps and 14 fan, car-haul, and miscellaneous motors.

The three-wire system has the advantage of being less dangerous than that using 550 volts pressure; the return or bonding need not be so good, and motors, etc., stand up better. The two voltages are also useful for variable-speed requirements. It is objected to on account of the care required in balancing the circuits. As a transmission problem, it is, with perfect balance, a 600-volt metallic circuit, and therefore requires just twice the copper—neglecting the difference in bonding—as a 600-volt, grounded-return system, or half the copper as compared with a two-wire, 300-volt grounded system. The balancing is most effective when a large number of small units are operated. The unbalanced current at Minden rarely exceeds 15 per cent.

In Woodward, Alabama, a plant has been installed at the furnaces of the Woodward Iron Company, taking steam

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from the furnace boiler plant, normally fired by blast-furnace gas. The plant includes three 400-kw., 3,500-volt, 25-cycle, three-phase generators, with cross-compound engines. At or near the furnaces two two-stage turbine pumps, delivering 3,000 gal. per minute each against a 135-ft. head, are operated for furnace use, while two 100-kw. motor-generator sets supply 250-volt direct current to shop motors, small locomotives handling ore wagons, and a travelling crane handling hot iron on the casting floor.

At No. 1 coal mine, about 2·5 miles away, the current is taken underground in a three-conductor, varnished-cloth insulated, steel-armoured cable. Four thousand feet inside are two 700-gal. triplex pumps chain-driven by two 150-h.p., 3,300-volt, induction motors and working against a 550-ft. head. A few thousand feet farther in is an endless rope haulage, chain-driven by a variable-speed, 3,300-volt motor, running at 200-480 rev. per min., with a controller and secondary resistance. About two miles from the pit mouth is an underground sub-station, containing one 200-kw. converter with step-down transformers, etc., supplying 275-volt current to mine locomotives. A number of small triplex pumps, operated by 440-volt induction motors, are also in use.

At No. 2 coal mine, about two-thirds of a mile farther from the power plant, current is taken underground approximately two miles to a duplicate sub-station, also supplying locomotives, and up an air shaft to a 50-h.p., 3,300-volt motor driving a mine fan. On account of the frequent labour troubles in that district, it was not advisable to take any power overhead, except along the railroad to the coal mines, where the line could be patrolled.

The plant is now being enlarged to provide power to the ore mines, 3 miles from the plant in another direction, to operate hoists, crushers, pumps, and air compressors for rock drills.

The six 150-h.p., 3,300-volt-motors on turbine pumps, triplex pumps, and motor-generator sets are duplicates. The underground cable is suspended from a messenger wire, with frequent loops for expansion and repair. There have been several rock-falls on the cable, most of which have caused short-circuits, but repairs are easily made. The armour is protected against corrosion by a layer of jute and asphalt, but the miners have cut a good deal of this off for kindling to start fires. They also stole about 40 gallons of oil out of the sub-station transformers one night, for use in their lamps.

These mines go in on a slope of about 20% for the first mile, after which the vein flattens out. There is only about 4 ft. of headroom. A good deal of the underground apparatus was skidded down on the track rails.

At Ehrenfeld, near Johnstown, is a plant in which belt-driven converters were first used for generators, supplying an underground sub-station through step-up transformers from 165 to 5,600 volts. This sub-station contained, besides the necessary step-down transformers, one 250-kw., 275-volt converter, operating on the trolley in parallel with the direct-current side of the double-current generators. This was the first alternating current plant operating underground sub-stations. Larger direct-connected generators have since been installed. It was the intention to use the original generators as converters later.

At Yatesboro, Pa., there is a successful installation, operating a number of motor-driven compressors, fans and sub-stations. The station equipment includes two 1,500-kw., 60-cycle turbine units, generating three-phase current at 6,600 volts. In two sub-stations are installed 300-kw., 550-volt converters running at 900 rev. per min., and in a third a motor-generator set, with an induction motor driving a 300-kw., 550-volt generator. Three motor-driven fans are in use at different mines, one with a 250-p.h. motor, belt-driven, one with a 250-h.p. motor and silent-chain drive, and a third with a 400-h.p. motor direct-connected through a flexible coupling. There are also, at the various mines, eleven 1,400-cu. ft. duplex compressors, belt-driven by 250-h.p., 6,600-volt induction motors. One interesting feature of this plant is that these high-tension induction motors are all started by throwing directly on the line.

At Windber, Pa., there have been operating, until this year, eight direct-current power plants supplying 12 mines. Two of these plants, those at No. 36 and No. 40 mines, are efficient installations with cross-compound condensing Corliss units, water-tube boilers, etc., but the range of distribution was such that the loss in transmission overcame the efficiency in the plants.

In most of the mines locomotives only were operated, at 550 volts, and the transmission was from 1·5 to 2·5 miles. Compressed air "puncher-type" mining machines and compressed air pumps were used, with steam engine-driven fans. It was decided to centralise the power, to do away with all the direct-current power plants, except No. 36 and No. 40, and to limit their field to a radius not exceeding 1·5 miles. The boilers from some of the dismantled steam plants have been assembled and a plant installed at No. 35 mine, in nearly the centre of the field. The equipment includes one 400-kw., 6,600-volt, three-phase, 25-cycle generator, driven by a cross-compound engine, and two 1,000-kw. steam-turbine units to operate at 140 lb. pressure and 1,500 rev. per min. One additional turbine unit, probably of 3,000-kw. capacity, will be installed early next year.

The 400-kw. engine-driven unit, with two 200-kw. converters, was purchased some years ago. These converters, with one additional, will be installed at No. 38 mine, and also supply No. 39. At No. 33 mine and also to supply the front end of No. 34 will be located two 150-kw., belted-type, 550-volt generators, formerly used at No. 30, now to be direct driven by 225-h.p., 6,600-volt synchronous motors at 500 rev. per min. In this sub-station will also be installed one 1,800-cu. ft., 2-stage air compressor, direct-driven by one 300-h.p., 6,600-volt, synchronous motor at 187 rev. per min. In a substation at the back end of No. 34 mine, also supplying No. 31 mine, will be located one 300-kw. converter and two direct-driven 1,800-cu. ft., 2-stage compressors.

At No. 41 mine electric puncher machines are supplied with 250-volt current from a 100-kw. generator driven by a 150-h.p. 440-volt induction motor at 750 rev. per min.

At No. 42 mine two 300-kw., 550-volt converters are installed, to operate locomotives in two drifts, one in each vein of coal, and also to feed into the back end of No. 36.

At No. 35 shaft, 2 miles back from the pit mouth, is located a large fan to ventilate No. 35 and parts of No. 36 and No. 40. This fan will be driven by a 400-h.p., variable-speed, 6,600-volt motor, direct-connected through flexible coupling, to operate at 200 to 285 rev. per min. A sub-station here contains two 300-kw. converters, with space reserved for one more, also six 150-kw. transformers, with a 6,600–440-volt ratio supplying two large pumps at the shaft bottom. A drainage level was located across mines Nos. 37, 40, 35, 36 and 42, all the water above which will flow by gravity to this shaft. Here will be placed two two-stage turbine pumps, each of 4,000-gal. capacity per minute against a 330-ft. head, and each will be driven by a 500-h.p., 440-volt induction motor at 730 rev. per min. These pumps will replace over 70 compressed air and steam pumps.

A sub-station will be located at the rear end of No. 37 mine, and contain one 300-kw. converter, and, later, one motor-driven compressor. This converter will work in parallel with No. 40 direct-current plant, supplying the outside haulage, etc.

An induction motor has been designed for the electric coal puncher, or "pneumelectric" machine, and it is expected, if this proves a success, to replace the compressed air punchers wherever found practicable. On account of the large investment in machines, pipe, etc., some mines will still be operated by air, as Nos. 33, 34, 31, 37 and 40, and wherever necessary for best economy, motor-driven compressors will be located near the work, displacing steam-driven machines.

The output of these mines is normally about 18,000 tons per day. The cost per ton has been slowly but steadily increasing from year to year, as the mines advanced, and transmission lines and water lines lengthened. It is expected to increase this output as desired to over 20,000 tons per day, and to reduce the cost at least 3d. per ton. This cost should then increase but very slightly for probably the next 5 or 10 years.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

"If thou hast knowledge, let others light their candle at it."

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should be *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

Question No. 1,194.—A mining fan ventilating the colliery workings is driven by two 150 kw. 500 volt motors directly coupled at each end of the fan shaft. Each motor was originally large enough to drive the fan by itself, but owing to the distance of the workings one motor has to be coupled in. Please give the method of determining the efficiency of the motors, fan, and the combined efficiency, water-gauge to register 3 ins., and the best method of making the test.

Answer to Question No. 1194 (*awarded* 10s.).—It would appear, from the nature of the problem, that Double Cross has become alarmed because on coupling in the second motor the plant takes considerably more current than with one motor only, although its output is not much greater, and that he wishes to check the efficiencies of the items separately.

It is not difficult to advise him how to ascertain the combined overall efficiency, but, in the absence of information as to the type of motors used and the length of time for which he can stop the fan at week-ends, it is not easy to advise him how to proceed with his motor tests, and until he has done so he cannot well get a separate test of the fan only.

The output of the motors is given in kilowatts, which, at first sight, would lead one to think that they are continuous-current machines, but, for these outputs, it is more likely that they are alternating current machines (either two-phase or more, probably three-phase), and the tests for motor efficiencies would be different in the three cases.

Since a mine fan runs continuously, except perhaps for a few hours on Sunday, it is not likely that Double Cross will be able to dismantle the two motors in the short time allowable, and to couple them together for the Hopkinson or equivalent tests and to have them back in position sufficiently quickly to avoid delay in re-starting the pit, and it is probable that the test curves of the motors will have been already supplied, or that he can get them by applying to the makers.

It would seem a pity to go to a lot of expense to take tests before communicating with the makers, since the test-bed figures are likely to be far more accurate than any he can take or cite, and, in any case, if he can get them, they will be a check on his own figures.

Moreover, if Double Cross will ascertain the efficiency of, say, half-a-dozen similar motors by different makers he will find so little variation between them that, by striking an average, he will arrive at a figure more likely to be accurate than his own tests.

Assuming, however, that he wishes to have his own figures, the best thing he can do is to arrange for a brake test of one of the machines by rigging up an absorbtion dynamometer close by and in such a position that the motor can be quickly lifted from its bed, coupled to the dynamometer, and replaced quickly when the test is over.

The efficiency will probably have to be ascertained at about 60% to 70% of the full load, since the power required by the fan is rather more than one machine can do alone.

The load will, therefore, be about 130 b.h.p., and water cooling of the dynamometer should be arranged for. The simplest form of dynamometer is that shown in Fig. 1, where—

L = length of lever in feet.
W = weight in lbs.
N = number of revolutions per minute.
The b.h.p. = ·0001904 N L W (Molesworth).
The weight of the lever and scale must be counterbalanced.

The above gives the output of the motor, and simultaneously the electrical input must be taken by a wattmeter or the equivalent. The type of wattmeter and its connections will depend on the winding of the motor, but Double Cross will find numerous diagrams of connections, suitable for all sorts of conditions, in the various test books.

The efficiency of the motor should be taken with the ammeter reading the same value as when the machine is driving the fan, so that it is ascertained as the normal output.

The efficiency then is :—
Output of motor in b.h.p.
Input of motor in watts ÷ 746.

Failing a wattmeter, Double Cross can get his input from the product of ampére by volts if the plant is continuous current or, if alternating current, he will also need a power factor indicator.

Then input two-phase =
Amps per phase × 2 × volts × power factor.
And input three-phase =
Amps per phase × volts × 1·732 × power factor.

The above inputs are in watts and $\frac{\text{watts}}{746}$ = h.p.

Double Cross must take care that his instruments are accurate.

Having ascertained the motor efficiency, the next step is to find the overall efficiency, *i.e.*, the relation between the air circulated and the electrical input.

Now there is only one set of conditions that will give a fixed quantity of air at a certain water-gauge, and apparently new workings have been opened out, thus reducing the frictional resistance of the air passages in the mine, and the increased quantity of air delivered has overloaded the first machine and necessitated coupling up the second as well.

Incidentally, it is worth noting here two causes for the current required by two machines being much greater than that required by one alone, although the output is not much greater.

(a) The power required by a fan varies as the cube of the speed, and as the load on each of the two machines will only be, say, 60% of that developed when one only was driving the fan, the speed of the motor will have increased somewhat at the reduced load, and the fan will thus require more power to drive it.

(b) The efficiencies of the motors will be less at 60% of full load than at full load or a little over, and there will be a slight further increase of input from this cause.

Also, if the machines are a/c machines, the power factor will also be less at 60% of full load, and the apparent watts will be greater.

It is very probable that this last effect is that which is giving Double Cross anxiety, but he should note that it is the "apparent" watts that are increased, and that it does not necessarily mean that the "real" power has increased except in so far as this is due to the causes set out in (a) and the first part of (b), and he can check this by taking wattmeter readings under the two conditions.

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To ascertain the output of the fan it is necessary to measure the volume of air passing and its pressure just before it enters the fan inlet, and for these tests he will require an anemometer and a water gauge. The former is, in itself, a small fan fitted with a revolution counter, and it is marked by the makers, or is given a constant, stating the volume of air that has passed through it corresponding to the revolutions it has made. Anemometers by different makers vary slightly in their means of registering, but Double Cross will find on his instrument, or with it, the relation between its readings and the volume of air that has produced the reading.

It is not advisable to use this instrument immediately in front of the fan, since there is frequently considerable swirling of the air here, and in some portions of the drift he may even get his anemometer to reverse; on the other hand, if the fan drift is a long one, there may be considerable air leakage through the brickwork, and a reading taken some distance from the fan may not show the total volume of air it is passing.

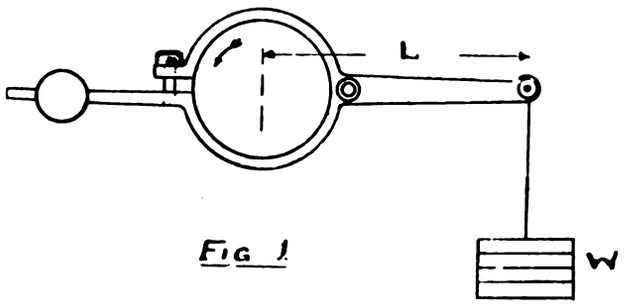


FIG 1

Fig. 2 shows a method of taking the anemometer reading which Double Cross must modify if necessary to suit his conditions; he should take a number of readings from several points, in each case standing in a manhole so as not to obstruct the air, and having the anemometer mounted on a long stick, by which he moves it slowly over the whole area of the air passage, and thus gets an average over the drift passage. The reason for this is that the friction between the air and the sides, roof and bottom causes the air to be passing most rapidly at the centre, and if he were to take a reading at the centre only it would show a greater volume than is actually passing.

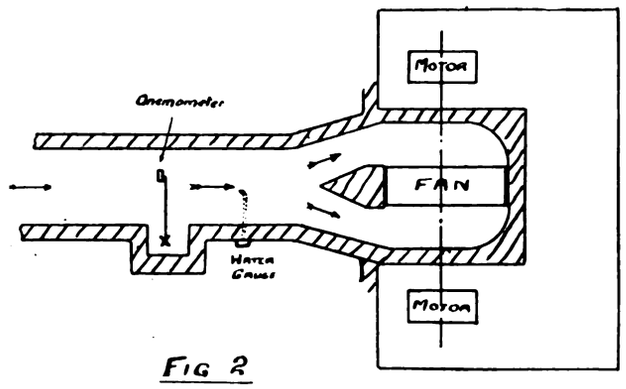


FIG 2

At the same time the pressure of the air must be measured by a water-gauge, which is simply a U-shaped glass tube connected by a pipe into the drift and, in this case also, several readings should be taken with the pipe end at various parts of the drift so as to get the mean pressure. A simple water-gauge is shown in Fig. 3.

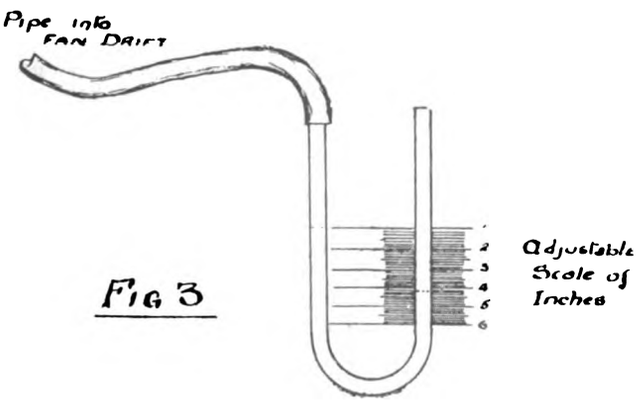


FIG 3

Then W.G. in inches × 5·2 = pressure in lbs. per sq. foot.

And h.p. in air =

$$\frac{\text{Volume in c. ft. passed per min.} \times \text{W.G.} \times 5{\cdot}2}{33000}$$

And combined efficiency per cent. of set. E =

$$\frac{\text{H.P. in air} \times 100}{\text{Watts input} \div 746}$$

And having ascertained the efficiency of the motors (either from a separate test or from the efficiency curve supplied by the makers from their own test bed), the efficiency of the fan will be :—

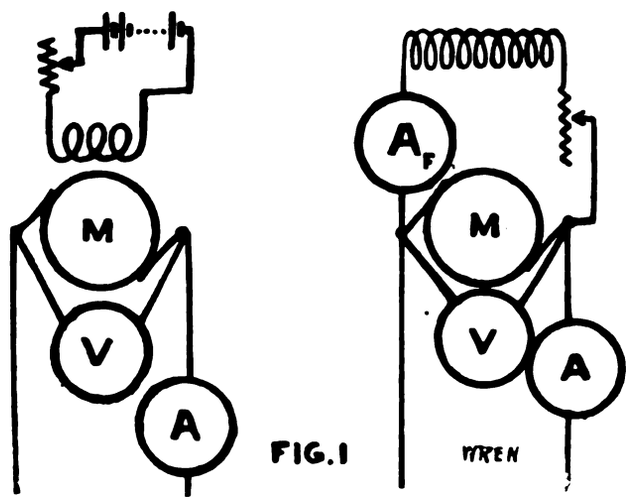
$$\frac{\text{Combined efficiency.}}{\text{Motor efficiency at power required by fan.}}$$

—WIGWAM.

Answer to Question No. 1194 (*awarded* 5s.).—The best means of determining the required three efficiencies is to determine the motor efficiency and the efficiency of the complete plant under running conditions; then taking the fan efficiency to be

$$F = \frac{C}{M} \text{ where } \begin{cases} C = \text{efficiency of whole plant.} \\ M = \text{efficiency of motors.} \\ F = \text{efficiency of fan.} \end{cases}$$

The motor efficiencies may be assumed to be equal, since the machines are similar, and to determine their value one motor must be uncoupled from the fan and the current taken by the machine running light under normal conditions as to voltage, speed and field, measured. If the motor be series wound, as it probably is in this service, this test will involve separately exciting the field by cells, or through resistance from the mains, the field current flowing being equal to the normal full load current of the machine. Separate excitation is, of course, necessary in such a case to prevent the motor racing. Shunt wound motors do not require such precautions when running light; the connections in the two cases are as shown in Fig 1. The "light losses" of the motor = A V where A =



current, in ampéres, supplied to the armature and V = terminal volts of motor. To obtain the true light losses, the A^2R losses in the armature should be subtracted, but in the case assumed below these would only amount to $\frac{6 \times 6}{30} = 1{\cdot}2$ watts—a negligible total. As the load on the motor increases, the light losses actually increase somewhat by reason of the higher hysteresis and eddy current losses, and if desired, 10% can be added to the value of the losses, as mentioned above, to allow for this fact at full load. In many cases the light losses are assumed to be constant, the errors arising from such an assumption not being important in this case.

The field and armature resistances are next measured by the ordinary voltmeter and ammeter method, or by a portable P.O. bridge as most convenient. Assuming, then, a number of values of the armature current between the

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ranges occurring in practice, the motor efficiency corresponding to each is determined thus :—

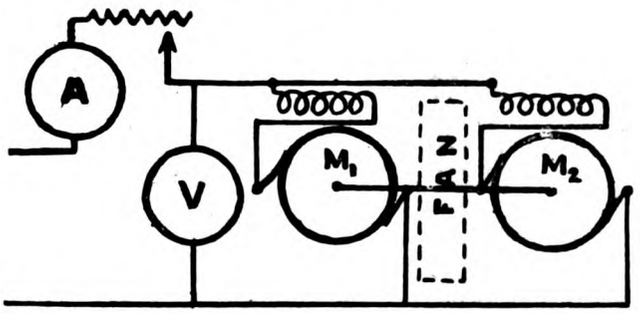


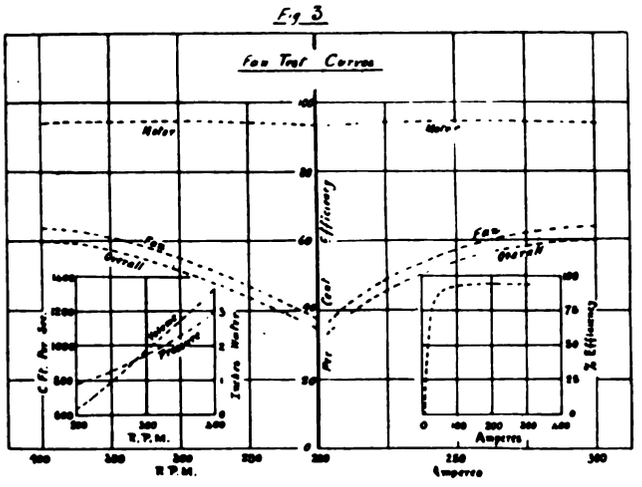
FIG. 2

Suppose the maximum and minimum armature currents are 300 and 6 ampéres respectively, and that the light losses are 3,000 watts, the light current being 6 amps. when terminal p.d. of motor = 500 volts, also that the machine is series wound and Σ armature and field resistances = R = $\frac{1}{15}$ ohm.—then

For motor currents C. amps	C^2R_T	Total losses Watts.	Input Watts.	Output Watts.	Efficiency per cent.
6	2·4	3,000	3,000	nil.	nil.
10	6·7	3,007	5,000	1,993	39·8
30	60	3,060	15,000	11,940	79·5
70	327	3,327	35,000	31,673	90·8
100	670	3,670	50,000	46,330	92·7
140	1,310	4,310	70,000	65,690	93·8
180	2,150	5,150	90,000	84,850	94·3
220	3,220	6,220	110,000	103,780	94·3
260	4,500	7,500	130,000	122,500	94·4
300	6,000	9,000	150,000	141,000	94·0
350	8,180	11,180	175,000	163,820	93·6

From the connections given and the particular example above (assuming data approximately the same as would be obtained in this case), no difficulty will be experienced in obtaining the load-efficiency curve of the motor alone (see Fig. 3). The results obtained will be slightly higher than would be found by a Hopkinson or brake test, owing to the assumption of constant light losses already explained.

Fig 3.



If the motor be shunt wound, the C^2R loss above will = $(C_A^2 R_A + C_F^2 R_F)$ watts (suffix A refers to the armature winding, and suffix F to to the field).

Efficiency of Combined Plant.—The motors being again coupled to the fan, the current input and the terminal volts are measured at various fan speeds, the speed variations being obtained by resistance in series with the motors in the case of series machines, or by varying the field resistance in the case of shunt machines. The motor speed is taken in each set of readings by an ordinary revolution counter and seconds-hand watch, and the air delivery is measured by an anemometer suspended in the delivery air tunnel at a considerable distance from the fan chamber so as to allow all eddy currents to settle down and a steady air stream to be formed. The anemometer will measure the velocity of the air if the difference in readings of its recording gear over a known length of time be noted. Frequently the anemometer scale is merely marked into equal divisions, which may, in such a case, be calibrated by carrying the anemometer over a measured or paced-out distance of, say, 100-200 ft. in as still air as possible—preferably under cover.

The velocity of air so measured × area of air-tunnel equals volume of air delivered very nearly, though a co-efficient, less than unity, should actually be introduced to allow for the skin effect of the tunnel walls. The latter correction becomes more necessary the smaller the area of passage and the rougher the walls. The pressure at which air is being delivered is measured by a water manometer of the U tube pattern, connected between the fan delivery and the open air with as short connecting tubes as possible, all leakage in these being avoided. The fan diameter over the blade tips being measured, all the data required is obtained, and is made use of as follows :—

If Q = c. ft. air delivered per sec. = V A where V = velocity air ft. per sec. and A = effective area of air-way,

and H = pressure of air delivery in inches of water,
and H^1 = h.p. output of fan, and H = h.p. in ft.,
then H^1 = 0·030 q.h. and efficiency of fan = $\frac{H^1}{H}$

As illustrating the data to be observed and the method of using it, the following table may be studied; this assumes that one motor will still deal with the load, but the procedure is identical, assuming two to be necessary, except that each motor will take half the total observed current, and the efficiency will therefore be slightly different, but is at once read off from the efficiency curve already obtained; also the maximum load dealt with will be higher than quoted in the table.

Terminal volts.	Amperes Input	Speed R.P.M.	Gauge Ins. Water.	Veloc. ft. per sec.	Deliv. c. ft. per sec.	Output H.P.	Input H.P.	% Overall Efficiency.	Motor Efficiency.	% Fan Efficiency
175	203	200	0·88	12·8	640	16·9	47·8	35·4 %	93·8	37·7
235	218	250	1·26	16·0	800	30·2	69·0	43·8	94·0	46·6
310	244	300	1·77	19·6	980	52·0	101·0	51·5	94·5	54·5
393	264	350	2·33	23·0	1150	80·5	139·0	58·0	94·4	61·4
500	300	400	3·00	26·6	1330	120·0	200·0	60·0	94·0	64·0
Observed.					Calculated.					

Area of air way equals 50 sq. ft. in above case.

From the above example, the results of which are plotted in Fig. 3, and the earlier example and illustrations the writer thinks no difficulty will be found in conducting the proposed tests.—"WREN."

WATER TURBINES.

Messrs. Jens Orten-Böving & Co. have secured an order for two water turbines for the Calgary Electric Power Co., Calgary, Canada, each to have an output of 3,750 h.p. The consulting engineers were Messrs. Smith, Kerry, and Chace, of Toronto, Winnipeg. The same firm have also received an order for two centrifugal pumps to be manufactured to their designs by Messrs. Willans and Robinson (Limited), to deliver 200 gallons per minute against a head of 535 ft. at 1,440 r.p.m. The main contractors for the work are the British Westinghouse Electric Manufacturing Co., Ltd., the consulting engineers being Messrs. Rendel and Robertson.

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COMPANIES' MEETINGS AND REPORTS.

BAKER STREET AND WATERLOO RAILWAY.

The half-yearly general meeting of the Baker-street and Waterloo Railway Co. was held at Hamilton House, Victoria Embankment, E.C., Sir George S. Gibb presiding. In moving the adoption of the report, he said the accounts showed a considerable improvement in all the main features to which one looked in studying railway accounts. Their receipts had gone up and their expenses had gone down, and they were able to double the small dividend which was declared on the first half of 1908. The capital account was not now of much interest. It showed a capital expenditure of £71,880, but that merely represented the balances due to the contractors. They had carried 14,300,000 passengers, which was an increase of nearly 11% on the corresponding half of 1908. The increase had mainly occurred in through passengers. Through passengers for the June half of 1908 were 36¼% of the total, and they were now 40¼%. Through traffic did not yield quite so much money as the local traffic, as they had to divide the receipts with the other companies concerned, but that increase of through traffic was due to the co-operation of all the companies and their efforts in establishing the habit of underground travelling, and they looked for a considerable advantage from that in the future. The average payment given by through passengers for through journeys came to 2·8d. Their share of that came to 1·3d., and their average of local traffic, including workmen, was 1·54d., while the average of their total traffic—local and through together, including workmen was 1·46d. Their principal exchange was with the Piccadilly Tube. They exchanged with that tube nearly 1¾ million passengers. Next came the Central London with 1¼ million passengers, the Metropolitan with just over one million, and the City and South London with just under one million. The gross revenue was £91,510, showing an increase of £7,981, or 9·56%. The working expenses, notwithstanding an increase of car mileage, showed a decrease of £3,228. Of that sum £2,100 occurred under the head of train working, and was largely due to a decrease in the price of electric current, which was due again to a decrease in the price of coal. They had put to reserve the sum of £4,000, the directors having considered that the time had come when they should establish a fund for contingencies and renewals. After that reserve there remained a balance of £18,304, out of which the directors were recommending the Preference dividend of 4% in full, a dividend of 1½% on the Ordinary shares, and an additional dividend of 1½% on the shares held by shareholders other than the Underground Co., that company having consented to waive their claim to a dividend. That left the sum of £3,105 to be carried forward to the next half-year. The total working expenses worked out at an average of ·71d. per passenger—an exceedingly low figure. It was interesting to consider that figure as showing that the large number of passengers which they carried at fares of 1d. and 1½d. made some slight contribution to their funds. Shareholders were aware that the directors were empowered to extend the railway from Edgware-road to Paddington. That line was originally authorised in 1900, and was included in the construction contract of the Underground Co. Subsequently the plans were altered. The original scheme was to have a terminus in Bishop's-road; then it was altered that the terminus should be at Praed-street, the line curving sharply to the south. There was an idea that the Bakerloo Co. should be debarred from extending the line beyond Paddington. He thought it unwise and unfair that, in the interests of the company and the public, a permanent physical barrier should be placed in the way for future extension beyond Paddington. The idea that the great terminus trunk railways yielded large traffics to a line like theirs was quite a mistake. As a matter of fact, the large railway termini did not give large figures in the way of earning money in that respect. It was much better to have a populous and well-built district around the railway. The directors had considered the subject very carefully, and they had no hesitation in recommending the abandonment of the existing powers for the Paddington extension. The report referred to the North-West London Railway. That railway had an authorised line through Victoria to Cricklewood, and they had come, he believed, to the conclusion that that piece of line from Edgware-road to Victoria would not pay. He thought that that conclusion was a very wise one, for he did not see how a line at that point could possibly pay. The promoters approached them with a statement that they wished to abandon the piece of line from Edgware-road to Victoria and to construct a line from Edgware-road to Brondesbury. It was also agreed that the Edgware-road and Baker-street Co. would work that piece of line as a continuous line. The details were most carefully worked out, and a working agreement was settled upon. They were to have nothing to do with the construction of the line, but were to give an annual contribution out of their share of through receipts of the line, which was to be worked as an extension of the Bakerloo Railway. The financial result would have shown a profit or payment to the Bakerloo Co. of about £25,000 or £30,000 a year. That line would, he thought, have been a valuable feeder. The promoters went to Parliament, but their Bill was considered by the Chairman of the House of Commons Committee, and it was rejected. He did not suppose that this would be the end of the matter, for it was clear that there was a very active desire on the part of the inhabitants in that district that the Baker-street line should be extended to them. If the Bill was again promoted they would welcome it, and would be prepared to arrange a similar working agreement. The London County Council were considering the promotion of a tramway down the Edgware-road. Whether they would go before Parliament, or whether it would pass through Parliament, nobody could tell. Some years ago there was a similar proposal, but it met with very great opposition from the frontagers, and was rejected. In any case, so far as their company was concerned their right policy was to keep themselves quite free for any event as regarded development that might occur in the future.

The report was unanimously adopted.

GREAT NORTHERN PICCADILLY RAILWAY.

The ordinary half-yearly general meeting of the Great Northern Piccadilly and Brompton Railway Co. was held at Hamilton House, Victoria Embankment, E.C. Sir George S. Gibb presided, and, in moving the adoption of the report, said that with regard to the capital account, the issue of the share capital to the contractors was now complete. Debenture stock to the extent of £75,000 was issued to the contractors during the past half-year, and there remained a balance of £227,000, the bulk of which would remain unissued. The number of passengers carried was 19,155,883, an increase of 1,709,000, or 9·8%. The increase during the last two years had amounted to the very handsome percentage of 60½%. Local traffic accounted for 68¾% of the total, and the increase in that particular branch was about 2½%, while the through traffic amounted to 31¼% of the total, and the increase in that branch was 30½%, thereby showing a very good growth on the through traffic. The gross revenue was £157,993—an increase of £10,229, or 6·9%. A decrease of £1,578 was to be seen in the working expenses. They had been running an increased number of trains and a decreased number of cars. They were now running a very full service, and it was working with the greatest regularity and success. The net revenue balance was £84,588, out of which the directors had decided to set aside £6,000 as reserve for contingencies and renewals, leaving a balance available for dividend of £40,732. It was proposed to pay 4% on the Preference shares, 1% on the Ordinary shares, and to carry forward £8,532. A great deal of new and useful experience had been gained in the working of the railway. It was very satisfactory to note the increase of those passengers who paid larger fares, if he might use the words, in connection with a tube railway. They carried 3½ millions local passengers at 3d. during the past half-year, and the increase in that branch of their traffic was 12%. The number of passenger swho travelled paying 2d. showed only 1·9% increase, so that they had a very great increase in the traffic carried by the larger fares. They also found that they got a substantial number of longer distance passengers which they had carried 2½ miles for 1½d. This was nearly 24% of their local traffic—excluding workmen, of course. No doubt these fares were too low. They had lately taken out a statement showing the average distances that their passengers travelled. That statement was a week's account of a week's traffic, and it went to show that those passengers who travelled and paid 1d. per fare travelled, on the average, ·85 of a mile. Passengers who paid 1½d. fare went 1·27 miles, so that the rate per mile paid by those passengers was 1·17 and 1·18 respectively. Taking the whole of their traffic, local and through, together the average distance travelled was 2·9 miles, and this was on a railway nine miles long. The average receipts from through passengers, taking the whole of the journey, was about 2·98d. Of course, some of this had to be divided between the various companies, so that their share was about 1·66d. The average receipt for the whole of their traffic was 1·89d.

The report was unanimously adopted.

CHARING CROSS, EUSTON AND HAMPSTEAD.

The ordinary half-yearly general meeting of the Charing Cross Euston and Hampstead Railway Co. was held at Hamilton House, Victoria Embankment, E.C. Sir George S. Gibb presiding. In moving the adoption of the report, he said that the capital expenditure during the past half-year had been £145,799, consisting of an issue of share capital to the contractors, which issue was now complete. As regarded the Debenture stock, £389,000 had been issued to the contractors during the past half-year, and the balance remaining to be issued was £172,000. The gross revenue amounted to £105,182, an increase of £16,299, or 18·3%, which he thought was the largest percentage of increase shown in any London traffic carrying company. The prospects for the future on the Hampstead line seemed to be very good, building was going on at a very rapid rate out at Golder's Green, and they anticipated a very large increase in houses and population in that district. Working expenses amounted to £57,795, an increase of £1,302, while the train mileage run had been 28% more than in the corresponding half-year, and the car mileage 17% more. The directors had set aside out of revenue the sum of £3,000 to a fund for contingencies and renewals, and the balance available for distribution was £18,813. Out of this the diretors recom-

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mended a dividend of ¾% on the Ordinary shares, carrying forward a balance of £2,950. The traffic carried during the half-year consisted of 14,862,882 passengers, and the average receipts per passenger amounted to 1·63d. This had been divided thus—As regards through traffic 26·87%, and as to local traffic 73·13%.

The report was unanimously adopted.

NORTH METROPOLITAN TRAMWAYS.

Mr. George Richardson presided over the half-yearly meeting of the North Metropolitan Tramway Co. at the Electrical Federation offices, Kingsway, and in submitting the directors' report, he said that the gross revenue for the period amounted to £752 7s. 10d., and the total expenditure was £451 6s. 3d. The balance of £301 1s. 7d., together with £2,101 5s. 4d. from the last account, made up the sum of £2,402 6s. 11d., which was carried forward to the next account. The position of the company was exactly the same as in February last. There was a possibility that in their next half-year's report they might have something to recommend. They were trying to sell their assets, for only when these were sold would they be able to wind up. The two depôts in the Romford-road and Jedburgh-road remained unsold, and the London County Council did not exercise their option to terminate the lease of the Leytonstone car works in June last. The accounts were passed unanimously.

TYNESIDE TRAMWAYS CO.

Dr. J. T. Merz presided over the half-yearly meeting of the Tyneside Tramways and Tramroads Co. at Newcastle. The accounts showed a surplus of £3,746, and £643 was brought forward. After deducting £1,142 for interest on debentures, etc., £3,246 remained, and a dividend on the Ordinary Shares of 1 per cent. was declared, £900 being reserved for renewals, £330 applied in reduction of formation expenses, and £773 carried forward. The chairman said he doubted whether there was really very much more work doing on the river than there was a year ago. The company were reaping some benefit from the stoppage of the ferries. The miles run were 338,790, against 332,100 in the corresponding period of last year. The increase was almost entirely due to workmen traffic. The number of passengers carried was 147,676 more. The receipts per car mile were 8·26d., against 7·89d., and the expenses 5·84d., against 5·79d.

ELECTRIC SUPPLY OF VICTORIA.

The accounts of the Electric Supply Co. of Victoria, Ltd., for the year ended March 31, 1909, show, after payment of Debenture and other interest, a credit balance of £7,760, to which has to be added the £8,582 brought forward, making a total of £16,342. From this amount has been deducted £7,800 for the Preference dividend to March 31, 1908, and £3,962 for Debenture stock redemption account, leaving £4,581. The dividend on the Preference shares due March 31, 1909, would amount to £8,250.

NORTHAMPTON ELECTRIC LIGHT AND POWER.

The directors of the Northampton Electric Light and Power Co., Ltd., have declared an interim dividend of 4½% per annum (5 2-5d. per share), less income-tax, on the "B" Ordinary shares for the past half-year.

CHLORIDE ELECTRICAL STORAGE.

The directors of the Chloride Electrical Storage Co., Ltd. recommend a dividend for the past year of 10%, placing £5,000 to reserve, and carrying £14,200 forward.

COMPANIES REGISTERED.

CHIPPENHAM ELECTRIC SUPPLY CO., LTD.—Registered July 19 Capital £5,000, in £1 shares (2,500 five per cent. Preference) Objects: To adopt an agreement with the Chippenham Corporation, and to carry on in Chippenham and elsewhere in Wiltshire the business of suppliers of electric light, electricians, engineers, etc. Private company.

BRITISH RADIO TELEGRAPH AND TELEPHONE CO., LTD.—Registered July 13. Capital £15,000, in £1 shares. Objects: To adopt an agreement with J. G. Balsillie and to carry on the business of manufacturers of and dealers in radio telegraphic and telephonic instruments and installations, electrical and general engineers, etc. Private company.

BARBADOS ELECTRIC SUPPLY CORPORATION, LTD.—Registered July 30 by Linklater & Co., 2, Bond-court, Walbrook, E.C. Capital £60,000, in £1 shares (40,000 seven per cent. Preferred and Participating). Objects: To adopt agreements with the Anglo-American Debenture Corporation, Ltd., and to carry on the business of electricians, mechanical engineers, suppliers of electrical, water and other power, manufacturers of and dealers in apparatus used in connection with the generation, supply, utilisation and distribution of electricity, etc. Minimum cash subscription, 10% of the share capital offered. The first directors (to number not less than two nor more than seven) are Colonel W. F. Leese, 23, Powis-square, W., and G. H. J. Hooghwinkel, 41, Chepstow-villas, Bayswater, W. So long as the Anglo-American Debenture Corporation, Ltd., hold 5,000 fully paid Ordinary shares they may nominate two directors. Remuneration, £100 each per annum (Chairman £150). Registered office, 24, Martin's-lane, E.C.

CAVERSHAM MOTOR CO., LTD.—Registered July 12. Capital £1,000, in £1 shares (950 Preference). Objects: To carry on the business of electrical engineers, manufacturers of and dealers in motor carriages and other mechanically propelled vehicles, etc. Minimum cash subscription, 60 Preference and all Ordinary shares. Registered without articles of association.

TRACTION SUPPLIES CO., LTD.—Registered July 28. Capital £5,000, in £1 shares. Objects: To carry on the business of electricians, electrical engineers, manufacturers of and dealers in fittings and accessories used in connection with electric traction, lighting or heating, etc., and to adopt an agreement with W. C. Thompson, W. M. Scott and A. White. Private company. Registered office, Gill Bridge-avenue, Sunderland.

LIGHTING, LTD.—Registered July 21. Capital £1,000, in £1 shares. Objects: To carry on the business of manufacturers of and dealers in lamps, burners, parts and apparatus for lighting and other purposes, electricians engineers, etc. Private company Table "A" mainly applies. Registered office, 25, King-street West, Manchester.

PAYNE & SONS (OTLEY), LTD.—Registered August 7 by Blundell Gordon & Co., 16, Sergeants'-inn, E.C. Capital £70,000, in £1 shares (20,000 seven per cent. Cumulative Preference). Objects: To carry on the business of printers' and general engineers, iron founders, manufacturers of printing, electrical, agricultural and other machinery, motor-car and cycle manufacturers, etc. Private company. The first directors (to number not less than three nor more than six) are F. Payne (permanent, special qualification 5,000 shares), C. Payne, S. Payne, H. Payne and W. A. Payne. Qualification of ordinary directors, £500 shares. Remuneration as fixed by the company. Registered office, Atlas Works, Otley, Yorks.

DYNAMIC ELECTRICAL CO.—August 6. £100,000 (£1). To acquire all or any of the undertakings, businesses, properties, and assets of the Dynamic Syndicate, Ltd., the Dynamic (French) Syndicate, Ltd., and the Mitcham Electric Fan Co., Ltd., to adopt agreements with the said companies and the liquidators thereof, and to carry on the business of electricians, engineers, makers and manufacturers of and dealers in electric and other motors, fans, dynamos, etc. First directors (not less than three nor more than nine), C. Simpson, T. H. Weguelin and B. H. Weguelin. Qualification of first directors one share; of other directors £100. £200 each per annum (except managing director), free of income-tax (chairman £250).

E. M. REDFERN, LTD.—Registered July 5. Capital £2,000, in £1 shares. Objects: To adopt an agreement with E. M. Redfern and to carry on the business of electricians, electrical engineers, etc. Private company. Regisstered office, 9, Ethel-street, Birmingham.

COVERWELL, LTD.—Registered July 23. Capital £3,000, in £1 shares (2,000 Preference). Objects: To adopt an agreement with H. V. Cornwell for the acquisition of the business carried on by him at 21, Church-lane, Battersea, and to carry on the business of manufacturers of the non-conducting material known as Coverwell. Private company. Registered office, 21, Church-lane, Battersea.

FILAMENTS, LTD.—Registered July 19. Capital £500, in £1 shares. Objects: To adopt an agreement with J. W. H. Reynolds for a secret process for the manufacture of metal filaments for electric lamps, and to carry on the business of manufacturers of and dealers in metal filaments for electric lamps and apparatus used in connection therewith, etc. Private company. Registered office, 6, Newcastle-street, E.C.

UNION OTTOMANE, SOCIÉTÉ POUR ENTREPRISES ELECTRIQUES EN ORIENT.—Registered July I. Capital 12,000,000 fr., in shares of 500 fr., of which half is paid up. Object: To undertake all business directly or indirectly connected with the electrical industry in the East. The promoting syndicate is headed by the Deutsche Bank, and includes, among others, the following firms:—The Société Générale de Paris, Banque de Paris et des Pays-Bas, Banque Impériale ottomane, Paris; Josse Allard, Brussels; Continentale Gesellschaft für elektrische Unternehmungen, Nürnberg; Commerz and Diskontobank, Hamburg; Elektrische Licht und Kraftanlagen A.-G., Mitteldeutsche Kreditbank, Berlin; Wiener Bankverein, Vienna; Société suisse pour l'industrie électrique, Bâle; Banque pour entreprises électriques and the Société de crédit suisse, Zurich. The offices of the new company are in those of the last-named establishment, at Zurich.

GEARY, ADAMS, AND COMPANY, LTD.—Registered August 9th, by Alfred H. Atkins, Limited, 27-8, Fetter Lane, E.C. Capital, £3,000, in £1 shares. Objects: To adopt an agreement with F. C. Geary, and to carry on the business of electrical, electrical installation and general engineers and agents, etc. Private company. The first directors (to number not less than two nor more than five) are: F. C. Geary and G. W. M. Adams (all permanent; no qualification required). Remuneration, as fixed by the company.

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LIENS REGISTERED.

NORTH METROPOLITAN ELECTRICAL POWER DISTRIBUTION CO., LTD.—Particulars of £20,000 Debentures created June 17, 1909, filed pursuant to section 93 (3) of the Companies (Consolidation) Act, 1908, the whole amount being now issued. Property charged—The company's undertaking and property, present and future, including uncalled capital. No trustees.

NEWCASTLE-ON-TYNE ELECTRIC SUPPLY CO., LTD.—Trust deed, June 30, 1909, to secure £687,500 Debenture stock (with power to increase to a sum not exceeding half the nominal amount of the fully-paid capital, if the share captial fully paid be increased beyond £1,375,000), charged on the company's electrical undertakings, subject to Acts and Provisional Orders relating thereto, certain freehold and leasehold premises, and the company's general assets, except uncalled capital. Trustees—Rt. Hon. Viscount Ridley and W. Cunliffe.

CONTRACTS OPEN.

HOME.

RHYL.—Urban District Council.—Contract No. 1, one 125-kw. Diesel oil engine set; Contract No. 2, one 50-kw. steam dynamo set. (Spec., £1 1s., E. H. Wright, Electricity Works.)

LEEK.—Theatre Co.—Electric lighting and fittings. (Part., £3 3s., Secretary, Ford-street).

DUBLIN.—Ballinasloe Lunatic Asylum.—Supply and erection of overhead cables. September 13. (Part., T.E.S., August 4).—BACHMUT.—Public electric lighting. (Part., T.E.S., July 21).

LONDON.—London County Council.—The Council invite tenders as follows:—(1) Manufacture, delivery, and laying of about 6¼ miles of 0·075 sq. in. 3-core lead-covered high-tension cables, etc.; (2) manufacture, delivery, and laying of about 46 miles of single-core lead-covered low-tension cables, telephone cables, etc.; (3) manufacture and delivery (but not erection) of 50 tramway feeder pillars; (4) laying about 16 miles of stoneware cable ducts, including the necessary manholes, repaving, etc.; (5) manufacture and delivery of 440,000 ducts of glazed stoneware for electric cables. Persons desirous of tendering can inspect the drawings and obtain the specifications, bills of quantities, forms of tender, and other particulars at the County Hall, Spring-gardens, S.W., upon payment to the cashier of the Council of the sum of £2 for each section (returnable). Full particulars obtainable at the County Hall before the payment of the fee for the specification, etc. The Council's list, rates of wages, and hours of labour will be inserted in and form part of the contract by way of schedule. Tenders not accepted from persons who have on any previous occasion withdrawn a tender unless for reasons satisfactory to the Council. Sealed and endorsed tenders, on the official form, to be sent to Mr. G. L. Gomme, Clerk of the London County Council, County Hall, Spring-gardens, S.W., by September 14.

OVERSEAS.

CAPE TOWN.—Tender Board.—Annual supply of dry cells. September 29. (Part. [L.], Commercial Intelligence Department, Board of Trade, E.C.)

TERAKOHE (New Zealand).—The Golden Bay Cement Works (Ltd.). Tenders are invited for the supply and erection at Terakohe, Golden Bay, of a complete Portland cement plant of the most modern description, electrically driven, capable of a minimum production of 400 tons of cement a week. Other things being equal, preference will be given to British manufactured engines, boilers, dynamos, motors, pumps, condensers, etc. Foreign-made machinery is generally liable to a preferential duty of 10% in excess of British-made machinery. With each tender a deposit of £250 will be required, and a deposit of £1,000 must be made by the successful tenderer. Tenders will be received at the company's offices, Nathan's-buildings, Wellington. Copies of the specification for the supply of the machinery and of the prospectus of the company may be seen by British firms interested on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C. Date, November 1.

PARIS.—Hotel de Ville.—Three electric travelling bridges, one ton capacity each. October 21.

MONTABAU (Germany).—The Kreisbauamt.—3,275 metres of cast iron water-pipes. August 27.

BREMEN.—Lighting and water offices.—A steam dynamo, 160 kw., for the central electric station. September 6.

RESULT OF TENDERS.

HOME.

BARNSTAPLE.—There were seven tenders for the electric lighting of Barum Workhouse: Pullen, Bradford, £191 10s.; Edmonds, London, £186 10s.; Harres & Co., Exeter, £141; Bristol Electricity Co., £135; Baker & Co., Newport, £130; J. Malone, Barnstaple, £122 10s.; and Rippon & Co., Exeter, £120 1s. 10d. The two lowest tenders were below the estimate, Mr. Malone's tender being accepted.

WOLVERHAMPTON COUNCIL.—The tenders of Messrs. Mobberley & Bailey, Stourbridge, £122, for supply of firebricks for lining the steel chimney at the electricity works, and of Mr. C. W. Hartley, Sheffield, amounting to £110, for supplying the labour, tools, etc., in connection with the work, were accepted. The tenders of the Electric Construction Co., Ltd., for the supplying of electric fittings, at a cost of £289, was also accepted.

BELFAST.—The tender by Messrs. Cowans, Ltd., of Salford, for feeder panels for lighting switchboards, has been accepted by the Corporation Tramways and Electricity Committee.

OVERSEAS.

DAWSON CITY (Klondyke).—The contract for the steelwork and erection of a generating station for the Northern Light, Power, and Coal Co., who are starting a large electric plant, has been secured by Messrs. John Booth & Sons, of Bolton. The order was obtained in competition with prominent American and German firms, and it appears that the scale was finally turned in favour of the British firm through the operation of the Canadian preferential tariff on British goods.

BUSINESS NOTES.

LIGHTING AND GENERAL.—Home.

ABERDEEN.—The Council have decided to expend £150 on the purchase of a stock of electrical and heating and cooking apparatus for hiring out for the depôt in Union-street.

AYR.—The number of units generated by the Electric Light Works at Ayr during the past month totalled 104,929, compared with 97,092 for the corresponding period of 1908. The units generated since April 30, 1909, were 268,285, an increase of 20,072 on the figures for the same period last year.

BARNSLEY.—A Local Government Board inquiry was held by Major J. Stewart, R.E., relative to the application by the Town Council for sanction to borrow various amounts, including for electric lighting purposes, £3,000, the bulk of which is for new mains, and £308 for the purpose of lighting with electricity the May Day Green Market. It was stated that the consumption had been reduced by the use of the new metallic lamps, but despite this the Inspector agreed that the financial results of the undertaking were very satisfactory. The net profit on outstanding capital had increased by 25·1%, and there was £3,400 in the reserve fund. In connection with the proposed lighting of the market with electricity, Mr. Barker gave edivence to the effect that it would be more economical and advantageous than the present gas and other illuminants.

BELFAST.—A sub-committee has been appointed by the Corporation Tramways and Electricity Committee to inquire into the investment and administration of the sinking fund, the depreciation fund, and any other reserve funds set aside by either the tramways or the electricity departments, and report as to whether the debit of each department is managed according to Statute, and in the most advantageous manner. The electrical engineer submitted to the Committee the summary of electrical rentals for the six months ended June 30 last, which was considered most satisfactory, the total revenue being £18,308 3s. 2d., as compared with £16,604 13s. 1d. for the corresponding six months of last year.

BOLTON.—Dealing with the proceedings of the Electricity Committee, the Council determined that, in view of the number of accidents to workmen in the service of the Corporation, those who are physically weak or defective be not employed. Councillor J. F. Steele strongly opposed the resolution, and asked the Council not to have, what he called, this disgrace on the minutes. Who, he asked, was going to judge as to who was weak and incapable? If the people did not afford the employment, the people might have to keep them through the rates, which would be a great deal worse. Councillor Tootill pointed out that the chairmen and Committees he had spoken to with regard to the resolution had given him a definite assurance that the resolution would be capable of liberal interpretation.

BRADFORD.—The route mileage for the year ended March 31, 1909, was practically the same as last year, so that the population available for tramway revenue purposes is, as far as can be ascertained, approximately the same, viz., 337,000. The car mileage run was 5,376,228, an increase of 45,221 over last year, or ·84%. The total revenue for the year from all sources was £244,235, a net increase on last year's figure of £1,086. On purely traffic receipts there was a decrease of £331, and the revenue from advertising on cars is £718 less than the amount received last year. Against this there was an increase in revenue in the Parcels Department of £1,327, in the Bowling Hill Department of £254, and in the Motor Garage Department of £540, which accounts for the net increase in receipts of £1,086. On the tramway side of the business there was a net decrease in receipts of £1,035. Undoubtedly the main factor which accounts for this decrease is the severe trade depression that has been felt throughout the country, and compared with most systems, Bradford has

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not suffered unduly from this unfortunate cause. The receipts per car mile for traffic and sundry revenue amount to 10·456d. as against 10·591d. last year. 47,660,011 passengers have been carried, as compared with 47,839,569 last year, a decrease of 179,558, or ·37%. The total expenditure, excluding interest and sinking fund, etc., is £170,196, as compared with £167,994 last year, an increase of £2,202, thus giving a net decrease in gross profit of £1,116. The increase in expenditure, apart from the Parcels Department, Motor Garage Department, etc., is comparatively slight, and amounts only to about £449. As a matter of fact, when the increased car mileage is taken into consideration the actual working expenses are slightly less than last year. The total working expenses per car mile, compared with last year, show a reduction of ·041d., or ·55%, viz., 1907-8, 7·262d.; 1908-9, 7·221d. Traffic expenses this year stand at 2·851d. per car mile, as compared with the record low figure of 2·812d. per car mile last year. The main item in this account that has increased is the wages of motormen and conductors to the extent of £627, or an increase from 1·958d. to 1·969d. per car mile. This increase is due to several causes, but mainly to the loss of mileage during the foggy weeks of October, November and December, and to the extra pay that was then given to the men for their excellent services during this trying period. The increase in power expenses from 2·045d. to 2·115d. per car mile (equal to £1,500) is, as the Committee are aware, at present under discussion between this department and the Electricity Department.

BRIGHTON.—The London, Brighton and South Coast Railway Company, having decided to abandon the existing electric lighting installation at Brighton, have contracted with the local gas company to light the entire central terminus by improved gas appliances.

COOKSTOWN.—A scheme for lighting the town by electricity is receiving the attention of the Urban Council.

DUBLIN.—The Corporation have approved of a loan of £18,650 for electric lighting purposes from the Royal Liver Friendly Society, at the rate of £3 15s. per cent. per annum, repayment to be effected within a period of 20 years.

DUNDEE.—The Lochee Electric substation, which marks the beginning of the new system of central and substations, has been satisfactorily started. It is situated in Whorterbank, and has a power of about 300 kw. The Carolina Port Station is now supplying Lochee and Grimond's Works direct.

FAILSWORTH.—To the Surveyor's Committee of the District Council the Clerk has now reported as to the information obtained from the Manchester Corporation Electricity Department with reference to the probable cost of street lighting by electricity. It was resolved: "That upon the information before them this committee cannot recommend the adoption of electricity for street lighting."

FAREHAM.—New cooling apparatus and other plant will be provided at the electric light works at an estimated cost of £182 10s.

GLASGOW.—The annual report of the Electricity Department for the year ended May 31 shows a deficit on the year's operations of £3,544 14s. 5d., as compared with a surplus of £910 9s. 8d. for the preceding year. The gross revenue amounts to £245,673 5s. 3d., and the working expenditure to £104,902 2s. 8d. The reduction in the charges for current granted last year, the introduction and extensive use of metallic filament lamps, and the general trade depression, caused a decreased income of £7,729, which, however, is more than counter-balanced by an all-round decrease in the working expenditure of £10,415. The balance on the year's ordinary working is £140,771, as compared with £138,085, which cannot be regarded otherwise than satisfactory. The deficit is due to the increased contribution to the sinking fund of £4,000, and to the increase in depreciation to the extent of £3,108 as compared with the previous year. The capital expenditure during the year appears as £168,378 8s. 11d., and the total capital expenditure at the end of the year, less depreciation written off, stands at £1,800,202 10s. 5d. The quantity of electricity sold to private consumers during the past year was 32,736,058 units, as compared with 31,087,322 units, being an increase of 5.34%. The consumers at the end of the year numbered 18,158, being an advance of 1,232. The price charged ranged from ¾d. to 8d. per unit. The total number of motors in use and supplied off the Corporation mains, as at the close of the year, was 4,292, an increase of 439, and the units consumed for power purposes during the year amounted to 17,612,483, at prices ranging from ¾d. to 1½d. per unit. For street and stair lighting 1,728,853 were used. New machinery has been erected at two of the stations; and the Hagga-road sub-station has been completed. The Kelvinside station will not be extended as a steam generating station, but will, as soon as convenient, be made a sub-station with extra high tension current delivered to it and transformed down there. In addition to the sub-stations there are six large customers whom it has been found more economical to supply through transforming plant placed in their premises. This plant is equivalent to 3,000 h.p. Ten miles of feeders and six miles of distributors have been laid on the north side of the river, and five miles of feeders and four miles of distributors have been laid on the south side of the river during the past year.

HOLSWORTHY.—The Bill to confirm a Provisional Order to Messrs. Christy, Brothers, & Co., of Chelmsford, under the Electric Lighting Acts, for power to supply the urban district with electricity, has been passed by the Select Committee on Unopposed Bills. The Bill provides that the Urban Council may, by 12 months' notice in writing, after the expiration of 25 years from the commencement of the Order, require the undertakers to sell, the price to be a sum equal to the fair market value of the undertaking purchased as a going concern. The sum is to be determined, in default of agreement, by arbitration.

ILFORD.—A surplus of £1 for the year ended March 31, 1909, as compared with a deficit of £375 last year, is shown in the annual report of the Electricity Department by the Electrical Engineer (Mr. Arthur H. Shaw). The total revenue was £28,721 against £27,637, of which the gross profit was £10,679, the latter amount being an advance of £1,008. Interest on mortgage debt, etc., absorbed £5,676, and repayment of debt £5,002. The number of consumers increased from 3,045 to 3,302.

IPSWICH.—Arrangements have been made to execute certain work for the Admiralty in connection with their telegraph station on Portman's Walk, and to afford them a supply of current for seven years. Mr. E. C. Ransome, Chairman of the Committee, said that the Admiralty would take something like 40,000 units during the year, and the price charged would be 1¾d. per unit, which would give the committee a considerable profit. The Admiralty were paying the entire cost of the surface cables, and £5 10s. a year for the upkeep of them.

LEEDS.—In the Leeds Bankruptcy Court recently, a receiving order was made on a creditor's petition, in the affairs of Herbert Shuttleworth, an electrical engineer, of Cross-court, Briggate, Leeds.

LONGTON (Staffs.)—The Council resolved to apply for Local Government Board sanction to the borrowing of £1,250 for the extension of the electricity mains.

MALDEN.—The Parliamentary and Electric Lighting Committee reported that letters had been received urging the Council to reconsider the question of the supply of electric light, and they, therefore, advised: "That in the interests of the district in the matter of electricity supply, the Council be asked to receive the report of the Parliamentary Committee, with a view to an opinion being obtained from an expert engineer for fuller consideration of the question." A lengthy debate ended in the report being negatived by nine votes to seven. Thereupon Mr. Davis and Mr. Marshall handed in their resignations as members of the Committee.

MIDDLESBOROUGH.—Local Government Board sanction to the borrowing of £18,922 for extensions of mains for public and private lighting has been received by the Town Council.

RADCLIFFE.—The Council decided that the statement of fees of Messrs. Lacey, Sillar and Leigh in connection with the Council's application for borrowing powers for Electricity Works extensions, the preparations of plan, specifications, etc., and the supervision of certain of the contracts be approved, and that the amount of £222 12s. 7d. now due thereon be paid.

RAMSBOTTOM.—Having considered correspondence and the amendments suggested in the draft deed for transfer of the Council's powers under their Electric Lighting Order to the Lancashire Electricity Power Co., the Council requested the Chairman of the Electricity Committee (Mr. Stockdale) and the Clerk to seek an interview with the Board of Trade on the matter.

RHYL.—A recommendation in favour of the expenditure of over £3,000 on the purchase of a Deisel engineer for the electricity works has been approved by the Council.

ROCHDALE.—The Council have agreed to extend the electricity cable from Sudden to Castleton at an estimated cost of £120.

STOURBRIDGE.—The Bill to confirm the Provisional Order dealing with the electric lighting of the urban district passed the Committee on Unopposed Bills at the House of Commons, and was sent for third reading. The Bill has passed through all its stages in the Lords.

WIDNES.—It was reported to the Town Council that a private firm had intimated its intention of applying for a provisional order authorising it to supply electricity in the borough, thereby bringing the newer illuminant into competition with the Corporation Gas Works, said to produce the lowest priced gas in the country. The Council resolved to obtain the advice of an electrical engineer as to a scheme prepared by its engineer, and arrangements are to be made for the securing of a site for a generating station. Mr. Clarke mentioned that it was not proposed to go in for a large scheme.

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LIGHTING AND GENERAL.—Overseas.

ARGENTINA.—The Pacific Railway Co. in Argentina is making arrangements for the electrification of its suburban lines.

BARCELONA.—An electric supply limited liability company named "La Electra de Cardona," has been established, with a capital of 250 shares of 1,000 pesetas each.

BASLE (Switzerland).—The Grosse Rat has voted a sum of 340,000 francs for the extension of the electric sub-station.

BUENOS AIRES.—The Government has resolved to establish wireless telegraph stations between Buenos Aires and Ushuaia, at a cost of $75,000 gold. The work to be finished by May, 1910.

DORDRECHT (Holland).—The Municipality has voted 7,500,000 florins for the erection of electrical works.

EAGLEHAWK (Victoria, Australia).—The borough of Eaglehawk, Victoria, Australia, has been authorised to supply electricity for lighting purposes within its borders.

OUDTSHOORN (Cape Colony).—The Oudtshoorn Electric Lighting Co. has transferred its agreement with the Town Council to the General Electric Co., of London. Lighting plant will be installed without delay.

LADYSMITH (British Columbia).—This city has given a contract for an electric light plant to the Canadian Westinghouse Co., Ltd., for a complete installation consisting of a 115 kw. 3-phase 60 cycles, 2,200 volt generator, 10 kw. each. Potts compound 12 × 18 × 14 Tivill regulator switchboards, boiler 72 × 19 C.H.R.T., pumps, rejector heater, etc., etc. Power house, foundations, pole line and transformers, street lights, etc., complete and installed. The whole will be a most complete and up-to-date plant, second to none on the Coast for its size, and will be erected under the supervision of Mr. George M. Turner, city electrical engineer.

LILLE (France).—The Société Chamonin et Cie. has been formed at 41, rue d'Angleterre for the construction of steam turbines.

MARIUPOL.—According to a report by Mr. W. S. Walton, the British Vice-Consul, the bulk of the machinery imported last year was for electrical purposes and was of Belgian, German, and French origin. This is an article in which the United Kingdom could, of course, compete, and the same may be said of tools. Files were received from the United States of America. Axes and various other tools were of German manufacture.

SYDNEY.—The establishment of a system of electric city and suburban railways on the lines proposed by the Chief Commissioner of Railways is recommended by the Royal Commission on the improvement of Sydney.

TRACTION.—Home.

ABERDEEN.—The tramway accounts for the year ended May 31, submitted to the Council, show that the revenue from passenger traffic for the year amounts to £70,325, being a decrease of £429 compared with the previous year, but other sources of revenue—carrying parcels, advertising, and rents from properties, etc.—have increased by £178. The net decrease in the total revenue for the year has, therefore, been £251. The balance of revenue, after deducting working expenses, amounts to £31,485, as compared with £33,261 last year. The charges for interest, sinking fund, and depreciation indicate a decrease of £861, and the last instalment of the Parliamentary expenses, amounting to £933, was paid off last year. The net result of the year's working is a slightly larger balance to set aside for renewals this year, £14,938, as compared with £14,920. The sum at the credit of the renewal account at present stands at £46,159. The expenditure on capital during the year totalled £1,906. The total capital expenditure of the undertaking now stands at £318,593, and the mortgage loan debt amounts to £260,853 at May 31 last. Mr. Coutts, the convener of the Tramways Committee, in detailing the accounts to the Town Council, remarked that they had had a very good year. Although they had been able to put past a very substantial sum to the revenue account, that account was not yet so high as it ought to be, because very heavy drains will be made upon it almost immediately. The proposal for the adoption of a universal penny fare over the system was agreed to by the Council. Halfpenny fares are abolished except on Union-street. On a report by the Electricity Committee, stating that Mr. W. H. Vatchell had pronounced his decree arbitral on the submission between the Council and the Aberdeen Suburban Tramways Co., in regard to the price of electrical enregy to be supplied by the Council to the company, Baillie Wilkie said that he did not commit himself in regard to this part of the minute.

DONCASTER.—The Council decided to extend the Bentley tramway route in the direction of the new colliery to a point near the proposed colliery football field, a distance of about 1,200 yds., the fare for the full journey from Doncaster being 1½d. The Colliery Co. had agreed to contribute £100 a year for two years towards the cost, and to give the Corporation facilities for laying the line. It was also resolved to construct three additional passing places on the existing route, and one passing place on the extension line. Councillor Wightman advocated the extension of the system to include other villages, and Councillor Smith said that it was intended that the line should come round some time on the old Bentley and Askern-road.

LIVERPOOL.—The Corporation tramways traffic returns for the week ended July 31 show receipts amounting to £11,113, being an increase of £30 as compared with the figures for the corresponding period of last year. The total decrease for 29 2-7th weeks appears as £3,331. The route open extends 104 miles.

MARYLEBONE.—The London County Council, it is stated, have no definite tramway projects before them with regard to Marylebone, except the proposed construction of electric tramways along Edgware-road from the Marble Arch to Cricklewood, and in Finchley-road.

PERTH.—At a meeting of the Finance Committee of the Corporation the annual accounts were submitted, showing that the loss on the tramways had increased from £1,200 to £1,500. In the next year's estimates a proposal was made to reduce the price of current for the tramways from a penny one-sixth to a penny. This was opposed by the Electricity Convener (Councillor Macnab) and Mr. John Lambert, the Tramway Manager, who said the system was not yet ripe for any reduction. After a heated discussion, the Committee agreed that it be remitted to the Town Council to fix the price. On the understanding that the price will be reduced, there will be an increase on the rates of 1½d., which will fall entirely on occupiers.

PORTSMOUTH.—The General Manager's report for the year ended March 31 shows an increase compared with the previous year of £1,708 6s. 4d. in the traffic receipts, and in the revenue received from other sources of £105 10s. 3d. The total income for the year under review stands at £101,154 9s. 11d., against £99,340 13s. 4d. for the preceding twelve months, an increase of £1,813 16s. 7d. The working expenses appear at £48,879 3s. 7d., being £864 0s. 1d. more than last year. The amount carried to net revenue account is £52,275 6s. 4d., and after allowing for capital charges, etc., there is left a balance of £13,615 3s. 2d. for appropriation, as compared with £13,132 8s. 8d. for the previous year. The traffic receipts for the year averaged 10·108d. per car mile, against 10·157d. The cost of generation at the power station was ·54328d. per unit, being ·05772 less than last year The passengers carried during the year numbered 21,247,048, being an increase of 488,565.

TRACTION.—Overseas.

ALBERTA.—The work of installing the machinery at the city power house is making good headway. A 9,000,000 gallon pump is being put in, and a large generator to supply electric power for the street car system, with engine and boiler accompaniment. The new plant is expected to give sufficient water and electric power for two years.

COBALT (Ontario).—The Toronto and North Ontario Railway has started grading for a new line from Cobalt to Haileybury to relieve the existing passenger congestion between those two points. The intention is to have an electric car system paralleling the railroad, affording a quick and frequent service. Another line, owned by private capitalists, is already in course of construction. The Government road should be in operation this year. There is a report current that the Government will transfer their divisional point from Englehart to Port Cobalt, where yard room is now being sought.

FREMANTLE (Western Australia).—It has been decided to float a loan for £25,714, to cover the cost of tramway extension and increased electric lighting plant.

HANNON (Ontario).—Muralt & Co., sub-contractors for the Hydro-Electric Power line, have commenced erecting towers.

MELBOURNE (Victoria).—In connection with the question of the electrification of suburban railway lines, it is estimated by the departmental committee that the percentage of working expenses to the revenue for the year ended June 30, 1906, in respect of regular suburban passenger services, amounted to 76·5 per cent., as shown hereunder: Estimated passenger revenue from suburban services, exclusive of race and special picnic traffic, in respect of all lines included in Mr. Merz's scheme of electrification, £572,650. Excess of estimated revenue over estimated working expenses, £134,572. Percentage of estimated working expenses to estimated revenue 76·5. The Commissioners state that on this basis only £134,572 of the net revenue from suburban traffic would be available towards the payment of interest on capital cost.

PRESSBURG (Hungary).—It is announced that the Minister of the Interior has commissioned Messrs. Ganz & Co. to construct an electric railway between Pressburg and the Austrian frontier. Hopes are entertained that the new line will be ready at the end of 1910.

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PATENTS.

Alternating Electric Current Distribution Systems.

15047.—1908. J. S. Peck, Trafford Park, Lancs. This is an improvement in electric distribution systems, in which an automatic switching device is provided, operated through a relay by variations in the current supplied to or delivered by the transformers for short circuiting the auxiliary transformer primary and secondary windings where a series system is employed, or for opening and closing the primary and secondary windings of the main transformer in the case of a parallel system. The invention provides an improved device for this system, whereby the blowing of a fuse in the auxiliary transformer circuit under light load conditions when the automatic switch is open shall cause the switch to close, and thereby transfer the load to the main transformer in order to avoid interruption in the supply of energy.

Multiple Switch Starting Devices.

3517.—1909. Cutler-Hammer Manufacturing Co., Milwaukee, U.S.A. The switches are all provided with interlocking parts, which necessitate closure in a definite sequence. This is effected by causing each switch, when closed, to hold a preceding switch closed. Hence each switch is free to open until the next succeeding switch is closed. The last switch has a retaining magnet to hold it in closed position.

Brush Holders for Dynamo Electric Machines.

13231.—1908. Allgemeine Elektricitats-Gesellschaft, Berlin. This holder comprises a fixed member and an adjustable brush-holding member angularly movable relatively to the fixed member, and a tensioning device carried by the adjustable member. By this arrangement the relative positions of the brush-holding and fixed members can be altered without altering the brush pressure nor the point of action of the tensioning device on the brush.

Dynamo Electric Machines.

11904.—1909. Siemens-Schuckert Werk, Berlin. This is an improvement in the arrangements for fixing the commutator segments in dynamo electric machines to the dynamo shaft. The contact surface of the supporting rings are shaped to conform to a portion of the surface of a sphere, the centre of which is situated in the axis of the shaft. Any sliding movement which takes place will thus have a much reduced tendency to impair the mechanical connection between the segments and the shaft, than with rings hitherto used, as the spherical segments will slide over each other in an even manner without the production of severe local pressure between the surfaces and with no tendency to grind parts of the surfaces away.

Electric Driving of Spinning Frames.

16144.—1908. J. & T. M. Greeves, Ltd., and R. V. Eves, Belfast. The motor employed may be of any kind usually used. On the motor shaft is fitted a small pinion provided with teeth to gear with an internal wheel. In place of the ordinary belt-pulley a wheel with internal teeth is mounted on the cylinder shaft. The teeth of this wheel are of the desired diameter to gear with those of the pinion on the motor shaft. The internal wheel is at one side formed solid, and at the other with a flange which extends some distance nearer the centre of the teeth. The flange holds an amount of oil, and the pinion teeth run in this, so that the drive is noiseless and without excessive wear. A sliding plate is provided, which moves on a fixed motor base plate in a direction parallel with the motor shaft. The motor slides on this plate in a direction at right angles to the shaft. This enables the motor to slide in two directions at right angles to each other for the purpose of changing the pinions on the motor shaft.

Transmission of Power from a Prime Mover to a Load.

15322.—1908. A. C. King, F. Hamer & J. King, Wood Green. This is a system for the transmission of power from a prime mover to a load through the medium of a dynamo electric element and epicyclic gearing characterised by the fact that the prime mover rotates the field magnet structure of the dynamo-electric element and the load is connected to one member of the epicyclic gearing. This member is geared to the armature part of the dynamo electric element, which is capable of rotation about its axis and about the axis of the field magnet structure. The arrangement is such that when the field magnet structure is rotated compound rotation is imparted to the armature part. The rotation of the armature part about its axis when the field magnet structure is energised is retarded more or less according to the excitation of the field magnet structure, and the power transmitted to the load is correspondingly varied.

Controlling or Braking Electrically Operated Machinery.

15268.—1908. G. W. Birkett, Cleckheaton. This system of braking is particularly applicable to electrically operated cranes, and consists in connecting up a braking mechanism to the starting rheostat of the crane in such a way that any tendency of the machinery to work at more than a predetermined speed increases the current passing through the coils of an electro-magnetically operated brake. For this purpose the electro-magnetic brake is placed in circuit with the brushes of the motor so that the E.M.F. across the brushes is communicated thereto; a second rheostat is employed to control the current in this circuit.

Electric Time Switches.

14934.—1908. G. Rosenbusch, Westminster, S.W. The object of this invention is to enable the rate at which ship's foghorns or other similar annunciators are sounded automatically to be varied as desired. For this purpose a multiple contact rotary switch is provided in the electric circuit, driven by clockwork at substantially constant speed, and so designed that the number of times the circuit is completed and broken per revolution of the switch may be varied at will. For example, a rotating disc of insulating material may be fitted with radial contact bars arranged in sets of different lengths so that when one or other of a series of radially disposed stationary contact strips or brushes is depressed to make contact with the bars the number of such contacts per revolution of the disc will depend on the radial position of the operative brush. Any one of the brushes may be rendered operative by means of a cam shaft, and means may also be provided for automatically stopping the motor when none of the brushes is in operative position.

Metallic Titanium Bodies for Electric Lamp Filaments.

14852.—1908. C. Trenzen & F. R. Pope, Willesden. This is a process for the manufacture of incandescent filaments with as small a content as possible of nitride, characterised by the fact that a thread is made of titanium and titanium nitride to which a carbon containing binding medium is added. The mixture is pressed into threads, which are heated in electric furnaces up to 1200° C. This causes most of the titanium nitride to combine with the carbon of the binding medium and form titanium cyanide, which at the temperature named is readily vaporised. In the final treatment of the filaments *in vacuo* by the passage of a high tension electric current, it is possible to produce a filament consisting of practically pure metallic titanium if the proportions of metallic titanium, titanium nitride and carbon containing binding medium have been chosen in the required way.

Armoured Electric Cables.

15054.—1908. R. K. Gray, Cannon-street, E.C. The inner sheathing wires of a double or multiple armoured cable are laid as nearly as practicable parallel with the axis of the cable instead of as is customary, being laid helically round it. The new cable, although sacrificing a portion of its pliability, will avoid complete rupture when only one side is abraded.

Manufacturing Metallic Filaments for Electic Incandescent Lamps.

14853.—1908. C. Trenzen & F. R. Pope, Willesden. In this process the hydrosol of an ammonia salt is used for making the filament. This aqueous solution is caused to pass through narrow openings into a gel forming medium, in which latter the stiffening of the material to a firm filament takes place at once. The openings through which the hydrosol is forced will be of the diameter of the filament desired.

Armatures for Magneto Induction Machines.

3511.—1909. R. Bosch, Stuttgart. The essence of the invention consists in mounting the armature to turn on an axis inclined to the axis of the winding so that the axle pins, of which each pole piece of the armature bobbin carries one, do not interfere with the operation of winding the armature, or if a previously wound coil is to be mounted this can be done without having first to remove a part of the bobbin.

Regulation of Electric Motors.

15275.—1908. Johnson-Lundell Electric Traction Co., Ltd., & W. A. Price, Southall. The auxiliary generator is connected with the series field windings of the main motor in such a way that the armatures of the auxiliary generator only is required during regeneration to carry the current for maintaining the series field windings of the main motors and a variable resistance is connected in parallel with the armature and the main series field windings. By this arrangement the regenerative current returned to the mains during retardation of the vehicle passes through the circuit of the variable resistance, so that the auxiliary generator need only be made large enough to carry the required energising current for the main series field windings during regeneration.

Coin Controlled Electricity Meter.

15186.—1908. J. A. Stoneham & F. A. Stoneham, Bickley. The meter has an additional mechanism to the ordinary coin controlled mechanism, by which the introduction of a sixpence or a shilling will release six or twelve pennies previously deposited in the meter. For this purpose the chute into which the coins fall has shutters which drop when six or twelve coins have been inserted. A second chute is provided for the reception of sixpences or shillings, the insertion of which automatically releases an equivalent set of pence. The obvious advantages of the scheme are, that the collector has less weight to carry, and the user can release the copper coins when required for re-insertion in the machine or for other purposes.

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INTERESTING CEREMONY AT CALDY.

ELECTRIC LIGHTING INAUGURATED.

An interesting ceremony has just taken place at Caldy, the beautifully-situated estate near West Kirby, now being developed as a high-class residential district. A number of Liverpool gentlemen have already secured land and are having residences built on the estate, which is being laid out on up-to-date lines, under the supervision of Mr. Rappart. The Caldy Railway Station, opened recently, gives convenient and rapid access to Liverpool, and will prove of immense value as the development of the district proceeds. A good service of trains is maintained, and the traffic up to now has justified the railway company in opening the station. It adjoins the new golf course which has been provided as an additional attraction of the district. The course is admirably situated along the shore of the Dee estuary, and there is a well-appointed clubhouse close to the station.

Parliamentary powers having been obtained for the lighting of the estate by electricity, the necessary installation has been laid down in a prettily-designed and compact building erected close to the ancient village of Caldy. The installation was inaugurated with due ceremony, among those present being Mr. and Mrs. Percy Eccles (Caldy Manor), Mr. R. Steel, J.P., and Mrs. Steel, Mr. Thomas Davis, J.P., and Mrs. Davis, Mr. and Mrs. Temple, Mr. and Mrs. W. Mounsey, Mr. and Mrs. Crowther, Dr. and Mrs. Middlemas Hunt, Mr. and Mrs. Rappart, Captain O. Bley, and others. The engine was started and the light turned on by Mrs. Eccles, who was presented with a silver electric reading lamp as a souvenir of her kind and valued service on the interesting occasion.

Mr. Richard Steel, in the course of a few remarks, referred to the great natural advantages and beauties of Caldy, and to the firm desire of Mr. Rappart and those associated with him to preserve those beauties whilst developing the estate on the best lines and with all the conveniences of modern life. They already possessed the advantage of a railway station and capital golf links, and had also an excellent service of gas and water, while the important matter of the sanitary arrangements had been carefully attended to. The plant which had been laid down for the electric lighting was asserted by Lancashire experts to be, for it dimensions, probably the finest and best yet installed, and he was sure the introduction of the electric light into the residences on the estate would be much appreciated and valued.

Mr. Percy Eccles moved a vote of thanks to Mr. Rappart, with whom he specially associated Mrs. Rappart, for their energy and success in pushing on the favourable development of Caldy.

The motion was carried by acclamation, and briefly acknowledged by Mr. Rappart.

It may be stated that the building containing the installation, and in which the company met, was designed by Mr. Guy Dawber, and was much admired. As the development of the estate proceeds it is intended that the corner near the electric lighting works shall be laid out as a model village on a small scale, with a green and a rustic cross in the centre. From Caldy Hill some lovely sunsets have been witnessed during the past week, while the view during clear weather of the surrounding country is worth going a long way to see. Just now, with the heather in bloom and the gorse clothed thickly with its second garb of yellow flowers for the season, and the autumn tints beginning to show in the foliage of the trees, Caldy is a picture of loveliness and sweet serenity. Being sheltered from the east and north winds, the vegetation in the many wooded dells which abound on the estate is semi-tropical in its luxuriant growth. In the laying-out and making of the roads care is being taken to preserve natural beauties, and no vehicular traffic, motor or otherwise, will ever trouble Caldy residents with dust, as all the roads on the estate are being finished with an absolutely dust-proof material. Corporation and district council engineers who have seen the Caldy roads have declared them perfect.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last price. £
Alliance Electrical Co., 5 p.c. Cum. Pref., Nos. 1-70,000	1 ..	¼-⅜
—— Ord., 1,125,000	1 ..	¼-⅜
Aron Electricity Meter, 6 p.c. Cum. Pref. Sh's, 1-125,000	1 ..	¼-⅜
—— Ordinary, Nos. 1-125,000	1 ..	¼-⅜
British Aluminium Co., Ordinary, 1-40,000	5 ..	¼-⅜
—— 7 p.c. Cum. Pref., 1-40,000	5 ..	1⅛-1¼
—— "A" 6 p.c. Cum. Pref., 1-20,000	5 ..	3-3⅛
—— 4 p.c. Funding Certificates, 1-20,000	5 ..	2¼-3⅛
—— 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	82-87
—— 5½ p.c. Loch Leven Deb. (Reg.), Red., 1-3,000	100 ..	93-96
British Insulated and Helsby Cables, Ord. 1-100,000	5 ..	7⅛-7¼
—— 6 p.c. Cum. Pref., 1-100,000	5 ..	6⅛
—— 4½ p.c. Mortgage Debentures	100 ..	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	91-96
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 275,001-475,000	3 ..	3 16-7 16
—— p.c. Mortgage Debenture Stock	100 ..	38-42
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	0-⅛
—— Non. Cum., 6 p.c., Pref.	2 ..	0-⅛
—— 4 p.c. 1st Debenture Stock	100 ..	43-48
—— 4½ p.c. 2nd Debenture Stock	100 ..	27-31
Callender's Cable, Debentures	100 ..	104½-106½
—— Ordinary	5 ..	10¼-10⅜
—— 5 p.c. Pref.	5 ..	5⅛-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7 16-9 16
Crompton and Co., Nos. 1-85,000	3 ..	⅛-1
—— 5 p.c. 1st Mort. Reg. Debs., Nos. 1-900 of £100, and 901-11,100 of £50, Red.	— ..	90-93
Dick, Kerr, and Co., Ordinary, 1,260,000	1 ..	1 1 16-1⅛
—— 6 p.c. Cum. Pref., 1-305,000	1 ..	1 3 32-1 7 32
—— 4½ p.c. Debenture Stock.	100 ..	100-103
Edison and Swan United, "A" Shares, 1-99,261	3 ..	⅛-⅜
—— "A" Shares, 01-017,139	5 ..	1⅛-2⅛
—— 5 p.c. Debentures	100 ..	84-87
—— 4 p.c. Deb. Stock, Red.	100 ..	68-73
Electric Construction, Nos. 1 to 112,100	2 ..	7 16-⅛
—— 7 p.c. Cumulative Pref.	2 ..	1 7 16-1 11 16
—— 4 p.c. Perp. 1st Mort. Deb.	100 ..	63-67
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	71-77
General Electric Company (1900) 5 p.c. Cum. Pref.	10 ..	7⅛-8
—— 4 p.c. 1st Mort. Deb. Stock	100 ..	85-88
W. T. Henley's Telegraph Works, Ordinary	5 ..	12⅛-12⅞
—— 4½ p.c. Preference	5 ..	5⅛-5⅜
—— 4½ p.c. Debentures	100 ..	105½-107½
India Rubber, Gutta Percha, and Telegraph Works	10 ..	14⅛-15⅛
—— 4 p.c. Debentures	100 ..	99-101
National Electric Construction Co., 1-170,000	1 ..	⅛-⅜
Telegraph Construction and Maintenance	12 ..	34⅛-36
—— 4 p.c. Bonds	100 ..	99½-101½
White, J. G., and Co., 6 p.c. Cum. Pref., 1-15,000	10 ..	9-10

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	5⅛-5⅜
Bournemouth and Poole, Ordinary	10 ..	9⅛-10⅛
—— 4½ p.c. Cum. Pref., 7,501-15,000	10 ..	9 15 16-9 13 16
—— 6 p.c. Cum. Second Pref., 15,001-22,500	10 ..	10⅛-10⅜
—— 4½ p.c. Debenture Stock, Red.	100 ..	99-103 xd
Bromley (Kent) Electric Light and Power Co.	5 ..	4⅛-4⅜
—— 4½ p.c. 1st Debenture Stock, Red.	100 ..	93-96
Brompton and Kensington, Ordinary	5 ..	7⅛-8 xd
—— 7 p.c. Preference	5 ..	7⅞
Calcutta Electric Supply Corp., Ord., Nos. 1-100,000	5 ..	5⅛-6⅛
Cambridge Electric Supply Company, £10 Ord.	8 ..	12⅞-13⅛
Canadian General Electric Co., Common Shares	$100 ..	123-127
—— 7 p.c. Cum. Pref. Stock	$100 ..	116-118
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100 ..	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5 ..	4-4⅛ xd
—— 4½ p.c. Cum. Pref., 1-80,000	5 ..	4⅛-5
—— 4 p.c. Debenture Stock, Red.	100 ..	96-99 xd
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5 ..	3⅞-4⅛
Chelsea Electricity Supply	5 ..	3⅞-4⅛
—— 4½ p.c. Debentures	100 ..	100-103 xd
City of London, Ordinary	10 ..	10⅞-10⅞
—— 6 p.c. Cumulative Pref.	10 ..	11⅞-12⅛
—— 5 p.c. Debenture Stock	100 ..	121-124
—— 4½ p.c. 2nd Deb. Stk., Red.	100 ..	99-102
Cordoba Light and Power Co., 1st Mt. Stl. 5 p.c. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	2⅞-3⅛
—— 5 p.c. Preference, 1-50,000	5 ..	3-3⅛
County of London Elec. Supply, Ordinary	10 ..	7⅛-8⅛
—— 6 p.c. Cum. Pref.	10 ..	10⅛-11
—— 4½ p.c. Debentures Prov. Certs. All pd., Rd.	100 ..	103-106
—— 4½ p.c. 2nd Debentures Prov. Certs.	100 ..	100-103
Edmundson's Electricity Corporation, Ord., 1-80,000	5 ..	3/16-5/16
—— 6 p.c. Cum. Pref.	5 ..	⅛-⅞
—— 4½ p.c. First Mort. Deb.	100 ..	58-61
Electrical Development Co. of Ontario, 5 p.c. 1st Mort. 30-year Gold Bonds, 10,751-15,750	— ..	84½-86½ p c.
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100 ..	85½-88½ xd
Folkestone Electric Supply, Ord., Nos. 1-10,000	5 ..	4⅜-5⅛
—— 5 p.c. Cum. Pref., Nos. 1-10,000	5 ..	5-5⅛
—— 4½ p.c. First Deb. Stock, Red.	100 ..	97-100
Hove Electric Lighting, Ord., 1-13,000	5 ..	7⅛-7⅜
Indian Electric Supply and Traction Co., 6 p.c. Construction Deb. Stock, Red.	5 ..	1⅛-2
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100 ..	74-79
Kalgoorlie Electric Power and Lighting, 6 p.c. Cum. Pref., 1-150,000	£ ..	25/32-⅞
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000.	5 ..	6⅛-6⅜ xd
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100 ..	95-98

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Name.	Amount paid. £	Last price. £
London Electric Ordinary	3 ..	1⅞-2⅛
—— 6 p.c. Pref.	5 ..	5⅛-5⅜
—— 4 p.c. st Mortgage Debenture Stock, Red.	100 ..	93-97
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100 ..	76-80
Metropolitan Ordinary, 100,001-300,000	5 ..	4⅛-4¼ xd
—— 4½ p.c. First Mortgage Debenture Stock	100 ..	105-108
—— 4½ p.c. Cum. Pref.	5 ..	4⅛-5
—— 3½ p.c. Mortgage Debenture, Red.	100 ..	83½-86½
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,000 ($500) M 1-4,400 ($1,000)	— ..	82-84 p.c. 75
($500), 1,001-14,000 ($1,000)	— ..	88-89½
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	94-97
Newcastle-upon-Tyne Electric Supply, Ord., 1-87,500	5 ..	4⅛-5⅛
—— do. 87,501-137,500 (issued at £1 prem.). All paid (Prov. Certs.)	5 ..	4⅛-5⅛
—— do., 5 p.c. Pref., 1-87,500 (Prov. Certs.)	2 ..	4⅛-5⅛
—— 5 p.c. Pref., 87,501-137,500 (Prov. Certs.)	4 ..	4⅛-5⅛
Notting Hill Electric Lighting	10 ..	11⅛-12⅛
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6-6¼
—— 4 p.c. Debenture Stock	100 ..	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1 ..	1 5/16-1 7/16
—— 6 p.c. Non-Cum. Pref., 1-100,000	1 ..	1 1/32-1 5/32
—— 5 p.c. Debenture Stock, Red.	100 ..	102-105 xd
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5 ..	5⅛-6
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5 ..	5⅛-6
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100 ..	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	.. —	94-95½
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	9/16-13/16
South London, Ordinary	4 ..	2⅛-3
South Metropolitan Electric Light and Power, Ord.	1 ..	5/16-9/16
—— 7 p.c. Cum. Pref.	1 ..	1 3/16-1 5/16
—— 4½ p.c. 1st Mort. Deb.	100 ..	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	8⅜-9
—— 7 p.c. Pref.	5 ..	7-7¼
—— 3½ p.c. Deb.	100 ..	84-88
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	⅛-1
—— 5 p.c. Cumulative Preference, 50,001-80,000	5 ..	1⅛-2
—— 4½ p.c. First Mort. Debenture Stock, Red.	100 ..	75-80
Westminster, Ordinary	5 ..	8⅛-9 xd
—— 4½ p.c. Cum. Pref., 110,101-138,251	5 ..	4⅛-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 10 p.c. Non-Cum. 2nd Pref., 260,008-280,007	5 ..	4⅛-4⅜
—— Permanent 6 p.c. Debenture Stock, 1888	100 ..	91-92
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	101-103
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	⅛-¼
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1 ..	9/16-11/16
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100 ..	87-91
Blackpool and Fleetwood Tramroad	10 ..	13⅛-13⅜
Bombay Elec. Supply and Trams. Co., 6 p.c. Cum. Pref.	10 ..	9⅛-10
—— 4½ p.c. Deb. Stock, Red.	100 ..	93½-95½
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	6⅛-6⅜
—— 5 p.c. Cum. Pref., Nos. 1-75,000	5 ..	5-5⅛
—— 4½ p.c. Deb. Stk., Red., Prov. Certs., all pd.	100 ..	100½-104½
British Columbia Electric Railway Co., Ord. Def.	100 ..	143-147
—— Ord. Pref.	100 ..	122-126
—— 5 p.c. Cum. Perpetual Pref. Stock	100 ..	107-110
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	102-104
—— 4½ p.c. Vancouver Power Deb.	100 ..	101-104
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10 ..	⅛-¼
—— 6 p.c. Cm. Pf., 30,001-60,000	10 ..	2⅛-2⅜
—— 5 p.c. Perpetual Debenture Stock	100 ..	86
—— 4½ p.c. 2nd Deb. Stock	100 ..	63-67
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	81-86
Buenos Ayres Gd. Nat. Trams. Co., 5½ p.c. Pref. Deb. Bonds, Red., 1-1,500	100 ..	102-107
—— 6 p.c. Deb. Bonds, Red., 1-2,275	100 ..	103-106
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	98½-97⅞
Calcutta Tramways, Ord., No. 1-137,610	5 ..	4⅛-4⅞
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5 ..	4⅛-5
—— 4½ p.c. 1st Deb. Stock, Red.	100 ..	99½
Cape Electric Tramways, Nos. 1-491,222	1 ..	⅛-¼
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5 ..	4⅛-5⅛
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	97-101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5 ..	5⅛-5⅞
—— 4 p.c. Deb. Stock, Red. (1985)	100 ..	98-101 xd
Colombo Electric Tramways and Lighting, 5 p.c. 1st Mortgage Debenture Stock, Red.	100 ..	98-101
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 p.c. Cum. Pref.	10 ..	12⅞-13⅛
—— 4 p.c. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13-14
—— 6 p.c. Pref., Nos. within 1-60,000	10 ..	12½-13½
—— 3½ p.c. Mort. Debs., 1-3,000 Red.	100 ..	90-95
Hastings & Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	75-80
Havana Electric Railway Consolidated Mort. 5 p.c. 50-year Coupon Bonds of 1952, 1-6,957	$1,000 ..	91-94
Imperial Tramways, Ordinary	all ..	18-19
—— 6 p.c. Cum. Pref.	all ..	14-14½
—— 4½ p.c. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 p.c. Cum. Pref., Nos. 30,001-60,000	5 ..	⅞-1⅛ xd
—— 4 p.c. 1st Mt. Db. Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/32-3/32
—— 5 p.c. " A " Deb. Stock	100 ..	90-93
—— 6 p.c. " B " Deb. Stock	100 ..	64-68
Kidderminster & District Lighting & Traction, Pref.	5	9 15/16-10 3/16
Lancashire United Tramways, Limited, 5 p.c Prior Lien Deb Stock, Red	100 ..	88½-90½
—— £296,500 2nd Mort Deb Stock	— ..	—
—— £83,330 Deferred Deb Stock (all fully paid)	— ..	—
Lisbon Elec Trams, Limited, Ord, Nos 1-594,188	1 ..	15/16-1 1/16
—— 6 p.c. Cum Pref, Nos. 1-425,553	1 ..	15/16-1 3/16
—— 5 p.c. Mort. Deb., 1-5,000, Red.	100 ..	96-100
London United Trys (1901) 5 p.c. Cum. Pref.	10 ..	2-2⅛
—— 4 p.c. 1st Mt. Db. Stock, Red.	100 ..	68-71
Madras Elec. Trams. (1904) 5 p.c. Deb. Stk., Red.	100 ..	93-94
Manila Elec. R.R. & Ltg. Corp., 5 p.c. 1st Lien & Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000 .	95-97
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5 ..	4⅛-5
—— 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	86-91
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	1/32-5/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1 ..	23/32-27/32
—— 4½ p.c. Deb. Stock, Red.	100 ..	95-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 p.c. Gold Bonds	.. —	97-96⅜
Milwaukee Electric Rail and Light, 5 p.c. 30-yr. Con. Mort. Bonds (1926) 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ p.c. Sterling Deb., 601-2,000 (1922)	100 ..	102-104
New General Traction, 6 p.c. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	⅛-¼
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100 ..	100½-103½
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	⅛-¼
—— 5 p.c. Cum. Pref., 300,001-545,000	1 ..	⅛-¼
—— 4½ p.c. Debenture Stock	100 ..	86-89
Provincial Tramways Co., Ordinary, 1-24,912	10 ..	4-4⅛
—— 6 p.c. Cum. Pref., 1-10,000	10 ..	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5 ..	5⅜-5⅞
—— 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	99-101
San Paulo Tramway, Light, and Power Co.	$100 ..	149-152
—— 5 p.c. 1st Mort. Deb., Red. (1929) 1-12,000	$500 ..	101
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	⅜-½
—— 4 p.c. Deb. Stock, Red. (1940)	100 ..	70-74
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red., 1-1,600	100 ..	82-86
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5 ..	⅛-¼
—— 6 p.c. Cum. Pref., 1-46,261	5 ..	1⅛-2⅛
—— 4½ p.c. 1st Deb. Stock, Red.	100 ..	82-86

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100 ..	62-64
—— 4 p.c. Pref.	100 ..	83-85
—— " " deferred	100 ..	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	99-101
City and South London, Consolidated Ordinary	100 ..	31-32
—— 4 p.c. Debenture Stock	100 ..	99-101
—— 5 p.c. Pref. Stock '91	100 ..	110-112
—— " " " '96	100 ..	106-109
—— " " " '01	100 ..	102-105
—— " " " '03	100 ..	94-97
Liverpool Overhead, 5 p.c. Pref.	10 ..	4⅛-5
—— Ordinary, 1-50,000	10 ..	⅛-13/16
—— 4 p.c. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 p.c. 4½ p.c. Bds.	— ..	89

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10 ..	2⅞-3⅛
—— 5 p.c. Debs., Red., within 1-1,060	100 ..	93-96
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000 ..	97-99
Anglo-American Telegraph Co., Ordinary	100 ..	60-61½
—— 6 p.c. Preferred Ordinary	100 ..	103-104
—— Deferred Ordinary	100 ..	20-20½
Anglo-Portuguese Telephone Co., 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	103-105
Chili Telephone Co., 1-44,000	5 ..	8-8⅜
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100 ..	90-92
Cuba Submarine Telegraph Co., Ordinary, 1 16,000	10 ..	8⅛-8⅞
—— 10 p.c. Preference, 1-6,000	10 ..	17-18
Direct Spanish Telegraph Co., Ordinary	5 ..	3-3⅛
—— 10 p.c. Cum. Preference	5 ..	8⅛-8⅞
—— 4½ p.c. Debs., 1-600	50 ..	99-101
Direct United States Cable Co.	20 ..	13-13⅛
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100 ..	99-101
Eastern and South African, 4 p.c. Mort. Debs., within 1-3,000 (1909)	100 ..	100-102
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	25 ..	103½-105½
Eastern Extension, Australasia and China, 1-300,000	10 ..	11⅛-11⅞
—— 4 p.c. Mort. Deb. Stock, Perp.	100 ..	102-104
Eastern Telegraph Co., Ordinary Stock	100 ..	129-132
—— 3½ p.c. Preference Stock	100 ..	84½-86½
—— 4 p.c. Mortgage Debenture Stock	100 ..	104½-106½
Great Northern Telegraph Co. (of Copenhagen)	10 ..	26½-27
Halifax and Bermudas Cable Co., 4½ p.c. 1st Mort. Debs., within 1-1,200, Red.	100 ..	99-101
Indo-European Telegraph Co.	25 ..	51½-53½
Marconi's Wireless Telegraph Co., Nos. 256,128-384,190	1 ..	23/32-25/32
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	13/16-15/16
—— 5 p.c. Preference, 1-86,492	1 ..	⅛-¼
National Telephone, Preferred	100 ..	106½-107½
—— Deferred Stock	100 ..	123½-124½
—— 6 p.c. Cum. First Pref.	10 ..	10-10⅛
—— 6 p.c. Cum. Second Pref.	10 ..	10-10⅛
—— 5 p.c. Non. Cum. Third Pref.	5 ..	5⅛-5⅜
—— 3½ p.c. Deb. Stock, Red.	100 ..	98-100
—— 4 p.c. Deb. Stock, Red.	100 ..	99-101
Oriental Telephone and Electric Company	1 ..	15/16-1 7/16
—— 6 p.c. Cum. Pref.	1 ..	1 1/16-1 3/16
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100 ..	99-101
United River Plate Tele. Co., Ordinary, 1-100,000	— ..	6 15/16-7 3/16
—— 5 p.c. Cum. Pref., 1-40,000	5 ..	5⅛-5⅜
—— 4½ p.c. Debenture Stock, Red.	100 ..	102½-104½
Telephone Co. of Egypt, 4½ p.c. Deb. Stock, Red.	100 ..	99-101
West African Telegraph Co.	10 ..	12⅞-13⅛
West Coast of America, 1-30,000 and 53,001-53,008	2½ ..	1⅜-1⅝
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	99-101
West India and Panama Telegraph Co., Ordinary	10 ..	⅛-¼
—— 6 p.c. Cum. 1st Preference	10 ..	8-8⅛
—— 6 p.c. Cum. 2nd Preference	10 ..	—
—— 5 p.c. Debs., Red., 1-800	100 ..	101-103
Western Telegraph Co., 1-207,930	10 ..	13⅛-13⅞
—— 4 p.c. Debenture Stock, Red.	100 ..	90-92

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.							
	Ending	1909.	1908.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	Co...
		£	£	£	£				£						
Aberdeen Corporation	Aug. 11	1,867	1,705	+ 161	— 665	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5·9
Ayr Corporation	„ 14	501	514	— 13	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	„ 7	2,770	2,650	+ 120	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	„ 1	1,073	1,108	— 35	— 492	13·52	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	July 31	6,446	6,326	+ 120	—	56·702	—	—	—	—	—	—	—	—	—
Blackburn Corporation	Aug. 11	1,407	1,215	+ 191	— 711	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	„ 5	3,052	3,141	— 92	+ 450	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,329	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	„ 1	2,210	2,500	— 290	— 990	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·5
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29¼	29¼	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·2
Bradford Corporation	„ 17	4,937	4,770	+ 168	+ 1,371	98¾	98¾	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	Aug. 15	1,443	1,365	+ 78	+ 696	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	„ 13	5,945	5,033	+ 912	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	„ 14	1,417	1,379	+ 38	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·9
Burton Corporation	„ 15	299	284	+ 15	—	10	10	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·8
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	July 31	5,216	6,504	— 1,288	— 7,762	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27
Charing X, Euston, & Hamp. Ry.	Aug. 7	3,695	3,515	+ 180	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	„ 15	2,983	2,876	+ 107	+ 1,083	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 19	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Aug. 5	586	586	—	—	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	„ 6	2,050	—	+ 152	+ 122	11¼	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·10
Darwen Corporation	July 30	216	231	— 15	— 196	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	„ 31	258	336	— 78	— 478	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Aug. 13	181	162	+ 19	—	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	„ 13	6,334	5,640	+ 694	— 432	54¼	54¼	—	—	—	—	—	—	—	—
Dundee City Tramways	„ 4	1,162	1,220	— 58	— 613	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	„ 14	1,049	924	+ 125	+ 2,817	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	July 17	15,961	17,286	— 325	— 2,745	185¼	179	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·9
Gloucester Corporation	Aug. 11	339	304	+ 35	— 513	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	„ 7	4,430	4,480	— 50	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	„ 14	2,002	1,737	+ 265	+ 675	28¼	28¼	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·1
Hull Corporation	„ 14	2,664	2,380	+ 283	+ 968	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	July 31	487	498	— 11	+ 687	10	10¼	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·4
Ilkeston Corporation	Aug. 12	156	144	+ 12	— 207	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·08
Kirkcaldy Corporation	„ 11	206	280	+ 16	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	„ 11	1,676	1,427	+ 249	— 105	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	„ 7	7,904	7,551	+ 443	+ 497	107½	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	„ 14	2,209	2,018	+ 190	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	July 2.	11,088	11,403	— 315	— 3,017	104	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Aug. 1	1,452	1,481	— 29	— 72	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	July 31	35,625	36,876	— 1,251	+ 21,172	119½	121½	Mar. 31	1,274,660	279,166,461	25,591,028	1·08	11·74	—	6·7
Lowestoft Corporation	„ 17	216	258	— 42	— 743	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·1
Maidstone Corporation	Aug. 14	225	221	— 4	— 305	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	July 31	14,874	16,424	— 1,550	— 2477	181	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Aug. 14	8,217	8,058	+ 159	—	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	July 25	16,333	15,975	+ 358	+ 1,010	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Aug. 14	163	152	+ 11	— 107	2½	2½	Mar. 31	7,362	2,060,712	204,7 6	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	July 31	3,860	3,850	+ 10	— 1,416	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·3
Newport (Mon.) Corporation	„ 31	672	713	— 41	— 382	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·2
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Aug 12	676	675	+ 1	— 89	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·6
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·4
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Aug. 2	4,551	5,379	— 825	— 3,017	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	July 18	5,718	5,528	+ 190	— 1,112	68½	66½	Mar. 25	289,745	17,568,686	7,065,380	·806	9·842	4,225	5·4
Southampton Corporation	„ 28	1,123	1,267	— 144	— 586	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·2
Southend-on-Sea Corporation	„ 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·7
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,084	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Aug. 11	183	181	+ 2	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	„ 12	683	611	+ 72	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	„ 14	1,033	1,026	+ 66	+ 523	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·7
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	„ 5	2,705	2,753	— 48	+ 2,362	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·7
Wolverhampton Corporation	„ 11	797	879	— 49	— 879	20½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·9

a Train miles. *b* Half-year's figures.

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THE
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WITH WHICH IS INCORPORATED "ELECTRIC LIGHT."

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NOTES.

STREET LIGHTING.

A deputation of the Corporation of the City of London has been making a round of certain of the chief Continental cities with a view to study street lighting as carried on abroad. The report of this Committee has now been issued, and it is rather inconclusive, though containing some useful information. Briefly stated, the report provisionally recommends the use of gas lamps with inverted incandescent burners wherever possible, but where electricity is necessary the open arc and flame arc lamps are advocated. It is admitted that further experimental lighting is advisable. This, too, seems to be the opinion of the City Engineer, Mr. Frank Sumner, who, in his latest annual report, summarised in another column of this issue, gives some details as to the various types of lamps used, but does not consider that sufficient data upon which to form a definite policy have yet been collected. As regards the distribution of light, the late wandering City Fathers opine that wherever possible streets should be lighted by centrally hung lamps with lowering gear, and open spaces should be lighted by standards with lowering gear. In most of the cities they visited centrally suspended lamps with lowering gear were the rule. At Munich as many as three lamps are found hung in a row. In Berlin, Vienna, Brussels, and other cities the practice prevails of using electricity from lighting up time till midnight, and then using gas. Berlin proposes to discard electricity altogether for street lighting, and is spending quite a large sum on an improved gas lighting system. The question of cost is a difficult one, and the report is quite unilluminating on this point. The prices per arc-lamp per annum varied from as low as £9 6s. 3d. at Cologne, to as high as £35 at Vienna; but in the former city it varied from the minimum above stated to £11 5s. 6d., and in the Austrian capital the minimum was £16. The only clear conclusion is that in the matter of street lighting, as in most other things, local circumstances alter cases; and finally, as regards our own particular city, that the authorities are still sitting on the fence.

LABOUR TRUCE.

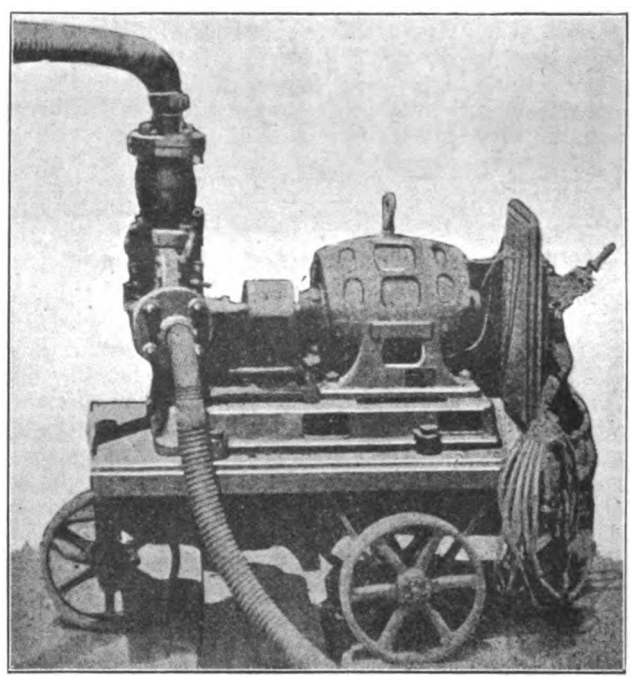
Although the refusal of the Manchester branches of the Amalgamated Society of Engineers to fall in with views of the eleven other trade unions that a five years' wages truce was advisable promised a breakdown in the negotiations between the masters and men, yet the difficulties have been overcome by a wise spirit of mutual concession which brooded over the Conference at Manchester. Ultimately, the representatives of the employers, of the Society and branches came to terms on the following understanding, which has been officially promulgated:

> After a prolonged discussion as to the reasons which prevented the unions from accepting the suggested five years' agreement, made in conference on the twenty-fourth of March last, instead of the proposed reduction in wages of one shilling per week in day rates, and 2½ per cent. in piece prices, the employers agree to accept the suggestion made in the letter dated the 18th July last, from the Joint Committee of Engineering and Kindred Trades, that the present rates of wages remain undistrubed for a period of three years, from September 30, 1909, provided that the trades union delegates present jointly and severally undertake to recommend strongly the acceptation of the foregoing terms on their members.
>
> Any subsequent alteration in rates of wages shall be subject to two months' notice.

This is not quite so good as the sanguine hoped for, but it is not bad, and shows a disposition to listen to the dictates of sweet reasonableness.

NEW USE FOR ELECTRIC PUMPS.

A new form of alternating electric pump has been devised by Messrs. Alsina & Co., wine merchants, of San Martin, Spain, for use in their cellars. It is a compact little motor, with diaphragm pump attached, fitted on a low trolley, and is used for transferring must from the presses to the great tuns, and again from the tuns to the barrels. Power is obtained by means of flexible cables from the



lighting mains, and the apparatus can be moved about with ease. A barrel can be filled in three minutes by this method of pumping, while by the old it took fifteen minutes, the discarded method also requiring more piping and manual labour. There appears to be a great economy, and the system might be brought under the notice of our brewers and distillers.

WIRELESS.

Africa may, at no distant date, be girdled by the magic of wireless telegraphy. Something has already been done in Cape Colony, and now Natal is negotiating for a station on the Bluff at Durban, to be put in communication with Cape Colony and Delagoa Bay. Interest in the subject is also being manifested on the West and East Coasts, and these may eventually by international agreements be linked up with South Africa on the one hand and with Egypt on the other. The action of Colonial Governments aiming to support the desire of the commercial world as expressed by the international movement among underwriters should greatly hasten matters. Meanwhile, progress is being made with wireless telephony. From the South of France we

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hear-that the system invented by Lieutenants Jeance and Colin, of the French Navy, is proving successful, long conversations being held between Toulon and Port Vendres, which lie over 155 miles apart.

CAUSE OF OFFENSIVE ODOUR WITH MERCURY LAMPS.

It is common to perceive a disagreeable smell in the neighbourhood of mercury vapour lamps. Hitherto this has been regarded as due to ozonisation of the air round the lamp by the ultra violet rays emitted by the latter, and Bordier & Nogier have tried to estimate the amount of ozone formed. The air was collected from the vicinity of the lamp, and drawn through a series of wash-bottles containing dilute solutions of caustic alkali. No ozone, however, was detected even after the air had been passing for several hours. It was then suggested that the smell might be due to oxides of nitrogen formed from the oxidation of the atmospheric nitrogen under the influence of the ultra violet rays, but these could not be detected either. The next experiment was to surround the lamp with pure nitrogen, so that the formation either of ozone or oxides of nitrogen was impossible. The smell, however, was still there. The true cause of the smell has now been found to be excitement of the olfactory nerves, itself due to the electric charges of the ionised air round the lamp. This was proved experimentally by passing the air removed from the neighbourhood of the lamp, not through wash-bottles, but through an earthed metal tube in which the ions were discharged. The gas issuing from the tube was perfectly odourless. If a glass tube was substituted for the metal one the odour persisted. This suggests that other electrical odours, those in the neighbourhood of a static electrical machine at work, may be due to the same cause and not as usually believed to the formation of ozone.

A GLASS WHICH CONDUCTS ELECTRICITY.

As we all know, glass owes its extended use in electrotechnics to its great insulating power and its transparency. Now, this latter quality, in conjunction with its strength, enables it to render great services as a cover for dial plates, and so on, where dust, moisture and air must be excluded, and yet readings of a scale or other observations of what is going on inside have to be made. But, on the other hand, the insulating power of glass is often a serious drawback, although its transparency is invariably an advantage. We need only mention the glass covered cases of high tension voltmeters where the insulating material is the only thing that prevents us from using the same instrument for both direct and alternating currents. The attempts made to overcome the difficulty by covering the glass with wire gauze or strips of metal have not been successful, because these devices prove hindrances to reading the indications of the instrument. Going further than this, many have tried to prepare a colourless transparent glass which would not be an insulator, and yet at the same time would be sufficiently resistant to atmospheric influences, and especially to acid and alkaline fumes, to act as a protection to a delicate and expensive instrument. Considerable advance attended the earlier attempts to make a glass of good conducting power, but the products were all deficient in chemical stability and some of them in transparency also. Success has apparently come at last, and a glass made by E. S. Phillipps, while having a conducting power 1,000 times greater than that of ordinary glass, is perfectly transparent, very strong, and as good at resisting atmospheric and gaseous action as most ordinary glasses. Its composition is as follows:—Sodium silicate, 83·7%; borax, 13·6%; sodium antimonate, 0·62%; lead oxide, 2·08%. This glass softens at a temperature a little above ·932° F. It is highly refractive (being a flint glass), and its co-efficient of heat expansion is somewhat greater than that of ordinary glass, a circumstance which is advantageous in many cases. Threads of this glass are found to form a good substitute for gold leaves in an electroscope.

PARLIAMENTARY.

The Electric Lighting Acts Amendment Bill has passed the third reading in the House of Commons, and now only awaits the Royal Assent to become law. The Royal Assent has already been accorded to the L.C.C. (Tramways and Improvements) Act, 1909. There is a prospect of the Telegraph (Arbitration) Bill being passed, should it not be seriously opposed, but the famous and much-discussed London Electric Supply Bill is to be dropped. From the electrical point of view the Session will not be very fruitful, and many will regret the Electric Lighting Acts Amendment enactment in its present form. Though not all that we could desire, it will serve a useful purpose by removing some of the anomalies.

MOTOR HEADLIGHTS.

At the request of the Local Government Board, the Royal Automobile Club has been carrying out a prolonged and elaborate set of tests as regards headlights on motor vehicles. The report of the Expert and Technical Committee is now out, and contains some valuable hints. Actual tests disproved the popular notion of the dazzling effect of headlights, most of the lamps ranging between 15 to 25 c.p., though the apparent illumination was often intensified by the use of mirrors and by reflection from the roadway. The committee recommend lamps of 20 c.p., requiring, in the case of electricity, about 21 watts. It appears desirable to reduce the source of light as far as practicable and to increase the size of the mirror, whereby undesirable dispersion of the beam is minimised. Gilded reflector mirrors gave excellent results, and should prove particularly useful in foggy and misty weather, owing to the greater penetrative powers of the yellow beam. It is interesting to note that the best and cheapest gold reflectors are the product of electro-deposition by the Cowper-Coles process, referred to in our pages a short time ago. As regards position, the best seems to be the horizontal at 2 ft. above the ground; if above 3 ft. the maximum dazzle is obtained by a downward tilt, if below 3 ft. by an upward tilt. The committee approved of devices for regulating the power of light, such as, for instance, the use of switches for reducing the voltage or appliances for inserting resistance.

IMPROVEMENTS IN THE DANIELL CELL.

The ordinary form of Daniell cell is an outer copper vessel, serving as the cathode, and containing a saturated solution of sulphate of copper. In this is immersed a vessel of porous clay, in which is the zinc anode and dilute sulphuric acid. The average E.M.F. is 1·777 volts. The cell is the most constant in its action yet known, and is hence largely used in spite of its low E.M.F. It has, however, the drawback that after long use and even after long standing with an open circuit, the copper sulphate diffuses into the zinc compartment and causes rapid destruction of the metal.

Saudino proposes to obviate this by making the porous cell double, the space between the two clay cylinders being packed with peroxide of lead. This device has been found to prevent the diffusion of the copper sulphate effectually. The new Daniell cell is nearly as powerful as the original form, its electromotive force being 1·1 under the same circumstances giving an E.M.F. of 1·177 with the old form of cell. The internal resistance of a Saudino cell is from 1·3 to 1·5 ohms. When used for 10,000 hours continuously with an external resistance of 30 ohms, the E.M.F. of the cell fell less than one-hundredth of a volt.

The *Elektrotechniker*, in the same article which we have so far quoted, after describing the Saudino element, speaks of what it calls "a further-going change of the Daniell element," proposed by Strachau. We leave our readers to decide, after perusing the following description of the Strachau cell in the article, whether our contemporary is justified in describing it as a modification of the Daniell element. The depolariser around the cathode is lead tetrachloride and the copper is replaced by carbon. Anode and cathode are separated by the usual porous diaphragm. With zinc in dilute sulphuric acid as the anode, the E.M.F. is from 1·2 to 1·5 volts. With an iron anode it is from 0·8 to 0·9 volt. The internal resistance of the element is very small, and the current is extremely constant. The tetrachloride of lead is prepared by reacting on a solution of lead acetate with one of calcium hypochlorite. The resulting lead peroxide is converted into the tetrachloride by dissolving it in concentrated hydrochloride acid.

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SWITCHBOARD ATTENDANTS AND SHOCKS.

One of the great advertising words with which makers of modern switchgear invest their manufactures is that they are "Fool proof." While it is the case that a large amount of the switchgear which is used in works and factories is so designed that the very unintelligent person can with safety handle it, "waiting at the first stop till the motor starts," or following some equally simple rule, it is, perhaps, a compliment to the average intelligence of the central station switchboard attendant that such a large proportion of the plant under his charge will, if handled improperly or approached without due circumspection, give him a nasty shock. Looked at in one way, this is gratifying to the self-esteem of the operator; from another point of view the dangers attendant upon the handling of the complex apparatus upon a modern switchboard warrant one or two notes upon the subject.

It is not too strong a remark to make that some of the switchboards of central stations are veritable death-traps. The often-quoted report issued by Mr. Scott Ram is sufficient vindication of this statement. No consideration appears to have been paid by some designers to the exterme care which is necessary even to walk along the narrow space behind the switchboard, still more to do any work upon a portion of the connections. Gangways 3 ft. wide, flanked by bristling points of possible contact maintained at voltages from 500 upwards, are by no means obsolete, and the difficulty of working on switchboards is aggravated by the inefficient way in which these are often lighted. A portable lamp is a very dangerous thing in such cases. Either the flexible wire gets kinked and worn so that its insulation is a snare, leading to short circuits in a confined space, or else, if it is armoured, the armouring is apt to put the whole system to earth by accidental contact.

A case came within the knowledge of the writer where, in a cellular switchboard, it was necessary to almost sit on the floor to draw fuses, and one switchboard attendant came within an inch of losing his life by bringing his head too close to some bus-bars just above while his attention was focussed on the fuses he was drawing. Luckily there was a second man on the board, who removed him from danger by pulling him back on to the floor.

Another fruitful source of trouble, closely allied with the above, is the bad design of some switchboards. It is not an uncommon thing to find terminals at the back of a switchboard at difference of pressures of 240 or 500 volts which are not separated by more than 6 or 8 in. Low tension boards are more frequent sinners in this respect than high tension, although culpable mistakes have been made in the latter. It may be suggested that where crowding of connections is inevitable they should be arranged so that the nuts can be taken off by a box-head spanner with a fairly long insulated handle, so that the workman can stand well back from the board and that the spanner will not foul adjacent connections. The danger of the spanner in cramped situations is so well known that most jointers tape the handle of their spanners, which they prefer single ended, with several layers of insulating tape. This is a make-shift device, however, whose chief use is its commentary on the designs which are permitted to pass as satisfactory. Apart from this, however, closeness of contacts gives the fullest scope for faults such as veins in slate or marble, or other insulation troubles to manifest themselves.

It may be suggested that a switchboard should be its own diagram of connections. Unfortunately, this is not often the case, and as the switchboard attendant is often called upon to make a circuit dead in order to enable repairs to be made outside, the complication of the board may very easily lead to trouble. A case in point may be quoted. A jointer attached to an alternating current system of power supply was instructed to cut through a 3,000 volt concentric feeder. This particular feeder was supposed to have been made dead, but owing to an error on the switchboard due to complexity of the connections, this was not actually the case. The jointer proceeded to cut through the cable with a saw. When he reached the inner conductor there were, of course, electrical phenomena of a striking nature, and, fortunately, the fuses at the station were blown. It was extremely fortunate for the man that the saw had a wooden handle, and that at the instant of the accident he was not touching any metallic part. The consequence might, however, have been extremely serious. This sort of thing is rendered practically impossible since this trouble, as the mains engineer goes personally to the station and sees that the correct feeder is made dead. Moreover, before the feeder can be switched in again this engineer has to report in person that the jointer has finished, and sees the operation of switching performed if this is at all possible. This is a wise precaution to take in any system of high tension supply, but should be no excuse for complexity of wiring arrangements.

All the above may be taken to refer more especially to the more common causes of shock. The reason for trouble is easily traced, and the danger of their occurrence is largely due to lack of forethought. There are, however, accidents on or connected with switchboards which cause shock, and which are more or less exceptional in their nature. It may be worth while recording one or two more of these.

It is now standard practice to thoroughly earth all metallic parts of a station switchboard which are not intended to bear pressure. This means that the insulating materials employed on the board must be of the best, and well arranged, as they receive no adventitious aid through the partial insulation of the whole board. It is, however, a precaution against shock, and should, therefore, be observed. Once having made this connection, however, it should not be taken for granted that it will hold good for ever; the earthing of the board should be tested periodically. A case in point occurred some time ago in a station board whose earth lead was conducted to a clamp on a 3-inch iron water-pipe. One day, however, an attendant received a severe shock from the framework of the board, and investigation revealed faulty insulation on a shunt lead in contact with a piece of channel iron forming part of the framing. The reason for the maintenance of potential on the framing was not, however, discovered until someone traced the earth connection past the clamp and along the actual pipe. It was then found that in alterations subsequent to the erection of the board the pipe had been put out of commission, and, as a fresh course for the water had been made, the pipe had been disconnected at both ends from the system ready for taking down. As the pipe was carried on brackets fixed to stonework, it naturally failed to give an efficient earth.

Measuring instrument connections have to be watched on alternating current supplies. It is increasingly common to measure current or potential through the agency of transformers, and where the connection or switch-plug arrangements are such that duplicate circuits can be switched on to the same instrument, it is quite possible for the high potential of one portion of the board, being transformed down to the potential required by the measuring instrument, to be retransformed up again through the agency of a second transformer put into circuit *viâ* the instrument, placing full induced voltage in a portion of the board which is supposed to be dead and on which someone may be working. Such transformers are usually provided with fuses; care should be taken to see that these are drawn when a portion of the board is made dead for repairs or alterations.

A rather interesting case of totally unexpected shock occurred in the sub-station of a system on which alternating current power was converted from a transmission system at 3,000 volts to a distributing pressure of 200 volts. The attendant had wished to remove some stains on the wall just above the switchboard, and for this reason stood on a box in front of the high tension switchgear, holding in his hand a piece of damp cloth wherewith to rub off the stain. No gloves were worn, and apparently a thread from the damp cloth must have hung down and touched one of the terminals at the back of the board. The attendant received a tremendous shock, which knocked him backwards across the station. In falling, he dropped the cloth which lodged across the two-feeder terminals and produced a short circuit, which blew the fuses at the main generating station and shut down the supply on that section. Fortunately, the attendant suffered no further harm beyond the bruises caused by his fall, and, later on, a severe inflammation of the eyes caused by the flare of the short circuit. The

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incident, however, serves to illustrate the necessity for the use of rubber gloves when working on or near a switchboard, and also the use of unremitting vigilance in order to avoid most extraordinary accidents.

Somewhat analogous to this is a case of short circuit which occurred on a central stations witchboard, owing to the fact that the wire binding of the feather brush with which the switchboard attendant was dusting the board came undone, and spreading out, managed to place itself across two terminals of different voltage. For this reason wire-bound brushes for use on apparatus liable to potential should be rigorously excluded, and this prohibition should be extended to any metallic joint or fastening upon such gear. The writer once saw a pair of insulating tongs used for gripping fuses on a high tension supply for the purpose of inserting or removing them, which was furnished with a circular shield on each leg near the handle, these shields being of metal and connected to a flexible wire having a clamp at the other end which was to be attached to the metal framework of the board before operations were commenced. The purpose of these shields was to provide a path to earth for any arc which might be accidentally struck, before the potential reached the operator, but in the writer's opinion this arrangement was a mistake. It would have been better to have had a longer pair of tongs, and to have seen that their insulating properties were of the very best. The flexible lead involved chances of short circuiting or earthing by accidental contact, and in such a case the presence of metal near the handles would have been a source of positive danger.

Rather a curious instance of shock occurred some time ago to a switchboard attendant in a low tension direct current station, the supply pressure of which was only 100 volts. Not much danger of serious shock could reasonably be apprehended in such a place, but the attendant managed to break the field circuit of one of the main dynamos, which were shunt wound, in such a way that the circuit was completed through his body, from hand to hand. On first feeling the shock due to the induced voltage of the shunt coils the attendant hastily drew his hand away from the contact, with the result that he received a very severe shock, which incapacitated him for the time being. The presence of a non-inductive shunt-breaking resistance would, of course, minimise the effect of such trouble, but the incident is chiefly useful in showing that even the simplest operation on the safest board is fraught with danger if it is not performed with extreme care.

It will, therefore, be seen from the above examples that not merely should the design and construction of central station switchboards be of the very highest quality, but also that the attendants themselves should be men of considerable mental calibre, able to perform their duties with a due appreciation of the risks which they run. The present practice of cutting down the wages of switchboard attendants to the absolute miniumm, which is so painfully evident in the advertisement columns of the electrical journals, is, therefore, to be strongly deprecated, as it can quite easily lead to a case for compensation under the provisions of the Employers' Liability Act.

ELECTRICAL MACHINERY IN FINLAND.

OPENINGS FOR BRITISH GOODS.

In the near future the demand for electrical apparatus and machinery will probably be increased, states the British Consul for Finland in reporting on the openings for British trade in that country. Every British firm, he says, wishing to trade in Finland—firms already trading with Russia especially—should take measures to appoint an agent in one of the larger towns—preferably Helsingfors.

Business on a very large scale is not to be expected in a country, the total imports of which amounted in 1908 to £14,504,000, but it certainly might exceed £1,824,000, *i.e.*, the value of the present imports from the United Kingdom. The main point is that British firms should become acquainted with the local demand, so as to be able to supply the article required at the price generally paid for it in Finland. All manufactures, being more expensive in comparison to the weight, and hence liable to relatively less freight, could be exported to Finland with great advantage, as British manufactures are held in high repute there, and only the high prices frequently asked, as well as the energetic and skilful advertising of competitors, prevents their being generally bought and used. Machinery, tools, and implements, could be exported in greater quantities than now. Only it is possible that there would be some expense and little profit at first till the ground is properly prepared. As regards prices, it may be mentioned that the German and American exports to Finland in many cases constitute the excess that cannot be placed at home, and consequently they are often sold at prices considerably below the average. Concerning the terms of payment, it will often be necessary to allow larger firms extended credit.

TAXATION OF ELECTRIC LAMPS.

The German Tariff.

The German Parliament have hit upon a new source of revenue by the taxation of electric lamps and gas mantles. A law, which comes into force on October 1, provides for an internal tax on certain lamps and materials for lighting purposes (so far as they are destined for use in Germany) at the rates shown in the subjoined statement. These duties are applicable both to German made and to imported goods, and as regards the latter, are leviable in addition to the import duty,

	Articles.	Internal Tax.
		Pfennig.
A.	Electric incandescent lamps and burners therefor—	*Each.*
	(*a*) Carbon filament lamps—	
	Up to 15 Watts	5
	Over 15 up to 25 Watts	10
	„ 25 „ 60 „	20
	„ 60 „ 100 „	30
	„ 100 „ 200 „	50
	And for each 100 Watts in excess of 200	25
	(*b*) Metal filament lamps, Nernst lamp burners and other incandescent lamps—	
	Up to 15 Watts	10
	Over 15 up to 25 Watts	20
	„ 25 „ 60 „	40
	„ 60 „ 100 „	60
	„ 100 „ 200 „	100
	And for each 100 Watts in excess of 200	40
B.	Mantles for incandescent gas and similar lamps	10
C.	Carbons (*Brennstifte*) for electric arc lamps :	*Per kilog.*
	(1) Of pure carbon	60
	(2) Of carbon combined with other materials (*mit Leuchtzusätzen*) and all other carbons	100
D.	Burners for mercury-vapour and similar lamps—	*Each.*
	Up to 100 Watts	100
	Over 100 Watts, for each 100 Watts in excess	100

The tax is to be paid by the producer of the articles by affixing tax stamps to the packages before the completely packed articles are removed from the factory, etc., where they are made. In the case of imported articles, the tax is to be paid by the importer at the time of clearance through the Customs house.

Articles and materials for lighting which are liable to taxation under the present Law may not be removed from the place of manufacture in Germany or imported into Germany from foreign countries, otherwise than in completely closed packages which cannot be opened without leaving recognisable traces. The kind of packing and the permissible size of each package is to be prescribed by the Bundesrat. Particulars of the contents are to be marked on each package, *i.e.*, in the case of electric incandescent lamps, burners therefor, and mercury-vapour and similar lamps, *the number and watt-consumption* ; in the case of mantles, *the number* ; and in the case of carbons for arc lamps, *the net weight*. In addition, each package must bear an indication of the tariff class under which it is liable to duty, and the designation of the contents (trade mark). The complete text of the Law (in German) may be inspected by persons interested at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall Street, London, E.C. The new taxes are estimated to produce an annual income of £1,000,000.

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BOARD OF TRADE REGULATIONS.

The Board of Trade new regulations are printed in full below. The letter covering these regulations runs as follows :—

These regulations are made subject to the power of the Board of Trade to make such further or other regulations as they may think expedient; and nothing in these regulations shall be construed to authorise the undertakers to lay any electric line or work their undertaking otherwise than in accordance with the Order and the principal Act, or to supply energy otherwise than by a system for the time being approved of by the Board of Trade under the Order.

These are the regulations and conditions for securing the safety of the public and for ensuring a proper and sufficient supply of electrical energy, made by the Board of Trade under the provisions of the Electric Lighting Acts, 1882 and 1888, and of the
referred to in the letter from the Board of Trade to the
, of the
30th day of June, one thousand nine hundred and nine.

Except as hereinafter mentioned the date of these regulations shall be the 1st day of July, 1909.

As to so much of any electrical station as was constructed before the 1st day of July, 1908, the date of these regulations shall be the 1st day of January, 1910.

ASSISTANT SECRETARY,
Board of Trade.

ELECTRIC LIGHTING ACTS, 1882 AND 1888.

Definitions.

In the following regulations—

The expression "the Order" means the

The expression "the Undertakers" means the Undertakers for the purposes of the Order.

The expression "consumer's wires" means any electric lines on a consumer's premises which are connected with the service lines of the Undertakers at the consumer's terminals.

The expression "sub-station" means any premises in which energy is transformed or converted for the purpose of supply to consumers, and which are large enough to admit the entrance of a person after the transforming or converting apparatus is in position, provided that for the purpose of these Regulations any place within any such premises which is used solely for some purpose other than such transformation or conversion shall not be deemed to form part of a sub-station.

The expression "overhead line" means any electric line which is placed above ground and in the open air.

The expression "pressure" means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and the earth; and subject to the variations allowed by No. B 3 of these Regulations :—

(*a*) Where the conditions of the supply are such that the pressure at any pair of consumer's terminals does not exceed 250 volts, the supply shall be deemed a low pressure supply;

(*b*) Where the conditions of the supply are such that the pressure exceeds 250 volts but does not exceed 650 volts, the supply shall be deemed a medium pressure supply;

(*c*) Where the conditions of the supply are such that the pressure exceeds 650 volts but does not exceed 3,000 volts, the supply shall be deemed a high pressure supply; and

(*d*) Where the conditions of the supply are such that the pressure exceeds 3,000 volts, the supply shall be deemed an extra high pressure supply.

The expressions "factory," "workshop," and "quarry" have the same meaning as in the Factory and Workshop Act, 1901.

The expression "mine" means a mine to which the Coal Mines Regulation Act, 1887, or the Metalliferous Mines Regulation Act, 1872, applies.

Where these Regulations require any metallic body to be "efficiently connected with earth," it shall be connected with the general mass of earth in such manner as will ensure at all times an immediate and safe discharge of electrical energy.

Other expressions to which meanings are assigned in the Order or in the Electric Lighting Acts, 1882 and 1888, have the same respective meanings in these Regulations.

A.—REGULATIONS FOR SECURING THE SAFETY OF THE PUBLIC.

General.

1. The pressure of a supply delivered to any consumer shall not exceed the limit of low pressure, except for special purposes, for which a medium pressure supply may be given on the consumer undertaking to comply with the following conditions :—

(*a*) Where the supply is for power purposes—

(1) The frame of every electric motor shall be efficiently connected with earth.

(2) The consumer's wires forming the connections to motors, or otherwise in connection with the supply, shall be, as far as practicable, completely enclosed in strong metal casing efficiently connected with earth, or they shall be fixed in such a manner that there shall be no danger of any shock.

(3) The supply to every motor shall be controlled by means of an efficient cut-off switch, placed in such a position as to be easily handled by the person in charge of the motor, and connected so that by its means all pressure can be cut off from the motor itself, and from any regulating switch, resistance or other device in connection therewith.

(4) Switches, efficient fuses or other automatic circuit-breakers shall be provided, so as to protect the circuits from excess of current, and all switches and cut-outs shall be so enclosed and protected that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

(5) A notice shall be fixed in a conspicuous position at every motor and switchboard in connection with the supply forbidding unauthorised persons to touch the motors or apparatus.

(*b*) Where the supply is for arc lamps in series—

(1) The consumer's wires forming the connections to the arc lamps, or otherwise in connection with the supply, shall be, as far as practicable, completely enclosed in strong metal casing efficiently connected with earth, or they shall be fixed in such a manner that there shall be no danger of any shock.

(2) The supply to every arc lamp shall be controlled by means of an efficient cut-off switch, placed in such a position as to be easily handled by the person in charge of the arc lighting, and connected so that by its means all pressure can be cut off from the arc lamp itself, and from any regulating switch, resistance or other device in connection therewith. Provided that where the arc lamps are connected in series across the outer conductors of a three-wire system, it shall be sufficient if one such switch be provided for each series of arc lamps.

(3) Switches, efficient fuses or other automatic cut-outs shall be provided, so as to protest the circuits from excess of current, and all switches and cut-outs shall be so enclosed and protected that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

(*c*) Where the supply is for incandescent lamps in series—

(1) The consumer's wires forming the connections to the incandescent lamps, or otherwise in connection with the supply, shall be completely enclosed in strong metal casing, and this casing together with the switches and lamp holders, if metallic, shall be efficiently connected with earth.

(2) Switches, efficient fuses or other automatic cut-outs shall be provided, so as to protect the circuits from excess of current, and all switches and cut-outs

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shall be so enclosed and protected that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

Where the supply is for any special purpose other than those above-mentioned, or where the pressure of the supply exceeds the limits of medium pressure it shall be subject to such other regulations as the Board of Trade may from time to time prescribe.

This regulation shall not apply within the premises of a factory, a workshop, a mine, or a quarry.

2. When the pressure between the outer conductors of a three-wire system exceeds 250 volts and the three wires of the system or two pairs of wires are brought into a consumer's premises, the supply shall be given to two pairs of terminals arranged in such a manner that there shall be no danger of any shock, and the wiring from those terminals shall be kept distinct.

This regulation shall not apply within the premises of a factory, a workshop, a mine, or a quarry.

3. An extra high pressure supply shall not be given to any consumer's premises other than a factory, a workshop, a mine, a quarry, or electric traction works, waterworks, sewerage or drainage works; and no such supply shall be given to electric traction works, waterworks, sewerage or drainage works, except with the consent of the Board of Trade and subject to such regulations as the Board may prescribe.

4. The sectional area of the conductor in any electric line laid or erected in any street after the date of these Regulations shall not be less than that of a strand of seven wires, each of which is of No. 20 standard wire gauge, and the sectional area of every wire in a strand forming any such conductor shall not be less than that gauge.

This regulation shall not apply in the case of an electric line placed in a lamp-post.

5. Every low pressure and medium pressure main shall be tested for insulation after having been placed in position and before it is used for the purposes of supply, the testing pressure being the maximum pressure to which it is intended to be subjected in use, and in any case at least 200 volts, and the Undertakers shall duly record the results of the tests of each main, or section of a main.

6. The insulation of every complete circuit used for the supply of energy, including all machinery, apparatus, and devices forming part of, or in connection with, that circuit, shall be so maintained that the leakage current shall not under any conditions exceed one-thousandth part of the maximum supply current; and suitable means shall be provided for the indication and localisation of leakage. Every leakage shall be remedied without delay.

Every such circuit shall be tested for insulation at least once in every week, and the Undertakers shall duly record the results of the testings.

Provided that where any part of any electric circuit is connected with earth, either in accordance with these regulations or with the approval of the Board of Trade, the provisions of this regulation shall not apply to that part of that circuit so long as the connection with earth exists.

7. A high pressure circuit shall not be brought into use unless the insulation of every part thereof has withstood the continuous application, during half-an-hour, in the case of every electric line of a pressure twice the maximum pressure to which it is intended to be subjected in use, and, in the case of every machine, device, or apparatus, of a pressure 50% greater than the said maximum pressure.

The Undertakers shall duly record the results of each test.

8. Every high pressure main, conductor, or other apparatus shall be protected by a suitable fuse or automatic circuit-breaker.

Provided that it shall not be incumbent upon the Undertakers to provide such a fuse or circuit-breaker for the outer conductor of a concentric main which is, with the approval of the Board of Trade, efficiently connected with earth.

9. In every case where a high pressure supply is transformed for the purpose of supply to one or more consumers, some suitable automatic and quick-acting means shall be provided to protect the consumer's wires from any accidental contact with or leakage from the high pressure circuit, either within or without the transforming apparatus.

This regulation shall not apply within the premises of a factory, a workshop, a mine, or a quarry, where the high pressure transformer is under the jurisdiction of the Home Office.

10. The metallic portion of every high pressure transformer, with the exception of the conductors thereof, shall be efficiently connected with earth.

This regulation shall not apply within the premises of a factory, a workshop, a mine, or a quarry, where the high pressure transformer is under the jurisdiction of the Home Office.

11. Where any portion of any electric line or any support for an electric line is exposed in such a position as to be liable to cause injury from lightning, it shall be efficiently protected against such liability.

12. Where any accident by explosion or fire, or any other accident of such kind as to have caused or to be likely to have caused loss of life or personal injury has occurred at any part of any electric line or work, the Undertakers shall give immediate notice thereof to the Board of Trade.

Overhead Lines.

13. Overhead lines shall not after the date of these regulations be erected or maintained except in accordance with such regulations as the Board may prescribe; provided that this regulation shall not apply to any electric lines which have been erected at the date of these regulations so long as those lines are maintained in accordance with any regulations of the Board of Trade which are in force and applicable thereto at that date and with any requirements of the Board made thereunder.

Electric Lines other than Overhead Lines.

14. All conduits, pipes, casings, and street boxes used as receptacles for electric lines shall be constructed of durable material, and where laid under carriage ways shall be of ample strength to prevent damage from heavy traffic, and reasonable means shall be taken by the Undertakers to prevent accumulation of gas in such receptacles.

15. Where any electric line crosses, or is in proximity to, any metallic substance, special precautions shall be taken by the Undertakers against the possibility of any electrical charging of the metallic substance from the line or from any metal conduit, pipe, or casing enclosing the line.

16. All metal conduits, pipes, or casings containing any high pressure electric line shall be efficiently connected with earth, and shall be so jointed and connected across all street boxes and other openings as to make good electrical connection throughout their whole length.

17. Where the conductors of electric lines placed in any conduit are not continuously covered with insulating material they shall be secured in position, and no unfixed uninsulated material of a conducting nature shall be contained in the conduit. No such conductor shall be at a pressure exceeding 300 volts from earth.

Adequate precautions shall also be taken to ensure that no accumulation of water shall take place in any part of the conduit, and to prevent any dangerous access of moisture to the conductors or the insulators.

The insulators of any such electric line shall be so disposed that they can be readily inspected, but this requirement shall not apply to any such insulators which before the date of these regulations were not required by any regulation then in force to be so capable of ready inspection.

18. Every portion of any high pressure electric line placed above the surface of the ground, or in any subway not in the sole occupation of the Undertakers, shall be completely enclosed either in a tube of highly insulating material embedded in brickwork, masonry, or cement concrete, or in strong metal casing efficiently connected with earth.

19. Where any high pressure electric line is laid beneath the surface of the ground, efficient means shall be taken to render it impossible that the surface of the ground or any neighbouring electric line or conductor shall become charged by leakage from the high pressure electric line.

20. A high pressure electric line shall not be used for the supply of energy before it has been completely laid, properly jointed, examined and tested, or until it is in the sole charge of the Undertakers, and every such line shall during its use be in the sole charge of the Undertakers.

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Sub-stations and Street Boxes.

21. Sub-stations shall be established in suitable places and shall be in the sole occupation and charge of the Undertakers. Sub-stations shall be erected above ground wherever possible, but where necessarily underground, due provision shall be made for ventilation, and for drainage.

22. In addition to the provisions contained in Regulation 14 as to the construction of receptacles for electric lines, the following conditions shall be observed with respect to street boxes :—

(*a*) The covers of all street boxes shall be so secured that they cannot be opened except by means of a special appliance.

(*b*) The covers of all street boxes containing high pressure apparatus other than cables shall be connected to strips of metal laid immediately underneath the street and efficient means shall be taken to render it impossible that the covers or other exposed parts of these boxes, or any adjacent material forming the surface of the street, shall become electrically charged, whether by reason of leakage, defect, or otherwise.

(*c*) Where street boxes are used as transformer chambers, reasonable means shall be taken to prevent as far as possible any influx of water, either from the adjacent soil or by means of pipes ; and in the case of any such street box exceeding one cubic yard in capacity, ample provision shall be made, by ventilation or otherwise, for the immediate escape of any gas which may by accident have obtained access to the box, and for the prevention of danger from sparking.

(*d*) All street boxes shall be regularly inspected for the presence of gas, and if any influx or accumulation is discovered, the Undertakers shall give immediate notice to the authority or company whose gas mains are laid in the neighbourhood of the street box.

(*e*) Where mains at different pressures pass through the same street box they shall be readily distinguishable from one another.

23. The maximum power supplied to any underground sub-station or street box shall not, without the consent of the Board of Trade, exceed 30 kw. in the case of a sub-station or street box containing a single transformer, or 75 kw. in the case of a sub-station or street box containing two or more transformers.

Consumer's Premises.

24. The Undertakers shall be responsible for all electric lines, fittings, and apparatus belonging to them, or under their control, which may be upon a consumer's premises, being maintained in a safe condition and in all respects fit for supplying energy.

25. In delivering the energy to a consumer's terminals the Undertakers shall exercise all due precautions so as to avoid risk of causing fire on the premises.

26. A suitable safety fuse or other automatic circuit-breaker shall be inserted in each service line within a consumer's premises as close as possible to the point of entry, and contained within a suitable locked or sealed receptacle of fireproof construction, except in cases where the service line is protected by fuses in a street box ; but no fuse or automatic circuit-breaker shall be inserted in the intermediate conductor of a three-wire system.

27. All service lines and apparatus placed on a consumer's premises shall be highly insulated and thoroughly protected against injury to the insulation or access of moisture, and any metal forming part of the electric circuit shall not unless efficiently connected with earth be exposed so that it can be touched. All electric lines shall be so fixed and protected as to prevent the possibility of electrical discharge to any adjacent metallic substance.

28. Where the general supply of energy is a high pressure supply, and transforming apparatus is installed on a consumer's premises, the whole of the high pressure service lines, conductors, and apparatus, including the transforming apparatus itself, so far as they are on the consumer's premises, shall be completely enclosed in solid walls, or in strong metal casing efficiently connected with earth and securely fastened throughout.

29. The Undertakers shall not connect a consumer's wires with their mains unless they are reasonably satisfied that the connection would not cause a leakage from those wires or fittings exceeding one ten-thousandth part of the maximum supply current to the premises ; and where the Undertakers decline to make such connection they shall serve upon the consumer a notice stating their reasons for so declining.

30. If the Undertakers are reasonably satisfied, after making all proper examination by testing or otherwise, that a leakage exists at some part of a consumer's wires or fittings of such extent as to be a source of danger, any officer of the Undertakers, duly authorised by them in writing, or, if the Undertakers so require, an electric inspector, may, for the purpose of discovering whether the leakage exists at any part of a circuit within or upon any consumer's premises, by notice require the consumer at some reasonable time after the service of the notice to permit him to inspect and test the wires and fittings belonging to the consumer and forming part of the circuit.

In any case where the Undertakers require the services of an electric inspector under this regulation they shall pay him the prescribed fee.

If on any such testing the officer or the electric inspector discovers a leakage from the consumer's wires exceeding one ten-thousandth part of the maximum supply current to the premises, or if the consumer does not give all due facilities for inspection and testing, the Undertakers shall forthwith discontinue the supply of energy to the premises in question, giving immediate notice of the discontinuance to the consumer, and shall not recommence the supply until they are reasonably satisfied that the leakage has been removed. This regulation shall not affect any power contained in the Order or otherwise enabling the Undertakers to discontinue the supply.

31. If any consumer is dissatisfied with the action of the Undertakers in refusing to give, or in discontinuing or in not recommencing the supply or energy to his premises, the wires and fittings of that consumer shall, on his application and on payment of the prescribed fee, be tested for the existence of leakage by an electric inspector.

This regulation shall be endorsed on every notice given under the provisions of either of the two last preceding regulations.

Arc Lighting.

32. Arc lamps used in any street for public lighting shall be so fixed as not to be in any part at a less height than 10 ft. from the ground.

33. All arc lamps shall be so guarded as to prevent pieces of ignited carbon or broken glass falling from them, and shall not be used in situations where there is any danger of the presence of explosive dust or gas.

Connection of Circuits with Earth.

34. Where the pressure of a supply between the adjacent conductors of a three-wire system of mains exceeds 125 volts, the intermediate conductor shall be connected with earth in accordance with the following conditions :—

(*a*) The connection with earth of the intermediate conductor shall be made at one point only on each distinct circuit, namely, at the generating station, sub-station, or transformer, and the insulation of the circuit shall be efficiently maintained at all other parts.

(*b*) The current from the intermediate conductor to earth shall be continuously recorded, and if it at any time exceed one-thousandth part of the maximum supply current, steps shall be immediately taken to improve the insulation of the system.

Penalties.

35. If the Undertakers make default in complying with any of the preceding regulations, they shall on conviction be liable to a penalty not exceeding £10 for every such default, and to a daily penalty not exceeding £10.

The recovery of a penalty under these regulations shall not affect the liability of the Undertakers to make compensation in respect of any damage or injury which may be caused by reason of the default.

B.—Regulations for Ensuring a Proper and Sufficient Supply of Electrical Energy.

1. From the time when the Undertakers commence to supply energy through any distributing main, they shall maintain a supply sufficient for the use of all the consumers for the time being entitled to be supplied from that main ;

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and that supply shall, except so far as the Board of Trade may otherwise from time to time permit, be constantly maintained, and in the case of continuous currents, without change of polarity. Provided that, for the purposes of testing, or for any other purposes connected with the efficient working of the undertaking, the authority by whom the electric inspector is appointed may give permission to the Undertakers to discontinue the supply at such intervals of time and for such periods as that authority may think expedient. When the supply is so discontinued, or the polarity is changed, notice to all persons likely to be affected shall be given of such discontinuance, or change, and of the probable duration thereof.

2. The system of distributing mains shall be separated into sections corresponding approximately to the different feeders, and these sections shall be interconnected only through suitable circuit breakers or fuses, arranged so as to be easily inspected.

3. Before commencing to give a supply of energy to any consumer, the Undertakers shall declare to that consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared shall be constantly maintained, subject to a variation not exceeding 4% above or below the declared pressure, under any conditions of supply which the consumer is entitled to receive, or such other variation as the Board of Trade may from time to time allow, and shall not be altered or departed from to an extent greater than that variation except by consent of the local authority, and upon such terms and conditions as the local authority may impose, and after public notice has been given during a period of one month, in such manner as the local authority may require, of the intention of the Undertakers to apply for consent to alter the same. If the local authority refuse to consent to an alteration or impose any terms or conditions with which the Undertakers are dissatisfied, the Undertakers may appeal to the Board of Trade, whose decision shall be final.

Provided that any regulation in force at the date of these regulations whereby the consent of any consumer (or in default thereof the consent of the Board of Trade) was then required to a change in the declared constant pressure to that consumer's premises shall, notwithstanding anything in these regulations, continue of full force and effect in the case of any consumer whose consent was then so required, and shall apply in that case as if it had been expressly set out in these regulations.

4. Before commencing to give a supply of energy to any consumer, the Undertakers shall declare to that consumer the system which they propose to adopt, whether alternating or continuous current, and, in the case of alternating current, the frequency, that is to say, the number of complete periods per second at which they propose to supply. The system and frequency so declared shall be maintained subject, as respects frequency, to a variation not exceeding 2½% above or below the declared frequency, and shall not be altered or departed from except by consent of the local authority, and upon such terms and conditions as the local authority may impose, and after public notice has been given during a period of one month, in such manner as the local authority may require, of the intention of the Undertakers to apply for consent to alter the same. If the local authority refuse to consent to an alteration or impose any terms or conditions with which the Undertakers are dissatisfied, the Undertakers may appeal to the Board of Trade, whose decision shall be final.

5. If the Undertakers make default in complying with any of these regulations as to supply, they shall, subject to the provisions of the Order, be liable on conviction to a penalty not exceeding £5 for every such default, and to a daily penalty not exceeding £5.

RAILWAY RATES AND THE ELECTRICAL TRADE.

BY S. WHETTALL.

Most manufacturers and traders are directly interested in the railway rate question, and, considering the inadequate methods available to the public for checking the railway accounts, the writer, who was with one of the leading railway companies for many years, has gathered together a few facts and figures connected with railway rates and accounts. The number of overcharges in railway accounts is very large, and the amount which goes annually into the coffers of the various railway companies from this source would astonish anyone not conversant with the enormous turnover of the railway companies each year. Experience has proved to the writer that the amount of the overcharges made exceeds ¼% of the net receipts for carriage on merchandise. This is a moderate estimate, considering the amount of unclaimed rebates and wrong higher rates charged. The matter and information contained herein is based on experience gained not only whilst on the railway, but also in commercial practice, so the writer is able to show both sides of the question. The matter has been placed in as a simple a manner as possible, with the object of showing the small trader, as well as the larger manufacturer, the best methods of checking railway rates. There is no doubt that traders are in numerous instances paying more than they should for railway carriage, owing to (1) Lack of knowledge on the part of the railway invoice clerk of both the traffic and the classification thereof. (2) Pressure of work preventing the railway clerk from taking sufficient care so as to avoid making mistakes. (3) Ignorance of railway rates and matters on the part of the public. (4) Errors made in not consigning properly. It is, perhaps, a peculiar thing to say, but, nevertheless, it is a fact, that when a railway company (through its officials) make a mistake in the rates they usually err on the side most beneficial to themselves. This is caused by their having young and inexperienced men, who think that as long as they charge sufficient, it will suffice, and, although the rates are supposed to be checked, the overcharges are frequently passed over by the checker. A great many mistakes are made in the weights of the articles, and it is surprising to notice some of the methods used at many railway goods sheds, as frequently when a package is bulky the weight is simply guessed. A moderate estimate of the amount which the railway companies obtain in overcharges would be £1,000 per week. This, no doubt, appears astounding to most people, but it would be no exaggeration to say that this is really under the actual figure, as the ways in which the overcharges can occur are so many and so varied that, considering the gigantic size of the iron roads, it is astonishing that the public are not overcharged to even a greater extent. As an instance of the prolific number of overcharges in railway accounts, the writer was asked a short while ago to check a certain firm's railway carriage accounts, when overcharges to the extent of £60 were discovered in accounts that had already been paid. Cartage rebates for hundreds of tons of goods that had never been handled or carted by the company had not been claimed or received by the firm.

It was noticeable that in almost every instance the highest possible rate had been charged, although in many cases a lower rate was applicable. Whilst the public remain in ignorance of the rates and have no private rate book compiled, so long will they have to pay for mistakes made by the inadequate and sometimes inexperienced staff employed on the railways. Things are getting cut fine on the railways, and the profits are probably not so large as they might be; but, at the same time, it must be borne in mind that very few of the existing rates would bear increasing. It would take no stretch of imagination to predict there will be considerable friction ere long between the traders and the railway companies with regard to the carriage charges, so that it behoves the trader to get as much information on the railway rate question as possible. Competition between the railway companies has had the tendency to lower the rates and of granting better facilities to the traders; but the present attitude of the railway companies makes it appear that in the near future their policy will be to do away with as much competition as possible by coming to some mutual arrangement with each other, thereby making matters so much the worse for the trader.

A list of some of the goods used in the electrical trade is given hereafter, along with the class of rate which the traffic is chargeable under, and these particulars will, doubtless, be of service to the reader. The traffic carried for the above-mentioned trade is usually charged for in any of the following classes—C. 1, 2, 3, 4, 5. Class C is the lowest rate amongst the above-mentioned six rates.

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Class 1 is lower than 2, but higher than class C.
„ 2 „ 3 „ „ 1.
„ 3 „ 4 „ „ 2.
„ 4 „ 5 „ „ 3.
„ 5 is the highest rate.

Example :—Classes C 1 2 3 4 5
Per ton .. 17/- 22/- 27/6 31/9 37/7 45/-

The list mentioned above is :—	Class
Armatures for generators or motors in cases	2*
Accumulator lead plates (worn out) from electrical accumulators	C
Do. in less lots than 2 tons	1
Accumulators, electric, containing acid, owners' risk	2
Do. do. dry	2
Do. do. wood boxes, lead lined	2
Do. do. lead plates for packed	1
Acid, sulphuric, diluted, owners' risk	5
Do. do. under 3 tons, minimum 5s. per consignment—Double	4th
Batteries, electric, containing acid, owners' risk	3
Do. do. Carbon candles or rods packed	2
Do. do. carbon plates for, packed	2
Do. do. dry cells for, packed	2
Do. do. leclanche cells for, in parts, packed	2
Do. do. magancal and carbon blocks for	1
Do. do. oxide of copper plates for, packed	3*y*
Do. do. porous pots for, packed	2
Do. do. zinc (rods, plates, or cylinders), packed	1
Do. do. or battery cells, not containing liquid, e. h.p.	3*y*
Commutators for generators in case	2*
Electric arc lamps (excluding globe and carbons), complete or in parts, in cases or casks	3
Do. e.o. h.p.	4
Electric cable	2
Do. scrap, cut into short lengths	1
Do. junction boxes, cast iron	C*i*
Do. terminal boxes, cast iron with brass fittings	2*y*
Do. in less lots than 2 tons	1
Do. wood supports for	1
Electric controllers, in cases	2*
Do. insulators, earthenware, packed	1
Do. e.o. h.p.	2
Do. lamps, incandescent	4
Do. light switches, made partly of earthenware and partly of brass	3
Do. lighting candles (carbon)	2
Do. meters	3*
Do. switch boxes, iron	2
Do. transformer coils, in cases	2*
Electric underground wireways, iron	C*i*
Electrical indicators, small boxes, containing discs	3
Do. instruments for lighting and power	4
Do. do. telephone purposes	4
End plate for generators, iron or steel	C*i*
Field coils for generators, in cases	2
Field pieces and housings for generator iron or steel, rough, unfinished	1
Field pieces and housings for generators, iron or steel, whole or in sections, finished, without windings	2
Field pole, pieces, iron or steel	2
Generator parts, e.o. h.p., in cases	2
Magnets for generators, iron or steel, rough, unfinished	1
Magnets for generators, iron or steel, whole or in sections, without windings	2
Magnet limbs, for generators, iron or steel, rough, unfinished	1
Do. for generators, iron or steel, whole or in sections, finished, without windings	2
Dynamos, in cases	2
Do. e.o. h.p.	3*y*
Motors as dynamos	
Rheostats, in cases	2
Shrink rings, for generators, iron or steel, whole or in sections, protected by packing	1*i*
Shrink rings, keys, iron or steel	1*i*

Class C rate is applicable to loads of 2 tons and upwards, when under 2 tons the traffic is chargeable (when cheaper) at actual weight at 1s. 5d. less than class 1 rate. Class C rate is a station to station or not carted rate. The services included in the rate are :—Conveyance over the railway, use of railway companies wagons and sheets, use of stations, loading and unloading, and practically every service excepting cartage. Classes 1, 2, 3, 4, 5 are collected and delivered rates or carted rates. These latter rates include all the charges mentioned for Class C and the charge for cartage in addition. Should the trader perform any of the services mentioned above as being included in the rate charge the trader should claim for a rebate or allowance for same. Some of the places where overcharges frequently occur are :—

(1) By charging traffic in lots 3 cwts. or under, in more than one lot from the same sender to the same consignee separately instead of lumping all the lots together. By charging separately the railway company obtain the benefit of the small scale under which they are empowered to make an additional charge from :: up to 1s. 6d. to the tonnage charge ; the amount varies according to the price of the rate.

(2) Overcharges in weight owing to the carelessness on the part of the railway officials.

(3) Charging wrong higher rates through placing incorrect interpretation on classification of the goods. When a railway clerk is not certain about the class under which a particular article is classified, he usually charges the higher rate ; then, if the trader complains about the rate, a refund is made. But, supposing an undercharge is made by charging a lower rate, and frequently it happens that the trader declines to pay the undercharge, the onus thus falls upon the railway clerk, hence the reason for always charging sufficient in the first case.

(4) Charging class rates when there are special and lower rates in operation.

(5) Not making allowance for the difference in the terminal charges when traffic is under the minimum load, and it is thus chargeable at a higher class of rate at the actual weight.

(6) Not making any reduction when traffic is sent at owners' risk, and there is a reduced rate for the traffic so consigned.

(7) Charging both the sender and the consignee with the carriage owing to the railway invoice having gone astray or a mistake being made by the railway people.

(8) Empties are often charged at a higher mileage than is correct.

(9) Should goods not be fully described on the consignment notes they are charged by the railway companies at Class 5, which is the highest rate, and in innumerable instances the traffic should be charged at a much lower rate.

NOTES ON THE ABOVE LIST :—

* Subject to special arrangement when of unusual length, bulk or weight, or of exceptional bulk in proportion to weight.

† If not properly protected by packing, will only be accepted at Owner's Risk, and no reduction is made off the rate.

i Iron or Steel list. Any special rate applicable to the Iron and Steel list applies to traffic so marked, and the special rates are usually lower than the ordinary class rates, which is a point worth bearing in mind.

y If an Owner's Risk note is signed, this traffic is carried at 15% less than the ordinary class rate, and the trader will sometimes find it favourable for the goods to be sent at the Owner's Risk rate, although this is not the case when the traffic is particularly fragile.

TELEPHONE EXTENSIONS IN THE TRANSVAAL.

The Imperial Trade Correspondent at Durban (Mr. A. D. C. Agnew) has, says the *Board of Trade Journal*, forwarded an extract from the *Natal Mercury*, which states that further extensions and improvements of the Transvaal telephone and telegraph services are in hand. Every town not yet linked up with the telephone system is to be brought into it, and the main trunk lines are to be carried to every point where the railway lines cross the border, with a view of preparing the way for the ultimate extension to the coastal ports and Bulawayo. It is regarded as certain that the Union Government will find telephonic communication between Cape Town and Pretoria absolutely essential under the proposed arrangement by which Parliament will meet at a place so far removed from the administrative centre. The scheme contemplates connections with farmhouses, and the establishment of call offices at convenient centres in rural districts. It is estimated that the coast extensions definitely undertaken will cost £250,000.

A receiving order has been made in the case of Herbert Shuttleworth, Cross-court, Briggate, Leeds, electrical engineer.

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ASSISTED ELECTRIC GENERATING PLANTS.

[This article, which appeared in the *Manchester Guardian*, is one of considerable importance to the electrical industry, and is commented on fully in our leading article.]

The purpose of this article is to outline a scheme under which the electric power of, say, a factory may be derived in part from its own generating plant and partly from an outside source such as a public supply. This arrangement is particularly suitable for adoption where the home generating plant is driven by gas engines, but it is also applicable where steam engines are employed. It is well known that the cost of electric energy is very largely dependent upon the load factor of the generating plant, that is, upon the ratio of its actual to its maximum possible total output for a year. The object of the assisted electric supply scheme is to raise the load factor of the home generating plant by running it at approximately full load during working hours, the peak loads being carried by means of current from the outside supply. This would involve a very irregular demand on the public supply from the individual consumer, and in part this irregularity and the poor (individual) load factor that it denotes would unfavourably influence the central generating station. Where, however, a number of assisted plants were connected to the public supply, the irregularities of their demands would overlap and to a large extent eliminate any detrimental influence.

The load factor of a generating plant affects the cost of power in three ways. The higher the load factor the less are the capital charges per unit or per h.p. hour, the less are the attendance and repair charges per unit, and the smaller is the fuel consumption per unit. The proportional effect of the first two of these charges is pretty much the same whether steam, gas, or oil engines supply the motive power, but the last—fuel consumption—is less influenced in a steam plant than with the other two. Some engineers, reasoning from central station theory, may be inclined to think that the reverse is true, and that it is in the steam station that the fuel consumption is most influenced by the load factor. Whether or not this relation would hold in the case of central stations we need not argue here, for in any case the conditions are different. In the central station there are a number of generating sets, and the engineer in charge varies the number in operation, so that each is running at nearly full load, and therefore at nearly maximum economy. On the other hand, the stand-by losses due to banked fires, leakage, and radiation are more serious in steam than in gas plants. Hence it is arguable that a low-load factor is especially detrimental to the economy of a central station steam plant. But in the case of a small factory plant it is seldom possible to adjust the number of engines in use to suit the fluctuations in load, and the average load is, therefore, considerably below full load. In the case of gas and oil engines this means a much greater falling off in economy than with a steam engine, and, further, there being no stand-by plant, the advantage to the gas engine from this cause does not appear. For instance, suppose that the average load is 50 b.h.p. and the maximum 80 b.h.p., the gas engine must then be capable of supplying continuously 85 b.h.p., so that its average load would only be 59% of its rated full load, and its gas consumption per h.p. would be about 20% greater than at full-rated load. On the other hand, 85 b.h.p. could be carried by a steam engine of which the normal full load was not more than 60 to 65 b.h.p., provided an expansion valve was fitted to vary the cut-off. The steam engine would then take the average load at its lowest steam consumption per h.p., and even if a throttle valve was employed, the extra steam consumption would only be 12%. It is not proposed here to compare the value of steam and gas plants for factory driving, but only to point out that an assisted supply is particularly desirable when gas engines are used. Another argument with the same lesson is the fact that the large gas engine on a small load is not only uneconomical of fuel, but also of capital outlay. Since it has no overload capacity, it must always be bought on the basis of the maximum and not of the average load. Thus in the case stated above, the size of the gas plant could be reduced from 85 to 55 b.h.p. and its price cut down by about 25%. Even in the case of the steam engine, there would be a reduction in the capital outlay of from 10 to 20% according to conditions.

On the technical side there is no great difficulty in satisfactorily arranging an assisted supply. Where the load at the factory changed only slowly, hand regulation of the factory generator would be sufficient. This would almost always be the case in large factories. Where necessary, however, the proper apportionment of the load could be made automatic. For instance, an automatic reversible booster could be placed in series with the external supply, just as is at present done with buffer batteries on traction systems. With this arrangement power would sometimes be delivered from the factory to the outside supply system, but the meter would, of course, register the net inputs. Another method would be to place the switch on the outside supply under the control of the current from the factory generator, so that the public supply was automatically switched on as the factory load approached the full load of its own generating plant. Once the outside supply had been switched on some device for maintaining approximately full load on the factory plant would be necessary. A booster could be used or, perhaps more simply, an automatic switch regulating the voltage on the factory generator, so as to maintain an approximately full-load current, the switch being brought into operation by the closing of the outside supply switch, and being governed by the factory generator current. In any case no great difficulty should be experienced in devising satisfactory regulating devices.

It is, perhaps, hardly to be expected that central station engineers will welcome a scheme which appears to be devised to restrict their motor load; their great aim in life being to increase this class of load. However, it is not at all certain that an assisted supply would not add to, rather than reduce the consumption of current for power purposes; although it may be admitted that the load on the power station would not be quite so steady except in the case of large supply systems. One of the most important considerations with a factory owner or tenant is capital outlay. It is quite certain that many such instal electric motors in the first instance in order to avoid the heavier capital outlay which would be required if steam or gas engines were to be employed, and it is equally certain that many factory owners are influenced in their decision not to adopt the electric drive and take current from an outside supply because of the cost of scrapping existing engines, boilers, and producers. Hence when it becomes necessary to extend their power plant, they are likely to extend it along existing lines. If, however, they are offered a satisfactory assistant supply, they are likely to consider it favourably. At present, when a manufacturer takes current from an outside supply as well as generates his own, he has to keep the two systems separate, and so loses the advantages of an assisted supply outlined above. Consequently the outside supply does not appear to him in its most attractive light, and it stands correspondingly less chance of favourable consideration. An assistant supply should be an integral part of the whole power supply, and, therefore, capable of indefinite expansion until it absorbs the whole system. This, indeed, is what would be most likely to happen in practice. As the existing plant became too small, or worn out, or inconvenient, the factory owner would be strongly tempted to throw more and more load upon the outside supply until finally the conversion would be complete. Indeed, the assistant supply promises to be the thin end of the wedge which central station engineers are so desirous of inserting into the power plants of existing factories.

ELECTRIFICATION OF AUSTRALIAN RAILWAYS.

The suggestion for electrifying the Melbourne suburban railway system, as recommended by Mr. Charles H. Merz in a special report to the Victorian Government, has not been favourably received by the Victorian Railway Commissioners. The magnificent success achieved by the conversion of the Sydney suburban system, writes a *Financial Times* correspondent, refutes the Victorian Commissioner's arguments that electrification would not pay in Melbourne. At June 30, 1908, the New South Wales State Tramways had cost £3,288,500, and they showed a net gain of £71,500, after paying all working expenses and interest on capital. The steam lines, with a total length of 43½ miles, belonging to the State, are run at a net loss of £3,100 a year. The New South Wales Railway Commissioners announce that they mean to electrify all their steam lines at an early date. During the past nine years, since the inception of electrification, the length of line has increased about 80 per cent. at an outlay of double the original capital, and three times the original number of passengers are carried. The interest return on the capital invested has risen from 4 to nearly 6 per cent. The total length of single track operated by electricity is 146 miles. The substitution of electric power for steam has been successful in every respect and the most important result of the change is not seen in the figures—namely, the extension and development of the city of Greater Sydney. The fares are charged on penny sections, about 1½ miles each, and workers can live a long way from their work, in better houses with more land, amid fresher air. The Sydney railway authorities contemplate a complete metropolitan scheme of underground electric traction, designed to help the future development of the city. With the Sydney example staring them in the face, it is extraordinary the Victorian Railway Commissioners should object to electrification. Unfortunately they are all three steam railroad men, with no knowledge of electric traction, so the expansion of the great City of Melbourne and the convenience of its citizens must await the advent of more modern railway experts.

NEW CATALOGUES.

Mr. James Ferguson, of Pollock-street, Pollokshaws, Glasgow, has issued a price list of his electrical switch gear, complete switchboards, etc.

"Trinidad Lake Asphalt" is the title of an attractive little pamphlet just issued, dealing with the Trinidad Lake-Asphalt industry and its product.

Messrs. Haslam & Schontheil, Cardiff, have issued a new catalogue of electric light, cast iron, water-tight fittings, etc., for collieries, factories, mills, ships, railways, and general lighting.

Messrs. Siemens Bros. & Co., Ltd., have issued the August supplement to their catalogue No. 509, describing ignition coils for use with dry cell batteries, and, in particular, with their own Siemens-Obach dry cells.

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CORROSION OF METAL STRUCTURES BY ELECTROLYSIS

BY A. A. KNUDSON, E.E.*

On the subject of the corrosion of the bottom of oil tanks and of other structures by electricity, a case of most pronounced corrosion has recently come to the author's notice, and this, it seems plain, comes squarely under the head of electro-chemistry. The case in question is the destructive effects found upon the bottom of oil tanks. Three such tanks have been examined and form the principal subject of this paper. Two of these are located in the gas works of an eastern city and one in the Standard Oil Works of another city. Discussing first the two tanks at the gasworks, these tanks which are located on the end of a dock are enclosed within a concrete wall, with concrete foundations; this presumably to prevent oil flowing into the harbour in case of leaks or fire. Both of these tanks were discovered to be leaking. The oil was run off and sediment of a consistency soap of soap removed. The numerous pittings and holes in the bottoms suggested to the men at first, electrolysis due to railway currents, as it was known such currents were flowing through the works. When the writer was called to examine, the first discovery made was the pittings originated at the interior of both tanks, the larger part of such pittings on the inside floor, and tapering downward, many of them terminating in holes through the iron. These holes ranged in size from ¼ in. in diameter to more than 1 in. in several cases.

These two tanks have been in service seven years. As they were much needed for storing oil, temporary repairs have been made by filling the pittings and holes with litharge and red lead, but it is probable that new bottoms will soon be placed in them. Samples of water obtained from the bottom of two of the gas company's tanks have been analyzed, the certificate stating that one contained 1·6% mineral residue, mostly salts of soda, and the other 1·3%, and that both solutions react alkaline. Tests have been made to ascertain the electrical conditions due with stray railway currents, as possible corrosion from this source, it is thought, might be going on at the underside of these bottoms. Railway currents have been discovered passing through the gas company's yard, mostly going through and leaving the ends of the power-house suction pipes placed in the river. One of these suction pipes, a 20 in. cast-iron, entered the river quite near these oil tanks. Current flow on this pipe was found passing to the river, ranging from 1 to 4 amps. maximum. The strainers at the end of this pipe have twice been destroyed by electroylsis. The voltmeter readings between tanks and river were taken several times during the past year. The tanks have always been found positive to the river. Tests for current flow on the 6 in. pipe connecting with the two tanks have also been made several times during the past year, but in no case has a flow been detected. There being no other pipes connecting with the tanks, it was concluded that no current was leaving them, notwithstanding 1 voltmeter indications. It is a question of the indications of feeble thermo. electricity play any part in the corrosion discovered, but it is mentioned as an item for possible discussion.

The pittings and holes found in the tank at the Standard Oil Works were very similar to those discovered in the other two. In this tank the roof supports were of steel, of the umbrella pattern. A second pipe, called a swing pipe, is used for drawing off the oil. It has a loose joint at the base, and a chain attached at the far end, the pipe being about 20 ft. long; the other end of the chain passed through an opening in the roof. The end of the pipe is thus lowered to take the oil from near the surface. When the writer visited this tank, it was cleaned out and one of the side plates removed preparatory to placing in it a new bottom, the former one being so badly corroded it was deemed unfit for further use. This tank had been in use 13 years. The interior sides of all three of these tanks were carefully examined, and no sign of corrosion of any kind could be found.

After calling attention to the great danger of explosion and fire in oil tanks from lightning by the pressure of the chain on the swing pipe, he says that in this case of such pronounced corrosion of oil tanks, these must of necessity be definite and pronounced cause. It is well known that crude oils contain more or less sulphur. In the purifying process we find it customary to subject such oils to treatment with sulphuric acid, and after that, to caustic soda. The oil is then, after each treatment, washed with water. It is reasonable to suppose that traces of acid or alkali remain with the oil when shipped away. When oil is shipped by steamers or lighters on the sea coast, which is often the case, there is more or less leakage through the roofs of the tanks. This layer of water which rests upon the bottom of oil tanks contains electrolytes, which are the products of the chemicals referred to, and are distributed over the surface of the iron bottom. Either through impurities of the iron, or from other causes, potential differences obtain, in other words, innumerable small galvanic couples are originated, which, when started, carry on the work of destruction.

Discussing remedies, the writer says:—"The use of bichromate solution as a protective measure for corrosion of iron has been strongly recommended by Dr. Cushman in his papers and letters, and to myself at a personal interview. His opinions are, it is well known, based upon the results of carefully conducted experiments and we believe worthy of the most favourable consideration. If this method is applied to oil tanks, we think it should be sent into the tanks from the same intakes as the oil, as in such case the remedy would be distributed where most damage occurs. In one instance, as a protection from corrosion, it was proposed by the manager of an oil works to place a layer of concrete upon the floor of tanks. We expressed doubts of this method being effective protection, in view of former experiments by the writer on corrosion of iron in concrete. Owing to the well known absorption qualities of concrete, water containing electrolytes would naturally pass through it to the iron bottom, probably causing the concrete to crack at points where electrolytic action takes place. Attempts have been made by some to prevent the absorption properties of concrete by incorporating with it certain waterproof materials, but we have no data to present at this time of the efficiency or otherwise of concrete so treated."

Referring to the Rochester steel conduit, Mr. Richard H. Gaines has given an interesting account of the corrosion of this water main in a paper before this society, at the Albany Meeting, April 30, 1908. We are inclined to believe with those who took part in the discussion that the author's conclusions should not be accepted as final, where he states: "The corrosion of the Rochester steel conduit was caused by electrolysis, the current for which resulted from chemical processes between water solution in the soil and the metal."

The deposition of both iron and lead has often been found by the writer upon pebbles, stones and soils adjacent to pipes which were undergoing electrolysis. While it is appreciated that electro deposition of iron is difficult under the most favourable instances, the samples, submitted for the inspection of the Society, are shown as a suggestion that there may be something in the process of underground electrolysis not fully understood. Finally, it would seem, as Prof. Ganz has stated, that co-operation in important cases between the stray current specialists and the electro-chemist would be desirable, and to that end we have brought this case of oil tank corrosion, as well as other matters, before this society for discussion, believing they are of the widest importance, and particularly refer to electro-chemistry.

* Abstract of paper read before American Electro-Chemical Society.

ELECTRICAL ENTERPRISE IN JAPAN.

There is likely to be a good opening for British electrical manufacturers in Japan in the near future. Until recently, an American firm had practically a monopoly for machinery, equipment, etc., in the Osaka district, but latterly British and German firms have secured contracts. With the opening up of electric railways and the extension of various electric light companies it is probable, writes the British Vice-Consul at Osaka, that large quantities of electrical machinery, etc., will be required during the next few years. It is impossible for manufacturers to secure contracts for machinery, etc., unless they have an experienced representative on the spot, as a knowledge of local and personal considerations and the methods of tendering, is absolutely essential.

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ELECTRICAL PROPULSION FOR SHIPS.

Interview with Mr. W. P. Durtnall, M.I.Mar.E.

"The marine engineering industry is on the eve of an awakening such as has never before been recorded," predicted Mr. W. P. Durtnall, M.I.Mar.E., M.I.Auto.E., in an interview on the problems of electrical power transmission on ships. A representative of the ELECTRICAL ENGINEER found Mr. Durtnall, who is a pioneer in this matter, busily engaged at his offices in Bush-lane, Cannon-street, London, E.C., drafting a scheme for a 2,500 cargo boat, to be fitted with his "Paragon" electrical power transmission for main marine propulsion. The plans are now practically completed, and the machinery will be constructed by a first-class firm in this country.

The whole secret of this latest development in electrical engineering, from the marine standpoint, he declared, lies in the production of modern efficient and light-weight prime-movers, such as steam turbines and internal combustion engines and their suggested application for main marine propulsion. Although he has been working on this subject now for eight years, it is only during the last two years that marine and electrical engineers have really given it serious consideration. It was an unfortunate fact concerning marine engineers that, though willing in many cases to grasp at every increase in efficiency, their knowledge of the possibilities of modern heavy electrical engineering was, up to quite recently, very limited. On the other hand, electrical engineers had not put that energy which was absolutely necessary into the research and ultimate development of this tremendous undertaking. Moreover, he was of opinion that the principals of large engineering concerns might have compelled their technical staffs to approach the subject with more earnestness than that which was for many years generally exhibited. The question of the electrical propulsion of an ocean liner, even up to three years ago, was looked upon as an impossibility, if not an amusing idea, and the majority of the electrical engineers meekly accepted the verdict of the pessimists. The ultimate result was that, instead of this vast field being now in active operation, real advance had been delayed.

But Mr. Durtnall cherishes great hopes of development in the near future. He has staked both reputation and time in investigating the possibilities of this progressive move by travelling under seagoing conditions, watching minutely the published tests of turbine and reciprocating engine boats, and simultaneously working on a similar problem of electrical power transmission for automobile and ordinary road traction purposes.

"My experiments," he asserted, "have proved conclusively that electrical power transmission for marine propulsion is not only possible, but, from the shipowners point of view, inevitable. In the coming decade superheated steam must be used in small diameter high-speed steam turbines in conjunction with electrical power transmission to slow and, therefore, efficient propellors, which will bring about such low coal consumption per ton of displacement per mile at given vessel speeds that no shipping firm will be able to subsist without it. During the progress of my experimental and research work, I was naturally drawn to the possible uses of continuous current apparatus. But, on carefully studying the mechanics and other characteristics of the marine propellor under various working conditions, I found it was impossible to use any sort of electric motor for the final drive that embodied the use of commutation. I have, therefore, devoted considerable time and attention to bringing out a system by means of which, I claim, the simplest and strongest of electric motors may be used for these purposes."

The view is held by Mr. Durtnall that the "squirrel cage" polyphase current induction motor, when supplied with current at periodicity which is equal to its top-speed, is unsuitable owing to the small starting torque that would be developed. In his "Paragon" power electrical transmission system polyphase alternating current is generated and utilised at variably periodicity. For starting very large motors without the use of resistances—consequently avoiding great electrical losses—current is supplied to the motors at extraordinary low periodicity, thereby also porviding means of efficient variable speed being given in either direction to the propellor. According to the propellor speed required the periodicity from these most interesting generators is selected. Thus, from the electrical standpoint, he claims that it is a combination capable of developing the maximum of efficiency.

Discussing some of the objections to the new idea, Mr. Durtnall pointed out that in reference to weight it must be remembered that steam power required per h.p. delivered to the propellor is less, and, therefore, the total weight of the stokehold equipment, together with the pumping and auxiliary pipes, etc., is reduced. The introduction of small light-weight high-speed turbines and the shorter length of propellor shaft must all go towards reducing the total weight of the steam plant and propellor machinery, as compared with the ordinary reciprocating engine or steam turbine fitted vessel. Taking, for example, the case of a cargo boat of 1,250 i.h.p., the reduction of weight would be about 16%, while for a 10,000 h.p. Atlantic liner there would be a reduction of 22%. The larger the installation, the greater would be the reduction in weight.

"And what do you think of the difficulty raised as to breakdown of insulation?" asked the interviewer.

"It seems to me," Mr. Durtnall replied, "the fears are more imaginary than real, as the voltages that will be used are extremely low. In the case of the cargo boat referred to, the voltage between phase would be 250, and in the case of the liner only 400. It must be remembered that the distance the power has to be transmitted is comparatively small."

Next Mr. Durtnall's attention was directed to the objection on the ground that electric motors cannot be built small enough in diameter for installation in the after lines of a vessel.

"This is an absolutely mistaken idea," he insisted. "My squirrel cage induction motors with single stator windings can be constructed with very high efficiency with the minimum of diameter and heating effect. Owing to supplying the motor direct with current at a periodicity which is suitable for the speed, low speed may be obtained without excessive heating and consequent loss of energy." He went on to observe that few of the critics have so far realised that, quite apart from statements generally made, one of the principal obstacles which he had had to overcome was the disposal of the heat from both generators and motors. The control of the very large motors by his system, he held, was the acme of simplicity, and might be directed at the engine room or by remote control from the flying bridge. In his opinion the auxiliary of a large steamer will have to be so constructed as to be supplied from separate auxiliary generating plant. It must be remembered that, in the case of sudden reversal becoming necessary, great confusion would arise if the excitation of the main generators were taken off with a view to changing connections under no-voltage conditions, which he advocated, for reverse. There are other and extensive problems that have had to be overcome, but my statement of application is on the assumption of the use of high speed steam turbines. There is another prime mover which is now making very rapid strides to the front, viz., the high speed internal combustion engine, with its extreme light weight and high thermal efficiency. Investigation proved to him that it is almost an impossibility, owing to the thermo dynamic principles involved, to make a satisfactory reversing gas engine for main marine propulsion.

Finally, Mr. Durtnall mentioned that he is receiving important and extensive inquiries for his system in this connection for irreversible suction gas and oil engines, which have come about after very close and minute investigation by the internal combustion engine manufacturers concerned. Before leaving, our representative had the pleasure of perusing a number of letters from naval engineers of high rank, and marine engineers, and manufacturers in different parts of the world, inquiring into the merits of the system, the success of which Mr. Durtnall is absolutely confident.

The works of Messrs. Ferranti, Ltd., Hollinwood, Lancashire, will be closed for the annual district holidays as follow:—Switch department, August 28 to September 4 inclusive; meter department, August 28 to August 31 inclusive. The offices will be open as usual.

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CONTENTS.

	PAGE
Notes	245
Improvements in the Daniell Cell	246
Switchboard Attendants and Shocks	247
Electrical Machinery in Finland	248
Taxation of Electric Lamps	248
Board of Trade Regulations	249
Railway Rates and the Electrical Trade	252
Telephone Extensions in the Transvaal	253
Assisted Electric Generating Plants	254
Electrification of Australian Railways	254
New Catalogues	254
Corrosion of Metal Structures by Electrolysis	255
Electrical Propulsion for Ships	256
Dual Service in Factories	257
Overhead Wires in the City of London	258
Central London Railway Extension	258
Hydro-Electric Development in Quarrying	259
The Tungsten Lamp	260
The Siemens Battery Signal Machine	261
Interesting Pumping Plants	263
Electric Cookers and Heaters	263
"Oerlikon" Motors and Generators	263
Newfoundland Cable Dispute	264
Inquest on Two Miners	264
Street Lighting	267
American Notes	269
Progress in Electricity	270
Technical Problems, with Solutions by Practical Men	272
Companies Meetings and Reports	275
Companies Registered	276
Contracts Open	276
Lighting and General Notes	276
Traction Notes	279
Personal	280
Patents	281
Companies' Stock and Share List	282
Traffic Returns	284

DUAL SERVICE IN FACTORIES.

We welcome the appearance in the columns of our contemporary, the *Manchester Guardian*, of a most suggestive article on assisted electric generating plant for factories, because discussion is wholesome and anything that helps to break down the timidity of manufacturers is useful. It is true enough that the cost of electrical energy is chiefly determined by the load factor of the generating plant, and this, no doubt, does act as a deterrent to men whose requirements of power has a wide range between the minimum and maximum. They, not unnaturally, hesitate to lay down plant probably considerably in excess of their average needs in order to provide for the necessary high pressure requirements, for this means a certain amount of idle capital and almost inevitably a swollen wages bill. Even if these drawbacks do apply to steam generation, the fact remains that the boiler and engine are in possession of the field, and manufacturers are accustomed to provide for a maximum far removed from their minimum calls; but when it is a question of adopting a new system, then the drawbacks, emphasised by disproportionate capital expenditure, gives them pause. Now, the suggestion of our contemporary is that the manufacturer should lay down plant not calculated on his maximum requirements, but his average, or even his minimum use. In this way he would find constant work for his plant and power generating staff. There would be no power machinery lying idle upon which interest has to be charged. Thus the first cost would be comparatively light and the cost of energy much reduced. These are, indeed, substantial inducements to a manufacturer to study the question. As for the extra power required, this could be obtained from central stations, being paid for, of course, as used. At the present, we may observe, many power users are employing both electricity and steam, the former generally being treated as an auxiliary for running particular machines. Such users are often enough substantial customers of central stations, though a goodly percentage

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of them generate their own power. But what our contemporary contemplates is the adherence of large manufacturers to the assisted generating plant system. Now, this would entail an uncertain, but often recurring, heavy call upon central stations, and might add enormously to the difficulties of the engineers. It is argued that where a considerable number of assisted plants were connected with a central station, the irregularities of demand would compensate one another. This is true enough in populous, busy manufacturing districts, especially if there was a diversity in the nature of local activities, for then the law of averages would set matters right. Even so, the engineer and the business manager would have to contend with the difficulties of supplying a number of customers with comparatively small amounts of power, instead of a few with large amounts, thereby multiplying the possibillty of troubles of one kind or another. Therefore, it is scarcely likely that energy could be supplied at the lowest rate (remunerative both to producer and user), to those who only required assistance, rather than constant and entire supply. It is probable, however, that even if the lowest possible rate was not charged, the system would prove economical to the user. While the central station engineer would prefer to supply a manufacturer with all the electric energy he requires, it must be borne in mind that at present the majority of large users who are bold enough to adopt electricity go in for their own generating plant, and pass the central station by. If, on the other hand, manufacturers could be induced to lay down plant for their minimum needs, it may well be that, as the *Guardian* says, the assistant supply would provide "the thin end of the wedge which central station engineers are so desirous of inserting into the power plants of existing factories." There is sound argument in this, and it would be well to find means to meet the suggestion, by entering into the particular needs of any manufacturer, and by placing cost of energy as low as is compatible with fair profit, to induce as many factory owners as possible to adopt this first stage. After all, it is good policy to increase the number of day users, and even if the central station engineer feels that he is only securing a temporary customer—a man who once having experienced the advantages of electricity is likely to extend his own plant as soon as he has gained the requisite knowledge—still, in the long run, matters would adjust themselves. Moreover, the basis of supply would steadily broaden, and while to-day and to-morrow the assisted manufacturers would chiefly be men in a big way of business, the day after to-morrow it would be the turn of the multitude of small users of power, and they (like the users of the night load), would give that desirable high total which would bring about that approximate equality between night and day load which is the ambition of all central station engineers to secure.

OVERHEAD WIRES IN THE CITY OF LONDON.

Mr. Frank Sumner, M.Inst. C.E., the City Engineer, in his annual report just issued, gives a summary of the various overhead wires in his district, and their condition.

It appears that since the year 1899, when the Corporation took in hand the work of supervision, a total of about 25 miles of derelict wires have been removed by the Inspector of Overhead Wires. During last year there were 5 broken derelict or unidentified wires removed by the Corporation, of a total length of 276 yards, together with their insulators and attachments. In addition, where identification was possible, a large number of disused wires and attachments were taken down by the companies and owners, at their expense, upon notification by the Corporation; the total length taken down being 4 miles 358 yards, the result of 184 notifications. All owners of overhead wires are required to identify them by having a perforated zinc label of approved pattern attached to each fixing. The numbers or identification marks are registered, and the system has proved of great advantage. One of the results of inspections on the roofs is, that large numbers of wires have been found to have been erected in the City without any notice at all having been given; and it is only due to very careful supervision that new lines are detected. This will be readily understood when regard is had to the enormous number of overhead wires now fixed in the City, which continue to increase, and during the year the number of private owners of lines were 137, and the number of companies increased to 23. Both have considerably added to their number of spans during the last twelve months, and these now total about 733,828 spans crossing public thoroughfares, as compared with 733,200 last year, and 260,000 in 1899. There has been a net increase of about 755½ miles of National Telephone Co.'s wires, whilst other companies and private owners have added about 22 miles to their lines.

The tendency of the National Telephone Co. is to take down their "open wires" and small cables, and substitute for them heavy cables; the larger and more recent contain as many as 400 wires, the number of wires thus increasing in a greater ratio than the spans.

The number of owners of overhead wires increased from 9 companies and 64 private owners in 1901, to 23 and 137 respectively in 1908.

Although the Exchange Telephone Systems of the Telephone Co. and the Post Office have been greatly extended, there is a continued addition in the number of private "direct" lines. The necessity of an immediate connection for business purposes is one cause of this increase, and there is nothing to prevent such lines being erected by firms having premises in more than one part of the City, or between one or more different firms, subject to license from H.M. Postmaster-General.

The number of defects notified during 1904 was 790, and increased to 5,602 in 1908. Owing to the acids formed in the smoky City atmosphere, the corrosion of exposed metal proceeds far more rapidly than is generally supposed, and the galvanising applied as a protection to pole-stays and cable suspending wires does not last long.

During the year several long spans of wires and cables contravening the bye-laws, which prohibits a span of more than 115 yards, have been removed, as have also a large number of cables crossing the roofs belonging to various companies that infringed the bye-laws by being less than 6 ft. in height above the roofs of the buildings. On the roofs of the buildings in the neighbourhood of the Stock Exchange being inspected, unmarked wires were found leading into stock brokers' offices which, on being followed up, were found to have been put in by a company owning a new instrument, being a writing machine and a telephone combined, called the "Tele-writer." Although a number of these instruments had been installed in various offices, it was found that the company were able to make use of the General Post Office underground cables and the National Telephone Co.'s lines for the purpose of their connections, only one such private line being now in existence in the City. The Amalgamated Radio-Telegraph Co., Ltd., of Salisbury House, London Wall, in the month of May, for the purpose of intercepting their wireless messages, suspended a line across Finsbury Circus from the highest part of the roof of Salisbury House to the top of the flag post of the "River Plate House" opposite, at a great height above the garden. This wire was put up by the company for experimental purposes only, and remained for about seven months, and has now been removed.

CENTRAL LONDON RAILWAY EXTENSION.

Royal Assent has been given to the Bill of the Central London Railway to extend the line from the Bank to Liverpool-street Station with a connection to Broad-street Station, and to construct subways. It is the intention of the directors to proceed with the scheme with all possible speed. Plans have already been prepared, and tenders will shortly be invited for the work. The length of the tunnel will be three furlongs six chains. The Bill includes authority to raise £330,000 additional capital, which carries with it borrowing powers to the extent of £110,000. It also permits the company to raise any unissued portion of capital already authorised as ordinary or preference, and to pay interest up to 4 per cent. (£10,000 in the aggregate) out of capital during construction. The scheme includes a new subway at the Bank, and it is also intended to construct a moving staircase to connect the platform at the British Museum Station of the Central London with that at the Holborn Station of the Piccadilly Tube.

The London & Provincial Electric Bioscope Theatres, Ltd., have decided that the company be wound up. H. Speer, 29B, Western-road, Brighton, liquidator.

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HYDRO-ELECTRIC DEVELOPMENT IN QUARRYING.

COLORADO YULE MARBLE CO.

Says Mr. S. S. Stone, a B.S. in electrical engineering, connected with the Colorado Yule Marble Co., Marble, Colorado, in giving a description of that enterprise :—

In the northern part of Gunnison County, Colorado, its snow-capped peaks towering 13,000 ft. above sea-level, stands White House Mountain. On its steep and oft-times precipitous slope are vast deposits of marble ; literally a mountain of snow-white marble. Here are the quarries of the Colorado Yule Marble Co., 9,000 ft. above the level of the sea. He quotes from an address given by the President of the company, Col. Channing F. Meek, to the effect that the company have over a billion and a half cubic ft. of white marble.

" This vast quantity is so exposed that you can measure it with a rule. We have opened the quarry and have on the face of the cliff, which is exposed for a mile in length, a quarry 240 ft. long by about 40 ft. in width.

" Our present quarry equipment has a capacity to produce about 700 cubic ft. of marble per day, and machinery is *en route* which will increase our production to 2,000 cubic ft. per day by the end of this year, We have erected a finishing plant which for its size is probably the most complete marble mill in the country ; our finishing plant has a capacity of 750 ft. per day. This finishing mill is 674 ft. in length, by an average of 65 ft. in width. The overhead travelling crane in front of the mill now in process of erection is 900 ft. in length. We have installed a hydro-electric plant of 1,250 h.p. capacity. We have built a railroad from the terminus of the Crystal river railroad above Red Stone, to Marble. We have built machine shops and have in process of erection a saw mill for lumber with which to box the finished marble. We have built roads and we are building the town. We are preparing now to work our quarries day and night. It is fair to estimate that within five years from this time our capacity will reach to 5,000 cubic ft. per day of merchantable product."

The first power plant, finished July, 1907, has been in operation since, and consists of a double DeRemer 5-foot water wheel belted to two 200 kw., 2,300 volt 60-cycle, three-phase alternating current generators, running at 600 r.p.m., the speed of the water wheel being 278 r.p.m.

The water from which the power is derived is taken from the Crystal River and brought down in a steel pipe-line, 3,677 ft. long, with a fall of 381 ft. Of necessity there are a number of bends which reduce the effective head by about 30 ft. The pipe at the intake end is 36 in. in diameter, tapering to 26 in. at the power-house. There it is projected through two 3 in. nozzles on to the buckets of the water wheel.

The site of the intake was selected where three huge boulders diverted the greater part of the water into a single narrow channel, thus reducing the size and expense of the necessary dam. A tunnel 119 ft. long was driven through the solid rock, up to and underneath the bed of the river, and tapping it underneath the channel at the intake. At the lower end of this tunnel the pressure box was located and here the pipe-line begins. The Crystal River, at this point, flows in a series of steep falls through a narrow box-like canon, the walls of which are nearly perpendicular cliffs from 1,000 to 2,000 ft. high.

The difficulties of laying such a pipe-line are at once apparent. To have driven a tunnel through the rock to the more level ground below would have required an enormous outlay of money and time. A shorter and much cheaper line was made by blasting a shelf out of the side of the cliff, and on this shelf the pipe-line now securely rests. To accomplish this men were let down by ropes or went down on wooden ladders, fastened to the top of the cliff. They there drilled and loaded holes in the face of the cliff, and were then drawn up out of danger while the blasts were fired.

At one place near the intake, the line is carried across the canon on a bridge, supported by cables securely anchored to the cliffs. At another spot a tunnel had to be driven 89 ft. through a projecting cliff. It was a most difficult and hazardous undertaking, but fortunately the whole work was completed without a single fatality.

The shelves and tunnels were made large enough to contain two pipe-lines in addition to the one now installed, and the wisdom of this is already apparent inasmuch as it is already necessary to lay a line to supply water for our second power-house.

The new plant, one unit of which is already installed and in operation, will contain two units, each consisting of a double DeRemer 4-foot water wheel, with double nozzles, directly connected to a 450 kw. 2,300 volt alternator.

The DeRemer water-wheels are made by the Dillon Iron Co., and differ from the Pelton wheel in that the buckets are ribbed laterally as well as radially. All of the electrical apparatus was manufactured by the General Electric Co., of Schenectady, N.Y.

Each alternator will receive its exciting current from 11 kw. direct-current generator, driven by its own water-wheel or motor, as the smaller sizes are called. Each exciter was placed on the shaft of its own generator in the old power-house. While this has its advantages in saving floor space and in economy of operation, it has this disadvantage : that a heavy load thrown on the generator momentarily retards the speed of both generator and exciter, and so furnishes a double cause for loss of voltage. The exciters running at constant speed and provided with their own water-wheels, will insure much better regulation.

The switchboard panels are made of marble from our quarries. They are arranged in the usual manner, one panel for each generator, one exciter, and one distributing panel. The main bus-bars are common to both power-houses. The two plants will run in parallel, giving a capacity of 1,300 kw. Each power-house is equipped with a 10-ton hand operated travelling crane, to facilitate the handling of the heavy machinery.

Two transmission lines are run from the power-houses ; one to the quarry, three miles away ; and the other to the finishing mill, a distance of 1¼ miles. The original line to the quarry consisted of three 75 kw. oil cooled transformers, located in a separate building, near the power-houses, which step up the voltage to 6,600 volts : three lines of No. 6 (B. & S.) gauge, bare copper wire carried in double petticoat brown porcelain insulators, supported on wooden poles. In the transformer-house, at the quarry, the voltage is stepped down to 440 volts, which is the voltage for all the motors. The transmission loss of this line, including both sets of transformers, is 9%. The capacity of the quarry line is now being doubled, each part with the exception of the poles, being duplicated.

In long distance transmission of power at a high voltage, line losses and sizes of conductors may be calculated to a nicety by the use of the tables of line constants published in electrical handbooks or furnished by manufacturers of line wire ; but for short distances and moderate voltages more simple methods are commonly used. In our case we have found the following simple formula to be of sufficient accuracy :

$$A = \frac{D \times W}{P \times E^2} \times K$$

Where A = Area of conductor in circular mils.
D = Distance of transmission (one way) in feet.
W = Total watts delivered at receiving end.
P = Per cent. loss in line of W.
E = Voltage between main conductors at receiving end.

Values of the constant, K, for any particular power factor are obtained by dividing 2,160 by the square of that power factor for single phase, and by twice the square of that power factor for three phase. The resistance of line wire is taken as 10·8 ohms per mil-foot. In our case, three phase system and 85% power factor, K = 1500.

The following data, together with what has been given above, although meagre, permits of comparison of the efficiency of the two plants :

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COLORADO YULE MARBLE CO.
HYDRO-ELECTRIC INSTALLATION.

Power House.	Old.	Old.	New.
Diameter of wheels (feet)	5	5	4
R.P.M. of wheels	278	278	360
Number of nozzles	2	2	4
Diameter of nozzles (inches) ..	3	3·25	2·5
Water pressure (lbs. per sq. in.) ..	165	165	165
Number of generators	2	2	1
R.P.M. of generators	600	600	360
Volts between phases	2300	2300	2300
Power factor (per cent.)	85	85	85
Ampéres	96	115	135

The load readings given are those of the greatest load which can be carried, at the rated speed, with the nozzles used and the gate valves wide open. The efficiency of the generators is guaranteed by the manufacturers to be 98% at full load and that of the water wheels to be 85%.

The uneven and rocky nature of the mountains present difficulties for electric transmission as well as pipe-line laying, which can hardly be appreciated by the eastern engineers. In placing the poles for the transmission line from the power-house to the quarry, for instance, fully 40% of the holes had to be blasted out of solid rock.

The quarry equipment consists of one 200 h.p. induction motor, directly connected to a compressor, which supplies the air pressure for the pneumatic channelers, drills, and hoist; one 15 h.p. motor for pumping water; six electric channelers; and one 100 h.p. motor to run the hoisting apparatus.

The power is transmitted to the mill at generator voltage, the original line being of No. 4, bare copper wire. The new line is of No. 0000 copper cable. The poles used have a diameter at the top of 10 in.

At the mill the voltage is reduced to 440 volts and distributed at that pressure.

The old mill contains two 75 h.p. motors which run the eight gang-saws employed in sawing the marble into slabs and blocks of the desired size; one 75 h.p. and one 50 h.p. motor furnish the motive power for the rubbing beds, polishers, planers, turning lathe, and hoisting machinery. One 50 h.p. motor is installed in the machine shop across the railroad track from the mill, and another of the same size in the wood finishing shop a short distance away.

In the new mill will be ten 75 h.p. motors; five will keep in continuous operation the 22 gangs, and the remainder will operate the finishing machinery. In addition to the outside crane, mentioned by Col. Meek in the abstract referred to (which crane has a span of 70 ft.), there will be an electric travelling crane inside the building for conveying the marble blocks from the saws to the finishing room and thence to the shipping department.

The road from the quarries to the mill, 3½ miles in length, is one of the best mountain roads in the State. Formerly a mountain trail, it has been transformed, by months of labour, into a hard, solid road, 12 ft. wide at its narrowest point.

At present, the marble is being hauled by one 120 h.p. traction engine, drawing four wide-tired, heavy wagons specially built for this purpose.

This train makes two trips daily, carrying from 60 to 75 tons of marble each trip. The wagons are loaded at the quarry by pneumatic hoist and unloaded at the mill by an electrically operated derrick.

This fall it is proposed to build an electric road over this route to transfer the marble from the quarries to the mill. A synchronous motor, direct-connected to a direct-current generator, will furnish the power. With a synchrouous motor it is possible to "build up" the power factor of the line, which is necessarily low by reason of the many induction motors used throughout the system.

As the population of Marble increases, and it has doubled the last year, the lighting load becomes more a factor. There are in operation at the present time 50 arc lamps and 700 incandescents, with the number increasing daily.

The demand for power more than keeps pace with the power-house construction, so that as soon as a new generator is installed it is at once put in commission. For that reason no opportunity is given for making tests and little data is available.

THE TUNGSTEN LAMP.

In view of recent discussions, readers of THE ELECTRICAL ENGINEER will doubtless peruse with interest the subjoined condensation of a discussion at the recent convention of the Ohio Electric Light Association, which has been transmitted by our New York correspondent.

Mr. W. E. Richards, Toledo: "The tungsten lamp is superseding both Nernst and arc lamps."

Mr. E. H. Beil, Youngstown: "In some cases the income from large installations has been reduced 40 or 50 per cent., but the general increase in business is more than enough to make up for this."

Mr. W. C. Anderson, Canton: "My company has put out about 3,000 ordinary multiple tungsten lamps, and has 1,000 more under contract; results with 250-watt tungstens have been gratifying."

Mr. M. E. Turner, Cleveland: "All advertisements of the tungsten lamp read, 'Two and one-half times the light for the same money,' rather than the same light for less money."

Mr. A. A. Pointer, Antwerp: "I bought the Antwerp plant last November with 68 consumers. There are now 120 consumers and 400 tungsten lamps."

Mr. J. C. Rothery, East Liverpool: "I had a street-lighting contract under which the company agreed to furnish 50-cp. carbon-filament lamps. These have been changed to 60-cp. tungsten series lamps, which have been in use one year, or about 4,000 hours, and less than six have been renewed. In Chester (W. Virginia), 35 80-cp series lamps have been in service with two or three renewals since Jan. 1, 1909. These have been competing with two-mantle natural gas arcs, and I expect to displace gas lighting with these lamps."

Mr. W. C. Anderson, Canton: "One 250-watt tungsten lamp replaces a gas arc in store lighting."

Mr. George C. Osborne, Detroit: "The tungsten lamp sales decrease central-station earnings 25 per cent. from existing arc and carbon lamp installations which they displace, but inside of six months the same consumers add enough tungsten lamps to bring the consumption up to the original figures."

Mr. Tait, of Dayton, describing street lighting in that city, said ornamental iron posts, 75 to 80 feet apart carried five 100-watt tungsten lamps, storekeepers paying for the installation and the city paying for current and maintenance.

The Rochester Railway and Light Company has for many months past placed tungsten lamps at the disposal of its customers for a fixed first cost, after which, if desired, the company will renew the lamp on a maintenance contract. The prices charged are as follows: 25-watt, 70 cents; 40-watt, 90 cents; 60-watt, $1; 10-watt, $1.10; 250-watt, $2.20. The maintenance charge on the 25-, 40-, 60- and 100-watt lamps is 8 cents per lamp per month and for the 250-watt lamp the charge per month is 10 cents. The energy used is charged for at schedule rates. In order that it might have some basis for costs, the company took the account of the customer and calculated as nearly as possible the average hours' use of installation. In October there was 189 kw of tungstens connected on maintenance apportioned as follows: 77 40-watt lamps; 1,176 60-watt lamps; 1,104 100-watt lamps, and 59 250-watt lamps. The maintenance cost for the month was $530.67 and the breakage cost $205.90, or a total of $736.57. The energy consumed approximated 35,269 kw-hours and the income from maintenance amounted to $199.08. The cost per kw-hour for maintenance on the assumptions made was 1.52 cents. In November there were 121 40-watt lamps, 1,298 60-watt lamps, 1,105 100-watt lamps and 109 250-watt lamps connected on maintenance, or about 221 kw. The estimated consumption of energy was 39,260 kw-hours, the cost of maintenance $561.85, breakage $145.14, or a total cost of $706.99 against which was a maintenance charge of $218.34. The cost of maintenance was 1.24 cents per kw-hour on the basis assumed. The Company's report for June, one of the lightest months of the year, shows a large increase on the connected load and an exceptionally large addition in the number of 250-watt lamps installed, and also shows a very material decrease in the cost per kw-hour. In June there were 27 25-watt lamps, 966 40-watt lamps, 2,505 60-watt lamps, 2,351 100-watt lamps and 391 250-watt lamps connected on maintenance, or about 523 kw. The estimated consumption of energy was 109,862 kw-hours; the cost of maintenance $801.12; breakage, $182.90, or a total of $984.02, against which was a maintenance charge of $504.17. The cost of maintenance for the month of June per kw-hour was, therefore, $0.004 figured on the same basis.

SOUTH LONDON "ELECTRIC."

It has been definitely decided to open the public service of electric trains on the newly-electrified South London line of the London, Brighton and South Coast Railway on Friday, October 1. The fixing up of the overhead apparatus at the Victoria and London Bridge Stations has been completed, and trial trains have been running every night for some time along the whole route.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

The Siemens Battery Signal Machine.

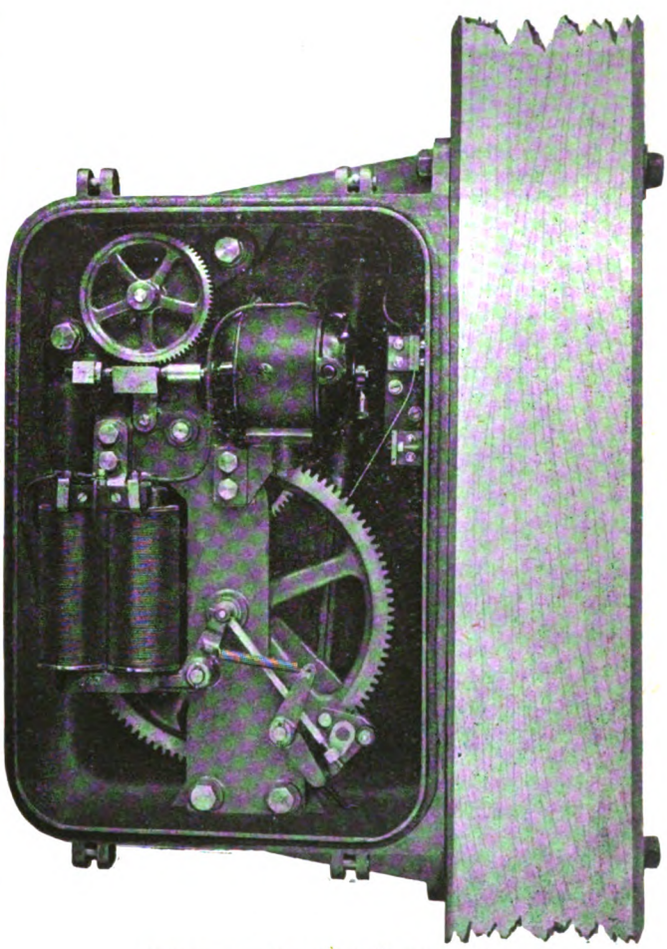
DESCRIPTION AND DESIGNS.

Messrs. Siemens, Brothers, & Co., Ltd., have patented and are now putting on the market a highly ingenious Battery Signal Machine, which is described as having been constructed to overcome the difficulties attendant on working signals by mechanical means when such signals are at a great distance from the levers working them, and also for operating signals automatically by track circuit or other means. The essential feature of the machine is that only a small primary battery is used to lower the heaviest signal to the clear position, the efficiency being so high that only the minimum amount of electrical energy is required. The machine can be fixed to any type of signal post and will work any semaphore arm with the fittings which may be the standard of the particular railway company. It can be used on posts which are fixed in cramped situations; can be worked either from a battery at the cabin or by a local battery at the signal post controlled by a relay; and the motor requires only the current and E.M.F. produced by a few cells of any ordinary type such as "Siemens-Obach" dry cells, Lechanché or Soda batteries, whilst the holding "off" current is practically negligible in affecting the life of the battery. The machine is self-contained in a rain and dust-tight case of cast iron. It is specially adaptable where slotting is necessary, as for example, the case where "distant" signals are fixed under and controlled by "starting" signals operated from two cabins. The slotting is effected by means of an electrical contact on the "starter" arm, no slot plate and extra weights being necessary, and it being immaterial which man pulls his lever first. Also where a signal is controlled by another signal, lever track circuit or other device. Another advantage is absolutely positive release to "on" position, there being no catches or brakes to hold the signal "off." Special attention has been given to the lubrication, so that the machine needs no attention for long periods. The signal arm cannot be lowered to the "off" position by anyone tampering with it, as the machine holds the signal arm at "danger" at all times except when the intended action is to take place by sending current through the motor.

The construction and action of the machine will easily be understood by the following description and reference to Figs. 1, 5 and 6. The machine can be attached to any part of the signal post either at the back or front, the upright rod working the signal, which is usually attached to the balance lever at the bottom of the post, being cut and attached instead to a crank 921 on the outside of the machine, which is keyed to a shaft which passes through and takes its bearings in the case. On the same shaft is keyed another lever arm 929, which carries at its end a pawl or half axle 934, which is caused to engage with, or be kept clear of, the teeth on the periphery of the wheel 916 (which revolves freely on the shaft) by means of a small crank attached thereto, and which in turn is connected by a rod on to a crank arm of the armature of the holding-off magnet 942.

The mechanism is so arranged that when the armature 942 is held attracted by the magnet, the crank arm centre 939 is co-axial with the shaft carrying the wheel 916, and turns, by means of the connecting rod and small crank, the half axle 934 into a locking position so that its flat side comes into contact with a tooth of the wheel 916, and is, therefore, carried round with the said wheel when the latter is caused to revolve by the motor 480. On the application of current, the motor revolves until the insulated roller 932 on the lever arm 929 lifts the contact spring 978, and thus automatically opens the circuit of the motor, thereby stopping further movement. The signal arm, however, is held "off" independently of this action owing to the holding "off" magnet 954 being energised from a shunt circuit, as will be seen from the diagram of connections. This shunt winding on the magnet is approximately 2,000 ohms resistance.

When the signalman replaces his lever, or if by any other means the circuit is opened, the magnet 954 becomes de-energised and allows the half axle 934 in the lever arm 929 to be released from the locked position and turn so as to freely pass by the teeth of the wheel 916, thereby allowing the lever arm and semaphore to return to its normal



SIGNAL AT "DANGER" POSITION.

position. In returning to the normal position, the lever arm is arranged so that just before it reaches its final position it presses on a bell crank 944, which is connected through a spiral spring 943 to the armature 942 of the holding "off" magnet 954. This is for the purpose of mechanically replacing the armature 942 on to the poles of the magnet 954, in readiness for the next operation. It will be seen, therefore, that only a very small current is necessary for the energisation of the coils 954, it not being necessary to magnetically attract the armature 942

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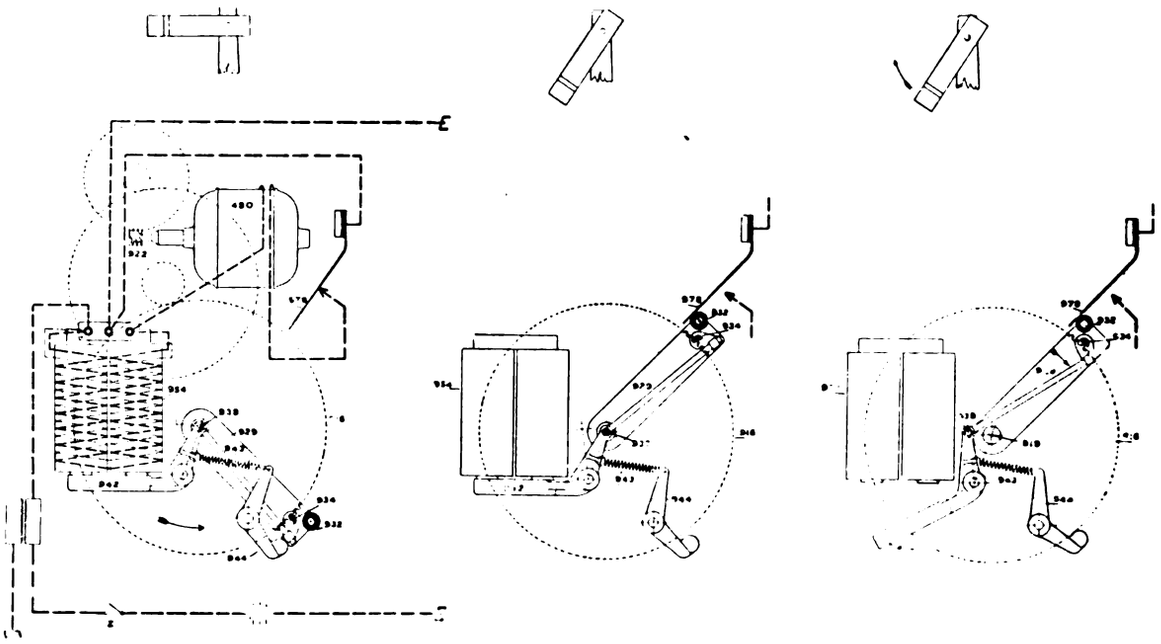
from its fallen position on to the poles of the magnet. Another function of the spring is that should the wheel 916 stop in such a position that its teeth will not allow the half axle 934 to enter one of the tooth spaces, the spring 943 is put into a state of tension when the lever arm 929 presses the bell crank 944, and the strain that would otherwise come on the armature 942 and connecting rod is taken up by the spring 943. As soon, however, as the wheel 916 begins to revolve, the half axle 934



DIAGRAMS SHOWING ACTION OF MACHINE AND ELECTRICAL CONNECTIONS.

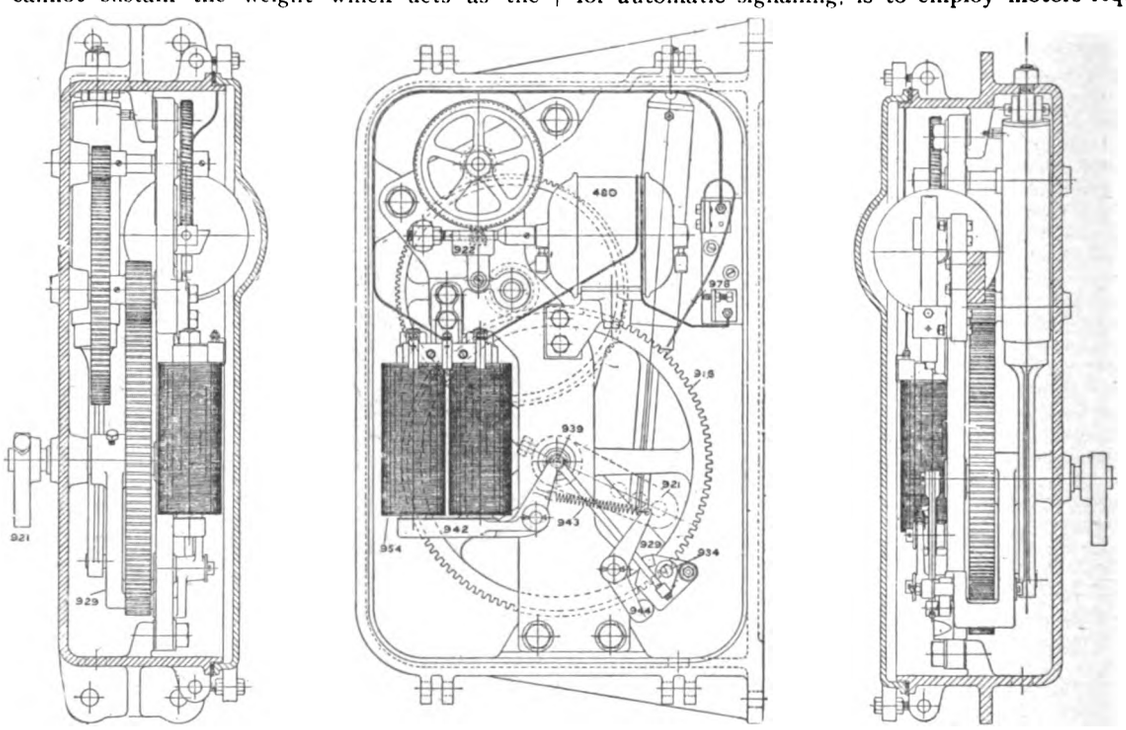
engages with the first tooth space passing it, and the armature 942 is brought up to the poles of the magnet 954 by the tension of the spring 943.

To minimise the shock the apparatus would otherwise receive when the signal arm returns to danger, a dashpot is provided inside the case, and the principle upon which it works is that of suction or vacuum. It is so designed that the area of the piston, with the atmospheric pressure upon it, cannot sustain the weight which acts as the counter-balance to the signal arm, and therefore possesses the great advantage over any compression forms of dashpot, inasmuch that it cannot prevent the signal arm from returning to danger should the escape passage become blocked. The dashpot is fitted with a valve whereby the degree of vacuum may be altered to suit varying weights of signal arm and gear in use on different railways.

No wood is used in the construction of the apparatus, all insulation being of ebonite; the case is dust and waterproof, a gasket being provided at the lid joint, and the cable outlet being made with a pipe secured by nuts and lead washers.

The machine has been specially designed with a view to the cost of general maintenance being reduced to the absolute minimum. The mechanism is mounted on a front casting which is secured in the case by four easily removed bolts, and all parts are made strictly to gauge and are interchangeable.

The amount of power which the arm can exert to release the half axle can be adjusted to suit varying weights and descriptions of semaphores. This is effected by altering the angle at which the half axle is held in relation to the teeth on wheel 916, when the armature 942 is attracted, by adjusting the length of the rod connecting the armature with the small crank on the half axle, one end of the rod being screwed for this purpose. The usual practice in working signal machines of this description, when used for automatic signalling, is to employ motors requiring a relatively low voltage, worked by a few cells locally at the signal post and controlled by a relay also at the signal post, the relay being connected electrically with another battery at the cabin by means of a telegraph line wire, or to a track circuit.



GENERAL ARRANGEMENT OF THE MACHINE.

In this case, as the current necessary to operate the relay is so small, the resistance of the line wire is practically negligible, and the entire voltage given by the local battery at the signal post is available at the signal motor terminals.

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The Student's Guide to Knowledge.—*Chap. I.*

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INTERESTING PUMPING PLANTS.

The contract for one of the most interesting pumping plants has just been settled, namely, that for the Newport Docks Co., for their new Alexandra Docks. The pumping plant proper consists of two main pumps coupled direct to two triple expansion steam engines, two separate 500 k.w. generating sets being installed for lighting and power purposes. These pumps will be capable when working simultaneously, of pumping 50,000,000 gallons of water from the River Usk into the dock extension in a period of five hours; the average quantity of water delivered during this period by one pump being 80,000 gallons per minute. Owing to the big quantities and comparatively low heads the pumps are dealing with, the average speed will be 90 r.p.m. The same pumps will be used for emptying the graving dock, which will be built at a future date. In this case, the pumps will work against a total head of 42 ft., and will each deliver an average quantity of 100,000 gallons per minute, running at speeds varying from 90 to 120. The maximum power required by each pump during this period will be between 1,100 and 1,200 b.h.p., from which data it will be seen that the pumps will be the biggest dock pumps hitherto built. Two schemes, differing in principle, have been carefully weighed with regard to this pumping plant. The question was whether the pumps should be driven direct by steam engines, or whether electrically-driven pumps should be installed, and it was decided that the direct steam-driven pumps would give much greater economy under the existing conditions. The main contractors for the whole of the scheme are Messrs. Cole, Marchent & Morley, of Bradford, while the pumps are being built to the designs of Messrs. Jens Orten-Boving & Co., of 9½, Union-court, Old Broad-street, London, E.C., by Messrs. Willans & Robinson, of Rugby.

ELECTRIC COOKERS AND HEATERS.

Electric cigar lighters, soldering irons, cooking and heating apparatus, and other novel and useful contrivances are being placed on the market by the A. E. G. Electrical Co., of South Africa, Ltd. (Caxton House, Westminster), agents for the A. E. G. Foreign Department (of Berlin). The use of their electric heating and cooking apparatus, it is claimed, is accompanied by numerous advantages, the chief of which is that absolute cleanliness is obtained, owing to the omission of open fires which cause smoke and soot. Further, the temperature can be maintained constant, a most important point in cooking. Moreover, there is no waste of heat by radiation, the heat being usually generated inside the apparatus itself by means of resistances imbedded in fireproof insulating material, or by means of interchangeable cartridge heaters. The electric kettles are particularly useful for boiling water quickly. As a basis for the working costs it should be assumed that 120 watts are required to bring 1 litre of water to boiling point in 60 min., *i.e.*, 720 watts are necessary to boil 1 litre of water in 10 min. The apparatus for table use is constructed of nickel-plated steel, and presents a handsome appearance.

"OERLIKON" MOTORS AND GENERATORS.

The latest pattern "Oerlikon" Direct Current and Alternating Current machines have many points of excellence to commend them to users. Owing to the enormous increase of inquiries and orders for small motors and dynamos the Oerlikon Works [British, Irish and Colonial Department of the Machinenfabrik Oerlikon, 34-35, Oswaldestre House, Norfolk-street, Strand, London, W.C.] have found it necessary to extend and reorganise their workshops. They are now in a position to effect deliveries of their Direct Current Motors and Generators for small outputs (starters and regulators) and single, two and three-phase Asynchronous Motors for small outputs more expeditiously, and the up-to-date method of manufacturing the adoption of limit gauges, etc., secures absolute interchangibility of all parts of one type of machine. The efficiencies are very high throughout, at maximum and minimum loads, and the overload capacity is exceptionally liberal, while the temperature rise is kept within very reasonable figures. Careful attention is also paid to the design of the machines from the æsthetic point of view. The machines built by the company are designed in accordance with the latest developments and principles of construction, and the works are capable of turning out something like 6,000 to 10,000 motors a year.

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NEWFOUNDLAND CABLE DISPUTE.

VIEWS OF SIR EDWARD MORRIS.

Sir Edward Morris, Prime Minister of Newfoundland, who has been in London attending the Empire Defence Conference, before returning home, gave an interviewer his opinions on the dispute between the Commercial Cable Co., of New York, and the Newfoundland Government. He emphatically denied that there had been any breach of faith on the part of the Newfoundland administration with the Commercial Cable Co., of New York, or any other company, or that the Government of Newfoundland did not recognise the contract made with its predecessors, or that it was in any way offering obstacles to the successful operation of the laying of the Commercial Cable Co.'s cable. As regards the remonstrance, the publication of it in the New York Press was the first intimation he had of any such remonstrance or communication. "The Government of Newfoundland," he said, "does not refuse to ratify agreements entered into. It did, however, refuse, without ample consideration to bring before the Legislature for ratification this contract of 1909, principally for the reason that it was unfair and prejudicial in many respects to the Anglo-American Telegraph Co. (Limited), which is a British cable company, and would create in favour of the Commercial Cable Co. a monopoly for 25 years of the transmission of all cable messages passing over the Newfoundland Government land lines. The Commercial Cable Co., under its agreement made in 1905 with the Newfoundland Government, are now bringing in their cables. There is no objection to this, as the Government, only a few weeks ago, gave them the land they require, but the Government have not felt justified (not, however, without fully considering the matter) in granting by Act of Parliament the further concession attempted to be given in the agreement of 1909—namely, a monopoly for 25 years and freedom from taxation, whilst taxing the Anglo-American Co. for doing business on the same street." Sir Edward added that there were other objections to the agreement from an Imperial, British and trade standpoint, which he was not prepared to state at present.

INQUEST ON TWO MINERS.

At Pyle, Mr. H. Cuthbertson, Neath district coroner, held the adjourned inquest on the bodies of Owen David and David Thomas, colliers, who were killed at the Cribbw Fawr Colliery, Pyle, on Thursday, 12th inst., by a cable carrying a current of electricity for working the pumps. The Home Office was represented by Mr. Robert Nelson, electrical engineer.

The colliery surveyor produced a plan of the scenes of the accident. From this it appeared that the mine is worked on a slant. The electric cable ran down this incline, attached to the roof timbers. The accident to Owen David happened about 250 yards from the mouth of the slant. The body of David Thomas was found about 90 yards nearer the mouth.

Joseph C. Llewellyn, collier, travelled down the slant to his work on a tram, and Owen David and others were with him. The carriages stopped for them to get out. He did not notice Owen David getting out, but on looking round saw that he had his hand clasped to the cable overhead. He caught David around the waist and dragged him away, and as he did so his face came in contact with David's, with the result that he (witness) received an electric shock, and was rendered unconscious for a few moments. Witness was unable to say how David came to catch hold of the cable. He himself had been warned not to touch the cables by the officials.

Mr. T. J. Nelson, electrician at the colliery, said this cable had been up nearly two years. On August 5, some trams went loose and went against the cable, but did not cut it or break it, only "kinking" it at one point. He made a test, but it showed no sign of leakage, but as a precaution he "earthed" the part "kinked" by connecting it to the soil by copper strips.

Replying to Mr. Nelson, the Home Office expert, witness said that this was an armoured cable.

Continuing, witness said that subsequently to the accident of the loose trams and before the present accident, it was reported to him by his assistant that the fuse had blown out at the generating station. This indicated something wrong with the cable. He was also told that a man had complained that he had had a shock in the feet. Witness immediately went down and cut the armour of the cable at the kink, and bent back the ends. He tested again for leakage and the test was reassuring. He thought then that he had cut the faulty part out of the cable. He thought that the accident was caused by a once good "earth" becoming ineffective owing to the drying of the soil around it, and the armouring consequently getting alive. He intended to have a large earth-plate on the surface instead of underground, and thought that that would prevent any such accident in the future.

Mr. Robert Nelson: I would suggest that whenever a cable is kinked again the whole system should be cut dead until the weak spot is discovered and dealt with. He added that he agreed with the electrician that the accident was caused in all probability by inefficient "earth." The "earthing" arrangements were all right in their way, but they were not sufficient. He agreed with the intention of the electrician to have an earth-plate at the surface of the colliery, but it should be large a plate, not less than a yard square. He thought the colliery had not been well advised electrically. But it could not be too clearly understood generally that under no circumstances should the miners touch electric cables.

The jury found that both men were killed by electric shock, and returned a verdict of "Accidental death."

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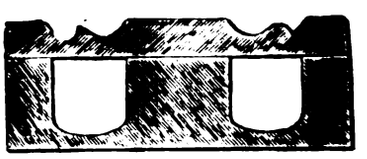

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STREET LIGHTING

CITY DEPUTATION'S REPORT.

The deputation from the Corporation of London, who recently visited a number of Continental cities for the purpose of inspecting the various systems of public lighting, have embodied the results of their observations in a special report. The party consisting of the Chairman of the Streets Committee (Mr. C. A. Tenten), Mr. Deputy Turner, and Messrs. J. Stopher, J. Gunton and G. Gordon Stanham left London, and visited Brussels, Cologne, Düsseldorf, Berlin, Dresden, Vienna, Munich and Paris, returning home on April 1. Having considered the various systems, they are of opinion that the public lighting of the City of London can be materially improved, and submit the following conclusions :—

(1) That, wherever possible, streets should be lighted by means of centrally hung lamps with lowering gear. This we think particularly important in the City of London where the number of obstructions upon the footways in the form of lamp posts, bins, letter-boxes, &c., is so large.

(2) That open spaces should be lighted by means of lamps upon standards, fitted with lowering gear.

(3) That high-pressure incandescent gas lamps with inverted burners should be adopted as the illuminant, but where gas is impracticable, electricity with open arc and flame arc lamps should be installed.

They think, however, before suggesting any drastic alterations in the general lighting of the City, that the Streets Committee should be authorised to arrange for some further experimental lighting of the City thoroughfares, and they recommend accordingly.

In each of the eight cities visited by the deputation gas as well as electricity is used. The main thoroughfares, squares and markets in Brussels are lit by means of electric arc lamps, with an ordinary incandescent gas burner on either side. The arc lamps are turned off at midnight, after which time the lighting is supplied by gas. The side streets are illuminated by incandescent gas burners. The total number of electric arc lamps in Brussels is 238, supplied by direct current, consuming energy at the rate of 440 watts, and fixed upon columns. The distance (not diagonal) between the open lamps is 98 to 115 ft., the average height of the lamps being about 20 ft. The width of the streets in which open lamps are used varies from 82 to 98 ft. The cost per lamp per annum (half night only), including interest, depreciation and all other charges is £14 9s. 7d. There are only two centrally-suspended electric arc lamps, and these are fixed in the Grand Place—from the Hotel de Ville across the Market Place (the lamps taking 1,100 watts each), at an altitude of about 70 ft.—the width of the Market Place being about 200 ft. ; the lowering gear in connection with the lamps is placed within the Hotel de Ville. No accidents have been reported to have occurred from this method of attachment. Electric glow lamps are not used in the public streets of Brussels. Incandescent gas lighting is largely used in the city, the lamps generally being fixed upon standards, but brackets are used in the smaller streets. The deputation was informed that the lighting of the city, both by gas and electricity, is carried out by the municipal authorities without the intervention of a contractor. At Cologne the important streets are lighted by centrally-hung electric lamps, the open spaces by a combination of electricity and gas, as in Brussels, the minor streets mainly by incandescent gas lamps upon standards. The total number of electric arc lamps in Cologne is 426, supplied by alternating current, both open and flame lamps being used. One-half of the lamps are centrally hung, the others being fixed upon standards. The distance between the open lamps is 88 to 115 ft., and between the flame lamps 121 to 148 ft. The lamps are fixed at a height of from 26 ft. to 33 ft. in streets from 23 ft. to 148 ft. wide. The cost per annum per lamp, including interest on capital outlay, depreciation, and all other charges, is for open lamps £11 5s. 6d. each ; for flame lamps £9 6s. 3d. each.

The centrally suspended arc lamps are fixed about 30 ft. above the roadway, 110 ft. apart, and give a light equal to about 1,300 candles each. The apparatus used for lowering the lamps is contained in a box 12 in. high, 8 in. wide, attached to the houses about 4 ft. from the pavement level. By a simple arrangement the lamps are drawn aside over the pavement and lowered for trimming, etc., and on being replaced are lighted by automatic contact with the main wire. Owing to the daily examination during the trimming of the lamps, the danger to the public from defective wires is reduced to a minimum, only one accident having been reported since the lamps were fixed. One hundred and seventeen electric glow lamps are used in the streets, of which 30 are carbon filament lamps, and 87 metal filament lamps. These carbon filament lamps are of 14 c.p., and take about 50 watts each, the metal filament lamps are 28 c.p., and take 32 watts. The lamps are fixed in groups upon columns about 100 ft. apart, at an average height of 11 ft. 6 in. The cost per annum per lamp, including interest on capital expenditure, depreciation, and all other charges, is : for carbon filament lamps £2 14s., metal filament lamps £2 4s. 2d.

Incandescent gas lighting (low-pressure) is largely used in the city, there being 192 miles of side streets in lighting, the lanterns being fitted with upright Welsbach mantles. The consumption of gas is about 4½ cubic ft. per hour, giving a light of 63 to 72 c.p., the average height of the lamps above the roadway, measuring from the burner, being about 11 ft. 6 in. The lamps are placed about 65 to 98 ft. apart diagonally, and are fixed partly on central columns and partly on wall brackets. The cost per annum, including interest on capital expenditure, depreciation, and all other charges, is : for lighting up to midnight, £2 11s. 8d. ; all night, £3 5s. 3d. The incandescent gas lamps (low-pressure), although fixed in nearly all the streets of Cologne, are only used in the main streets after midnight, or when the electric light fails. The deputation was informed that the municipality, which has control of the lighting and of the waterworks, makes a profit on these of about £150,000 a year in relief of rates. Electricity is also supplied by the municipality. The city is encircled by a ring street, which is lit by electricity, and during the summer months, when trees are in full leaf, incandescent gas lighting is also used.

The City of Düsseldorf is lighted in a somewhat similar manner to Cologne—arc lamps on standards and centrally hung, supplemented by incandescent gas. The total number of electric arc lamps in Düsseldorf is 334, of which 24 are supplied by alternating current, and 310 by direct current. Open and flame lamps are used, each lamp taking about 650 watts. One hundred and forty-nine of these lamps are fixed upon standards and brackets, centrally suspended lamps to the number of 185 being used in narrow streets, the lowering gear being fixed to the sides of the houses in the same manner as in Cologne. Owing to the daily systematic examination during the trimming of the lamps, the danger from defective wires is reduced to a minimum. The average distance between open lamps is about 164 ft., and between flame lamps 197 to 394 ft. The lamps give a light of about 2,000 c.p., and are fixed at a height of about 30 ft. in streets from 33 ft. to 98 ft. in width. One-half of the lamps are extinguished at midnight. The total cost per annum per lamp, including interest on capital outlay, depreciation, and all other charges, is £17 13s. Electric glow lamps are also used ; there are 120 carbon filament lamps of 14 and 22 c.p., taking about 50 and 75 watts respectively, and 111 metal filament lamps of 22 and 90 c.p., taking 25 and 100 watts respectively. Incandescent gas lighting is used generally in the streets and for ornamental lighting, and the lights are of the upright incandescent type, consuming about 4·4 cubic ft. per hour, with an illuminating power of 72½ candles. The lamps are fixed about 10 ft. 6 in. above the roadway, and the cost per annum, including interest on capital expenditure, depreciation, and all other charges, is : up to midnight £1 14s. ; all night, £3 8s. 3d. There are no public high-pressure gas lamps in Düsseldorf, but experiments with the low-pressure inverted incandescent lamps are being carried out. Gas and electricity are made and supplied by the municipality.

In Berlin gas is manufactured by the municipality, but electricity is purchased in bulk from a private company. The total number of electric arc lamps (open and flame) in Berlin is 864, supplied by direct current. Six hundred and sixty-four of these lamps are fixed upon standards, and 200 are suspended across the streets centrally hung. The distance between the open lamps is from 100 ft. to 130 ft. and 98 ft. between the flame lamps. The open and flame lamps are fixed at heights of 26 ft to 31 ft., a few flame lamps being 52 ft. high ; one-half of the lamps are extinguished at midnight. Two hundred and twelve electric glow lamps are used in the city, 177 being of the Nernst type, 14 carbon filament lamps, and 21 metal filament lamps, the carbon filament lamps giving a light of 14 candles and taking 57 watts per lamp ; the metal filament lamps being of 440 c.p., and taking 440 watts per lamp. High-pressure gas lighting is very largely and effectively used in Berlin, 25 miles of streets being lit by 1,531 lamps fitted with upright and inverted burners, 2 and 3 burners in each lantern ; they are supplied direct from 4 separate compressing plants at a pressure of about 53 to 78 in. (water-gauge). The newest type of lamps, viz., the "Graetzin" high-pressure inverted lamp, being fitted with 3 burners per lantern, giving an illuminating value of over 4,000 candles, 2 burners being extinguished at midnight. The distance apart of these high-pressure lamps is from 90 ft. to 100 ft., and the average height of the lamps above the roadway, measured from the burner, about 19 ft. Gas manufactured by the municipality is of 12 c.p., *unenriched*, but tested by the "Metropolitan No. 2" burner, a light equal to 14 or 15 c.p. is obtained—the price of gas was stated to be 1s. 4½d. per 1,000 cubic ft. for public lighting purposes. The deputation was informed that the Berlin authorities have decided to spend seven million marks (£350,000) in installing the latest patterns of high-pressure gas lamps with *inverted burners* in lieu of the existing gas and electric lamps. Expenditure in this direction has been going on for two years at the rate of one million marks (£50,000) a year, and will be continued at the same rate for the next five years. In future incandescent gas lighting only will be used in Berlin.

The total number of electric arc lamps in Dresden is 425, supplied by alternating current, the type of lamps used being : open (124), flame (301), the open lamps taking 500 and 375 watts, the flame lamps taking 350 watts. Two hundred and thirty-eight lamps are fixed upon side posts, 187 being suspended

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across the centre of the streets, with side lowering gear. The average distance between open lamps is about 148 ft., and flame lamps 180 ft. The lamps are fixed at a height of about 26 ft. in streets having an average width of 65 ft. The average cost per annum per lamp, including interest on capital outlay, depreciation, and all other charges, is about £26. Electric glow lamps are largely used in the streets, and are fixed upon standards and brackets, and also centrally hung. Seventy-two carbon filament lamps are of 14 and 22 c.p., and take 55 and 87 watts respectively. Four hundred and thirty-seven metal filament lamps are of 22, 44 and 260 c.p., and take 30, 60 and 330 watts respectively. The lamps are fixed about 100 ft. apart at a height of 16 ft., and cost £2 14s. per lamp per annum. The side streets are lit by means of low-pressure incandescent gas in lanterns fixed upon brackets. The electric arc lamps are switched off at midnight, leaving incandescent gas lighting only. There are 11,715 low-pressure incandescent gas lamps. The type of lamp used gives an illumination of 82 to 109 candles, and consumes about 5 cubic ft. of gas per hour. The lamps are fixed about 10 ft. 6 in. above the roadway at distances of 50 to 100 ft. apart, the cost per annum per lamp being given as £3. Gas and electricity are made and supplied by the municipal authority.

The general arrangement for lighting in Vienna is by means of electric lamps upon columns with incandescent gas lamps fixed upon brackets below, the electricity being switched off at midnight. The total number of electric arc lamps in Vienna is 1,155, of which 1,139 are supplied by direct current, 16 only being by alternating current. There are but five centrally hung electric lamps in this city. Up to the present there have been three cases in which arc lamps have fallen owing to breakage of the wire, but without causing injury to passers-by. The open lamps take about 660 watts, and are fixed upon standards at a distance of about 115 ft., at a height of 25 to 40 ft. The average width of streets in Vienna is nearly 100 ft. The cost per annum per lamp, including interest on capital outlay, depreciation and all other charges, varies from £16 to £35, according to the hours of lighting. There are 686 electric glow lamps in use for street lighting, and 148 for the three bridges over the Danube. The electric glow lamps are fixed at a height of about 10 ft. At points where the traffic is heavy, as at street crossings, etc., two lateral arms (each with one carbon filament lamp of 25 c.p.) are fixed to the arc lamp columns. These glow lamps are not switched on until 12 o'clock at night, when the arc lamps are extinguished. The annual cost of those burning all night is £6 12s. 6d. per lamp, including interest and renewal of lamps, £3 11s. 9d. per lamp being the estimated cost of running the half-night carbon filament lamps. Only nine high-pressure inverted gas lamps have been fixed for experimental purposes; these are of the "Graetzin" type, and the gas is supplied direct from a small compressing station placed in the cellar of an adjacent house at 53 in. pressure (water-gauge). The consumption of gas with two-burner lamps is 42 cubic ft. per hour, the three-burner lamps consuming 84 cubic ft. per hour each. At present the lamps are only kept alight until 10 o'clock in the evening. They are fixed upon standards at distances of about 90 to 105 ft. apart, at an average height of 23 ft. The cost of gas in Vienna is about 4s. per thousand cubic ft.

Low-pressure incandescent gas lighting is largely used both with the upright and inverted mantles. The estimated cost per annum, including interest on capital expenditure, depreciation, and all other charges, is—for a single burner, evening £2 3s. 7d.; all night £2 12s. 3d. The side streets are lighted generally with incandescent gas (low-pressure) fixed on wall brackets, and are placed at an average height of about 11½ ft. and about 82 ft. apart on the diagonal. Gas and electricity are made and supplied by the Municipal authorities. There also exist two privately owned gas companies, and one private electric light company.

The electric arc lamps in Munich number about 900, supplied by direct current. Open lamps of the "Alba-Carbon" type are generally used, taking 450 and 270 watts. There are also 78 flame lamps taking 300 watts. About one-half of the lamps are fixed upon standards at distances of about 200 ft. apart, the lamps being about 33 ft. above the pavement level in streets about 80 ft. wide. The flame lamps are placed at average distances of 160 ft., at a height of 33 ft., in streets about 70 ft. wide. Centrally hung lamps are fitted with lowering gear, and in some of the widest streets as many as three arc lamps are suspended across the road on a single line. The cost per annum per lamp for electric arc lamps, including interest on capital outlay, depreciation and all other charges, was stated to be—for open lamps about £29, flame lamps £27, the current being supplied by the municipal authority. Of electric glow lamps, there are 96 in use, metal filament lamps being generally adopted, of 28 c.p., taking 55 watts. They are fixed on central posts (three in each lantern), and also on brackets, the distances between the lamps being about 162 ft., at a height of 13 ft. in streets

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about 33 ft. wide. The cost per annum per lamp, including capital expenditure, depreciation and all other charges, for metal filament lamps is £3 8s. 8d. In the low-pressure gas lamps, Welsbach upright incandescent burners are used, consuming about 3½ cubic ft. per hour. The illuminating power was stated to be 72 c.p., the lamps being fixed about 11½ ft. above the roadway at distances of about 60 ft. The cost of these low-pressure incandescent gas lamps, including interest on capital expenditure, depreciation and all other charges, is £4 4s. 4d. per annum. The lamps are fixed upon side columns. The inverted incandescent gas lamp is being introduced, about 10% of the gas lamps being of this character. Gas and electricity are made and supplied by the municipal authorities.

The general arrangement for lighting the streets in Paris is much the same as in London, electric lamps upon columns being generally used. The total number of electric arc lamps in Paris is 1,899, of which 559 are supplied by alternating current, and 1,340 by direct current. The lamps are fixed about 100 ft. apart at about 14 ft. to 18 ft. high, the main streets of Paris being 70 ft. to 100 ft. wide. A large number of these lamps are extinguished at 1 o'clock a.m. Electric glow lamps are not used in the public streets of Paris, The types of incandescent gas lamps (low pressure) principally used are: Bandsept, Denezrouze, La Couronne, Kern, Honderele and Tricquet, etc., the 3 ft. per hour lamp giving a light of about 66½ candles, and the lamps are fixed about 80 ft. apart on columns on the sides of the streets. In the "Rue de la Paix," which is about 73½ ft. wide, standards with three lanterns fitted with incandescent gas burners (two of these lanterns being extinguished at midnight) are used; the columns are directly opposite one another, the distance between them being about 39 ft., the central one being about 11 ft. 11 in. above the ground, the two side ones 11 ft. 7 in. The burners consume eight cubic ft. per hour. There is not any high-pressure gas lighting in Paris. Electricity and gas are supplied by companies under arrangements with the municipal authorities.

AMERICAN NOTES.

[From Our Correspondent.]

NEW YORK.

I hope to be able to transmit for the information of your readers, in the course of the next two or three weeks, a rough sort of practical survey of the immense strides made by electricity on this Continent during the past ten years. So far as public uses are concerned, the Old Country has, I know, made wonderful progress in recent times, but the survey I hope to send you will concern itself more particularly with domestic electricity for cooking, ironing, small motors for driving machines, heating and so on, in which the developments in this country have been simply phenomenal. The fact is the lighting corporations here especially lay themselves out to popularise the use of electric energy, and make their charges so low, that almost the poorest householder can be supplied, and the sequel is found in a great and always increasing demand for electrically-operated utensils of every variety for cooking, heating, and domestic purposes generally.

Titanium Carbide Lamp.

The Union Light, Heat, and Power Co., of Covington, Kentucky, has recently introduced a titanium-carbide arc lamp, which bids fair, when further developed, to be a great success. Mr. C. R. McKay, of that company, in describing the new lamp, says the magnetite or metallic oxide flame lamp now produced by two of the leading electrical manufacturing companies uses a solid metal positive electrode, generally of copper, and a negative composed chiefly of powdered magnetic oxide of iron with oxides of titanium and chromium in small quantities, the mixture being contained in a thin soft iron tube. In this mixture each oxide appears to perform a distinct function, the iron furnishing the required conductivity, the chromium the essential life, and the titanium the majority of the brilliant light of the arc. Both types of lamp owe their illuminating superiority chiefly to the titanium contained in the negative electrode. They operate with direct current, and necessitate some rectifying apparatus when only alternating current is available. In the new system use is made of lamps with electrodes composed largely of titanium carbide, thereby avoiding current rectification, and obtaining increased lighting efficiency. The luminous efficiency is high, the specific consumption approaching 0·33 watt per mean horizontal c.p., but much remains to be accomplished toward reduced operating and maintenance expenses before the titanium-carbide system will prove its superiority.

Hints to Consumers.

The Edison Electric Co. is issuing to domestic consumers a leaflet in the following form: "*Points to Remember.*—This is the time of the year when the days shorten and the nights lengthen. Naturally, more artificial light is needed—much light is also wasted for lack of care. The light you waste does no good and costs you money. We recommend the following: Turn off your electric lights when they are not required—you don't even need a match to relight them. Use lamps of low candle power for halls, pantrys, cellars, and small rooms. Use a drop light or portable electric lamp for reading. For this purpose, one light low down is better than four lights high up in the air. You can obtain a 'turn down' electric lamp, which works like gas. Use one of these when 'all night' light is required. If you have any trouble with your service, don't tell your neighbour, tell us; we'll make it right."

Street Lighting.

Colorado is going ahead rapidly with new street lighting systems. In Denver the three principal streets are equipped with ornamental trolley and pole lamps, fixed 100 ft. apart, each carrying a single arc light with a 15 in. globe, and the effect is very striking and handsome.

Telephone and Telegraph Merger.

The American Telephone & Telegraph Co., in a memorandum on the projected consolidation of the Bell operating companies, says that the full development of the movement will extend over a period of several years. In the meantime, no further exchange of American shares for the shares of local companies will be attempted until the results of the four offers already made have been worked out. The first step was taken two years ago, when the Bell of Philadelphia, the Pennsylvania, the Chesapeake and Potomac, the Delaware and Atlantic, and the Diamond State companies were consolidated, but the work was not completed until the end of 1908. The next step was bringing under a common management the large New York companies, and the making of a practical consolidation of the companies operating in central New York. This step was completed this year. The results of consolidation from both the economical and practical standpoints have been so great that a step further was decided upon in order that the maximum advantages could be obtained. That the closely interrelated territory of the New York & New Jersey, Bell of Philadelphia, Bell of Buffalo, and Central District & Printing Telegraph Co. of Pittsburgh might be more effectually rearranged the American Telephone & Telegraph Co. offered an exchange of its shares for the outstanding local shares. The basis of exchange with the Bell Co. of Buffalo was 15 shares of American for 16 shares of the local company.

Electric Railway Developments.

The gross earnings of the Interborough Rapid Transit Co. to June 30 were $25,775,392, as compared with $24,059,299 in the previous year. The returns derived from the operations of the subway and the elevated lines after paying all charges were equal to 13·11% on the $35,000,000 stock, and the net income for the year after all fixed charges have been paid amounts to $8,789,823. To these earnings the subway contributed $11,917,313, an increase of $1,896,774 over the previous year, and the net for the subway was $7,369,692, a gain of $1,772,468.—Mr. C. H. Pierce announces that the project for an electric railway from Denver to Greeley is progressing healthily, and the end of the summer will probably see the line begun. The proposed line is nearly 60 miles in extent, and energy will be purchased from either the Central or the Eastern Colorado Power Co.—A contract has been closed for the erection of the new Troy-street sub-station of the Commonwealth Edison Co., Chicago. The building is located on South Troy-street, one block west of Kedzie-avenue and half a block north of West Twenty-second-street. It will house a step-down transformer sub-station of the usual type, the equipment consisting of two 1,500 kw. transformers.—Among recent Mexican developments the most important is the formation of the El Paso & Fort Hancock Railroad Co., which proposes to build an electric railway down the Rio Grande Valley from Fort Bliss to old Fort Hancock, passing through El Paso and Ysleta. The line will be about 60 miles long, and will do both a passenger and freight business. The project is a sequel to the agricultural development of the valley region given by the assurance of the early completion of the great Elephant Butte dam and irrigation project. The proposed line will handle the products of the irrigated farms and afford transportation service to the many settlers in the valley. —The Interborough Rapid Transit Co. (New York City) has ordered from the General Electric Co. two 5,000 kw., low-pressure turbines, to be operated in connection with reciprocating engines of the same rating in the subway division power house on Fifty-ninth-street and Eleventh-avenue. The turbines will be vertical machines driving 3-phase, 25 cycle, 11,000 volt induction generators, the leads from which will be connected without switching apparatus to the generators driven by the respective reciprocating engines.

Japan.—A Bureau of Electricity has been added to the Japanese Department of Communications, in order to cope with the enormous growth of the electrical industry. In five years the demand for electric current has risen from 58,000 kw. to 380,000. The amount generated by hydraulic power has risen from 16,000 to 62,000, and permits have been granted for another 158,000 kw. Of 817 registered manufacturing industries, 198 use electricity.

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PROGRESS IN ELECTRICITY.*

By Professor Sir J. J. Thompson, M.A., LL.D., D.Sc., F.R.S.

It has usually been the practice of the President of this Association to give some account of the progress made in the last few years in the branch of science which he has the honour to represent.

I propose this evening to follow that precedent and to attempt to give a very short account of some of the more recent developments of physics, and the new conceptions of physical processes to which they have led.

The period which has elapsed since the Association last met in Canada has been one of almost unparalleled activity in many branches of physics, and many new and unsuspected properties of matter and electricity have been discovered. The history of this period affords a remarkable illustration of the effect which may be produced by a single discovery; for it is, I think, to the discovery of the Röntgen rays that we owe the rapidity of the progress which has recently been made in physics. A striking discovery like that of the Röntgen rays acts much like the discovery of gold in a sparsely populated country; it attractt workers who come in the first place for the gold, but who may find that the country has other products, other charms, perhaps even more valuable than the gold itself. The country in which the gold was discovered in the case of the Röntgen rays was the department of physics dealing with the discharge of electricity through gases, a subject which, almost from the beginning of electrical science, had attracted a few enthusiastic workers, who felt convinced that the key to unlock the secret of electricity was to be found in a vacuum tube. Röntgen, in 1895, showed that when electricity passed through such a tube, the tube emitted rays which could pass through bodies opaque to ordinary light; which could, for example, pass through the flesh of the body and throw a shadow of the bones on a suitable screen. The fascination of this discovery attracted many workers to the subject of the discharge of electricity through gases, and led to great improvements in the instruments used in this type of research. It is not, however, to the power of probing dark places, important though this is, that the influence of Röntgen rays on the progress of science has mainly been due; it is rather because these rays make gases, and, indeed, solids and liquids, through which they pass conductors of electricity. It is true that before the discovery of these rays other methods of making gases conductors were known, but none of these was so convenient for the purposes of accurate measurement.

The study of gases exposed to Röntgen rays has revealed in such gases the presence of particles charged with electricity; some of these particles are charged with positive, others with negative electricity.

The properties of these particles have been investigated; we know the charge they carry, the speed with which they move under an electric force, the rate at which the oppositely charged ones recombine, and these investigations have thrown a new light, not only on electricity, but also on the structure of matter.

We know from these investigations that electricity, like matter, is molecular in structure, that just as a quantity of hydrogen is a collection of an immense number of small particles called molecules, so a charge of electricity is made up of a great number of small charges, each of a perfectly definite and known amount.

Helmholtz said in 1880 that in his opinion the evidence in favour of the molecular constitution of electricity was even stronger than that in favour of the molecular constitution of matter. How much stronger is that evidence now, when we have measured the charge on the unit and found it to be the same from whatever source the electricity is obtained. Nay, further, the molecular theory of matter is indebted to the molecular theory of electricity for the most accurate determination of its fundamental quantity, the number of molecules in any given quantity of an elementary substance.

The great advantage of the electrical methods for the study of the properties of matter is due to the fact that whenever a particle is electrified it is very easily identified, whereas an uncharged molecule is most elusive; and it is only when these are present in immense numbers that we are able to detect them. A very simple calculation will illustrate the difference in our power of detecting electrified and unelectrified molecules. The smallest quantity of unelectrified matter ever detected is probably that of neon, one of the inert gases of the atmosphere. Professor Strutt has shown that the amount of neon in $\frac{1}{20}$ of a cubic centimetre of the air at ordinary pressures can be detected by the spectroscope; Sir William Ramsay estimates that the neon in the air only amounts to one part of neon in 100,000 parts of air, so that the neon in $\frac{1}{20}$ of a cubic centimetre of air would only occupy at atmospheric pressure a volume of half a millionth of a cubic centimetre. When stated in this form the quantity seems exceedingly small, but in this small volume there are about ten million million molecules. Now the population of the earth is estimated at about fifteen hundred millions, so that the smallest number of molecules of neon we can identify is about 7,000 times the population of the earth. In other words, if we had no better test for the existence of a man than we have for that of an unelectrified molecule we should come to the conclusion that the earth is uninhabited. Contrast this with our power of detecting electrified molecules. We can by the electrical method, even better by the cloud method of C. T. R. Wilson, detect the presence of three or four charged particles in a cubic centimetre. Rutherford has shown that we can detect the presence of a single α particle. Now the particle is a charged atom of helium; if this atom had been uncharged we should have required more than a million million of them, instead of one, before we should have been able to detect them.

We may, I think, conclude, since electrified particles can be studied with so much greater ease than unelectrified ones, that we shall obtain a knowledge of the ultimate structure of electricity before we arrive at a corresponding degree of certainty with regard to the structure of matter.

We have already made considerable progress in the task of discovering what the structure of electricity is. We have known for some time that of one kind of electricity—the negative—and a very interesting one it is. We know that negative electricity is made up of units all of which are of the same kind; that these units are exceedingly small compared with even the smallest atom, for the mass of the unit is only $\frac{1}{1700}$ part of the mass of an atom of hydrogen; that its radius is only 10-13 centimetre, and that these units, "corpuscles" as they have been called, can be obtained from all substances. The size of these corpuscles is on an altogether different scale from that of atoms; the volume of a corpuscle bears to that of the atom about the same relation as that of a speck of dust to the volume of this room. Under suitable conditions they move at enormous speeds which approach in some instances the velocity of light.

The discovery of these corpuscles is an interesting example of the way Nature responds to the demands made upon her by mathematicians. Some years before the discovery of corpuscles it had been shown by a mathematical investigation that the mass of a body must be increased by a charge of electricity. This increase, however, is greater for small bodies than for large ones, and even bodies as small as atoms are hopelessly too large to show any appreciable effect; thus the result seemed entirely academic. After a time corpuscles were discovered, and these are so much smaller than the atom that the increase in mass due to the charge becomes not merely appreciable, but so great that, as the experiments of Kaufmann and Bucherer have shown, the whole of the mass of the corpuscle arises from its charge.

We know a great deal about negative electricity; what do we know about positive electricity? Is positive electricity molecular in structure? Is it made up into units, each unit carrying a charge equal in magnitude though opposite in sign to that carried by a corpuscle? Does, or does not, this unit differ, in size and physical properties, very widely from the corpuscle? We know that by suitable processes we can get corpuscles out of any kind of matter, and that the corpuscles will be the same from whatever source they may be dreived. Is a similar thing true for positive electricity? Can we get, for example, a positive unit from oxygen of the same kind as that we get from hydrogen?

*Presidential Address before the British Association for the Advancement of Science, Winnipeg, 1909.

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For my own part, I think the evidence is in favour of the view that we can, although the nature of the unit of positive electricity makes the proof much more difficult than for the negative unit.

In the first place we find that the positive particles—"canalstrahlen" is their technical name—discovered by our distinguished guest, Dr. Goldstein, which are found when an electric discharge passes through a highly rarefied gas, are, when the pressure is very low, the same, whatever may have been the gas in the vessel to begin with. If we pump out the gas until the pressure is too low to allow the discharge to pass, and then introduce a small quantity of gas and restart the discharge, the positive particles are the same whatever kind of gas may have been introduced.

I have, for example, put into the exhausted vessel oxygen, argon, helium, the vapour of carbon tetrachlaride, none of which cantain hydrogen, and found the positive particles to be the same as when hydrogen was introduced.

Some experiments made lately by Wellisch, in the Cavendish Laboratory, strongly support the view that there is a definite unit of positive electricity independent of the gas from which it is derived; these experiments were on the velocity with which positive particles move through mixed gases. If we have a mixture of methyl-iodide and hydrogen exposed to Röntgen rays, the effect of the rays on the methyl-iodide is so much greater than on the hydrogen that, even when the mixture contains only a small percentage of methyl-iodide, practically all the electricity comes from this gas, and not from the hydrogen.

Now if the positive particles were merely the residue left when a corpuscle had been abstracted from the methyl-iodide, these particles would have the dimensions of a molecule of methyl-iodide; this is very large and heavy, and would therefore move more slowly through the hydrogen molecules than the positive particles derived from hydrogen itself, which would, on this view, be of the size and weight of the light hydrogen molecules. Wellisch found that the velocities of both the positive and negative particles through the mixture were the same as the velocities through pure hydrogen, although in the one case the ions had originated from methyl-iodide and in the other from hydrogen; a similar result was obtained when carbon tetrachloride, or mercury methyl, was used instead of methyl-iodide. These and similar results lead to the conclusion that the atom of the different chemical elements contain definite units of positive as well as of negative electricity, and that the positive electricity, like the negative, is molecular in structure.

The investigations made on the unit of positive electricity show that it is of quite a different kind from the unit of negative, the mass of the negative unit is exceedingly small compared with any atom, the only positive units that up to the present have been detected are quite comparable in mass with the mass of an atom of hydrogen: in fact they seem equal to it. This makes it more difficult to be certain that the unit of positive electricity has been isolated, for we have to be on our guard against its being a much smaller body attached to the hydrogen atoms which happen to be present in the vessel. If the positive units have a much greater mass than the negative ones, they ought not to be so easily deflected by magnetic forces when moving at equal speeds; and in general the insensibility of the positive particles to the influence of a magnet is very marked: though there are cases when the positive particles are much more readily deflected, and these have been interpreted as proving the existence of positive units comparable in mass with the negative ones. I have found, however, that in these cases the positive particles are moving very slowly, and that the ease with which they are deflected is due to the smallness of the velocity and not to that of the mass. It should, however, be noted that M. Jean Becquerel has observed in the absorption spectra of some minerals, and Professor Wood in the rotation of the plane of polarisation by sodium vapour, effects which could be explained by the presence in the substances of positive units comparable in mass with corpuscles. This, however, is not the only explanation which can be given of these effects, and at present the smallest positive electrified particles of which we have direct experimental evidence have masses comparable with that of an atom of hydrogen.

A knowledge of the mass and size of the two units of electricity, the positive and the negative, would give us the material for constructing what may be called a molecular theory of electricity, and would be a starting-point for a theory of the structure of matter; for the most natural view to take, as a provisional hypothesis, is that matter is just a collection of positive and negative units of electricity, and that the forces which hold atoms and molecules together, the properties which differentiate one kind of matter from another, all have their origin in the electrical forces exerted by positive and negative units of electricity, grouped together in different ways in the atoms of the different elements.

As it would seem that the units of positive and negative electricity are of very different sizes, we must regard matter as a mixture containing systems of very different types, one type corresponding to the small corpuscle, the other to the large positive unit.

Since the energy associated with a given charge is greater the smaller the body on which the charge is concentrated, the energy stored up in the negative corpuscles will be far greater than that stored up by the positive. The amount of energy which is stored up in ordinary matter in the form of the electrostatic potential energy of its corpuscles is, I think, not generally realised. All substances give out corpuscles, so that we may assume that each atom of a substance contains at least one corpuscle. From the size and the charge on the corpuscle, both of which are known, we find that each corpuscle has 8×10^{-7} ergs of energy; this is on the supposition that the usual expressions for the energy of a charged body hold when, as in the case of a corpuscle, the charge is reduced to one unit. Now in one gramme of hydrogen there are about 6×10^{23} atoms, so if there is only one corpuscle in each atom the energy due to the corpuscles in a gramme of hydrogen would be 48×10^{16} ergs, or 11×10^{9} calories. This is more than seven times the heat developed by one gramme of radium, or than that developed by the burning of five tons of coal. Thus we see that even ordinary matter contains enormous stores of energy; this energy is fortunately kept fast bound by the corpuscles; if at any time an appreciable fraction were to get free the earth would explode and become a gaseous nebula.

The matter of which I have been speaking so far is the material which builds up the earth, the sun, and the stars, the matter studied by the chemist, and which he can represent by a formula; this matter occupies, however, but an insignificant fraction of the universe, it forms but minute islands in the great ocean of the ether, the substance with which the whole universe is filled.

The ether is not a fantastic creation of the speculative philosopher; it is as essential to us as the air we breathe. For we must remember that we on this earth are not living on our own resources; we are dependent from minute to minute upon what we are getting from the sun, and the gifts of the sun are conveyed to us by the ether. It is to the sun that we owe not merely night and day, springtime and harvest, but it is the energy of the sun, stored up in coal, in waterfalls, in food, that practically does all the work of the world.

How great is the supply the sun lavishes upon us becomes clear when we consider that the heat received by the earth under a high sun and a clear sky is equivalent, according to the measurements of Langley, to about 7,000 h.p. per acre. Though our engineers have not yet discovered how to utilise this enormous supply of power, they will, I have not the slightest doubt, ultimately succeed in doing so; and when coal is exhausted and our water-power inadequate, it may be that this is the source from which we shall derive the energy necessary for the world's work. When that comes about, our centres of industrial activity may perhaps be transferred to the burning deserts of the Sahara, and the value of land determined by its suitability for the reception of traps to catch sunbeams.

This energy, in the interval between its departure from the sun and its arrival at the earth, must be in the space between them. Thus this space must contain something which, like ordinary matter, can store up energy, which can carry at an enormous pace the energy associated with light and heat, and which can, in addition, exert the enormous stresses necessary to keep the earth circling round the sun and the moon round the earth.

(To be continued.)

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

"If thou hast knowledge, let others light their candle at it."

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should be *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

———

Question No. 1195.—In a certain station a rotary converter combined with a transformer is used to step down from high-tension alternating current to direct current. The rotary is wound for six-phase current. Explain why a six-phase arrangement is more efficient than a three-phase one.—C. L.

Answer to Question No. 1195 (*awarded* 10*s.*).—The increased output of rotary converters, as compared with D.C. machines of equal C^2R loss, with increasing number of phases on the A.C. side of the converter, is explained by the more uniform distribution and less magnitude of the armature C^2R losses the higher the number of phases. The reduced C^2R losses in a machine of given output, and consequent higher efficiency, the greater the number of slip rings are due to improved balancing of the A.C.'s and

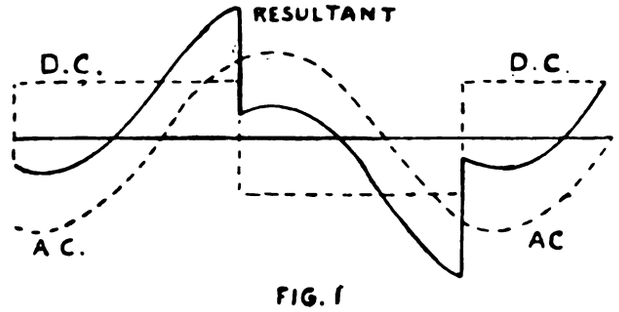

FIG. 1

D.C.'s in the armature conductors. Considering the rotary converter as built up of two separate machines—in fact, a motor-generator set—the armature heating in each machine is uniform, but on combining the two armatures in one machine the superposed A.C. and D.C. yield a current wave of peculiar form (Fig. 1), having its maximum just before commutation. Fig. 1 assumes a uniform strength of D.C. and a sinusoidal A.C. From this curve, and the particular example worked out below it, will appear that the heating of the armature winding is greatest near the points of connection of the A.C. slip ring leads. Though

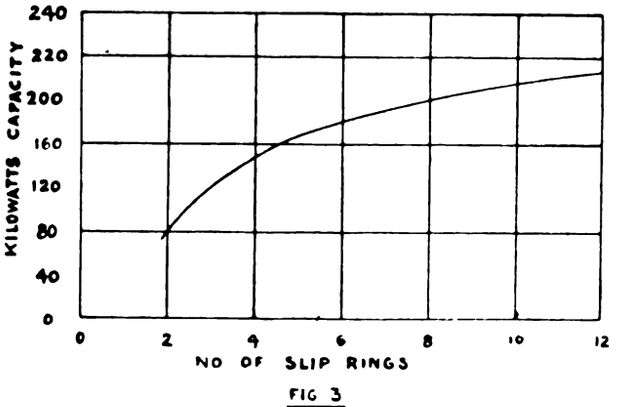

FIG 3

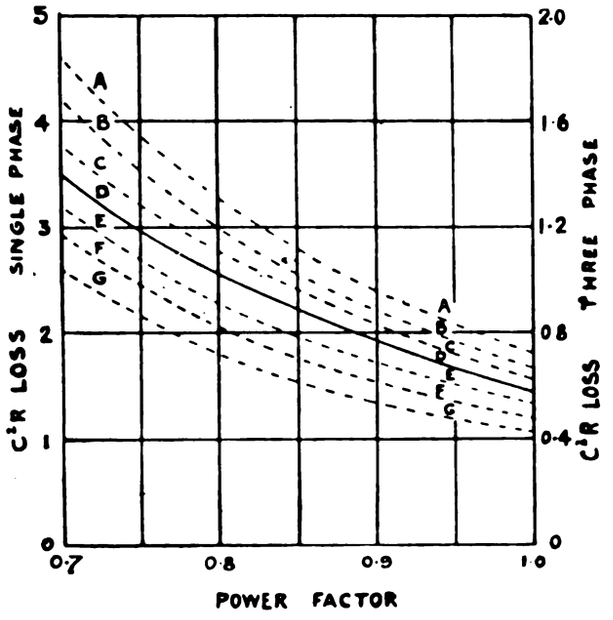

FIG 4

this local heating may be reduced by careful armature ventilation, it always forms a certain limitation to the output of the machine (commutating difficulties being, however, the greatest limitation).

Assuming a two-pole parallel wound one-phase rotary converter as in Fig. 2, and assuming 100 v. 100 amps on the D.C. side of the machine, the hypothetical A.C.'s and the resultant currents under various conditions are as shown in cases (1)—(9). Assuming unity p.f. and 100% efficiency of conversion, the A.C. R.M.S. volts = 70·7, and therefore $C_{R.M.S} = 141{\cdot}4 \times \sqrt{2} = 200a$. Consider two coils one, ***a***, near the slip ring connection, and one, ***B***, midway between the connections, the value of the D.C. is 50 amps. through each half of the winding throughout, while the A.C. is a periodic current which has its zero in the position shown in *diagram* (2), Fig. 2 the points tapped then being at the same potential. Superimposing (1) and (2), (3) is obtained, showing both ***a*** and ***B*** to be carrying 50 amps. Displacing the armature 30°, as in (4), the A.C. $= (\sin 30) \times C_{MAX.} = \frac{1}{2} \times 200 = 100a$, half of which flows to the rings from each side of the tapping point, so that combining (4) and (1) in (5), ***a*** carries 100 amps. and ***B*** 0 amps. Similarly, taking in succession displacements of 45°, 60° and 90°, and taking account of the directions of current flow, the results of Table 1 are obtained.

The advantage of increasing the number of phases on the A.C. side of the machine lies in the more uniform heating attained and the more nearly complete balancing of the alternating and direct hypothetical currents, resulting in a higher efficiency, the C^2R losses for a given output being reduced. This is shown by the columns of data for three-phase and six-phase converters (Table 1), similar in other respects to the one-phase machine already dealt with. These data correspond to those obtained above, and are derived in the same manner. The statement that the coil ***a*** near the slip rings always carries a current greater than or equal to that carried by ***B***, midway between the rings, is also justified by Table 1. For intermediate coils an intermediate duty is obtained. Since the heating aC^2, it is obvious that local heating is considerable in one-phase machines, but much less in three and six-phase machines. The coil ***B*** in no case gets so hot as it would were the machine run as a simple D.C. generator, since the current ***B*** then = 50 amps. throughout, whereas its *maximum* value is now 50 amps.

Taking the output of a D.C. machine as 1·0, its output as a rotary converter for the same gross heating is:

With one phase on the A.C. side	..	0·85
,, three phases	,,	,,	..	1·34
,, four	,,	,,	,,	..	1·64
,, six	,,	,,	,,	..	1·96

Similar information is otherwise conveyed by Fig. 3, which shows the capacity of a D.C. machine of 100 kwatts output when used as a rotary converter with various

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numbers of slip rings and assuming equal temperature rise in every case.

The above comparative figures assume 100% efficiency of conversion, unity p.f. and a sinusoidal E.M.F. wave. The effects of a lower efficiency and lower p.f. are shown in Fig. 4, in which the relative C^2R losses for one and three-phase machines are plotted to a p.f. base, and for the following cases :—

Curve A :—A.C. to D.C. and 30% D.C. power lost in armature and bearings.

Curve B :—A.C. to D.C. and 20% D.C. power lost in armature and bearings.

Curve C :—A.C. to D.C. and 10% D.C. power lost in armature and bearings.

Curve D :—Either A.C. to D.C. or D.C. to A.C. with *no losses* in armature and bearings.

Curve E :—D.C. to A.C. and 10% D.C. power lost in armature and bearings.

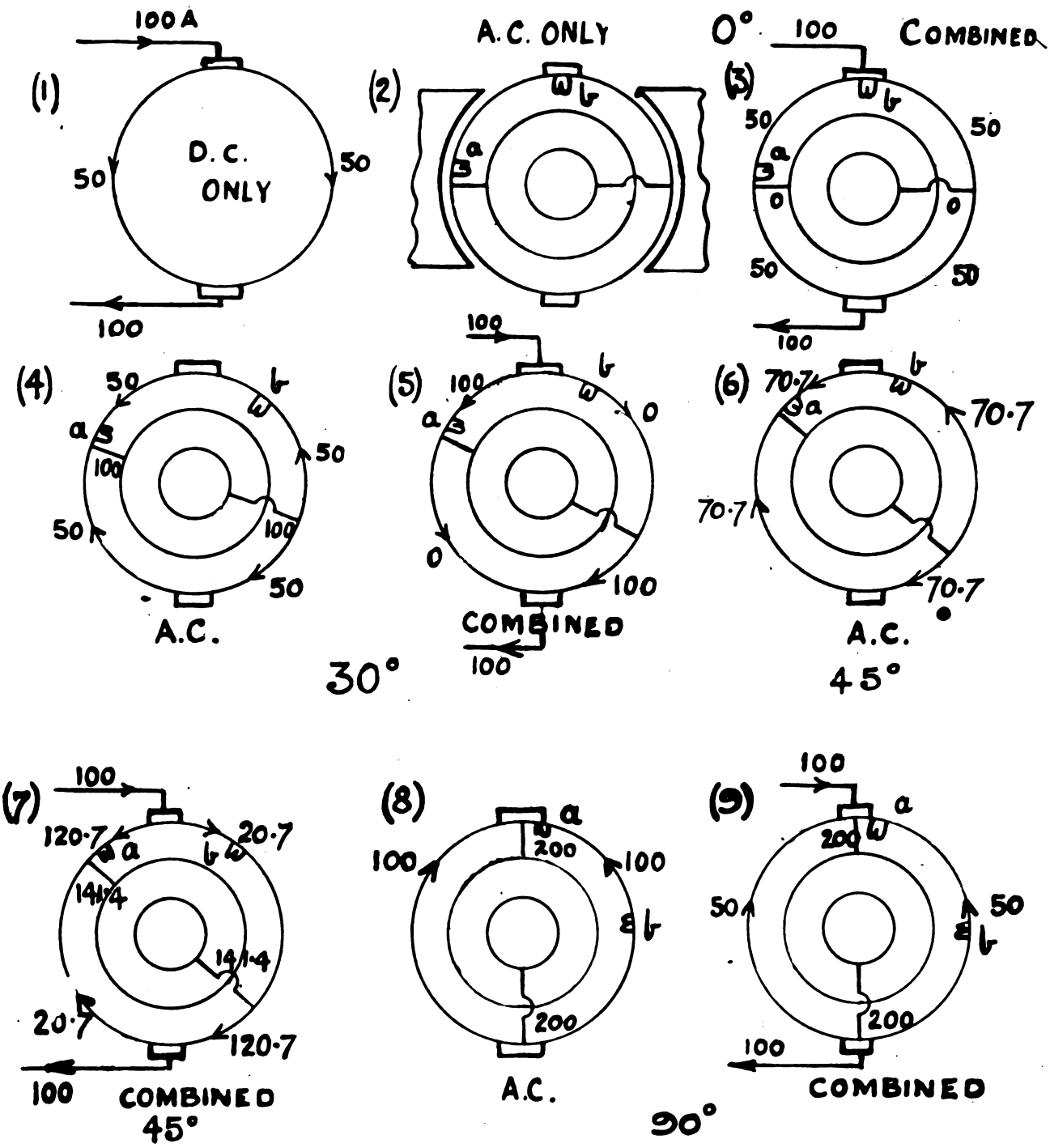
Curve F :—D.C. to A.C. and 20% D.C. power lost in armature and bearings.

Curve G :—D.C. to A.C. and 30% D.C. power lost in armature and bearings.

The assumption made in obtaining these curves is that half the total losses of conversion are C^2R losses in the armature, *i.e.*, the electrical losses = mechanical losses—a well-known practical approximation of very reasonable accuracy.

Any departure of the p.f. from unity detracts from the perfection of the balancing of the alternating and direct currents, and consequently decreases the capacity and efficiency of a converter for given temperature rise. It is easy to maintain unity p.f. over a wide range of load conditions by varying the excitation of the converter, the consequent effect being as in any synchronous motor.

The above notes fully explain the rising efficiency and load capacity of rotary converters as the number of phases increases.—"L. C."



UNEQUAL HEATING IN 1 PHASE ROTARY CONVERTER

FIG. 2

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ROTARY CONVERTERS.

Table 1.—*Unequal Armature Current Distribution.*

Angular Displacement from neutral position case (2) fig. 2)	Single-phase.		Three-phase.		Six-phase.	
	Ct. α amps.	Ct. β amps.	Ct. α amps.	Ct. β amps.	Ct. α amps.	Ct. β amps.
0°	50	50	50	50	50	50
30°	100	0	69	31	33·3	33·3
45°	120·7	20·7	77·25	22·75	26·5	26·5
60°	136·6	36·6	16	16	21	21
90°	50	50	11	11	16·6	16·6
135°	20·7	20·7	22·75	22·75	26·5	26·5
180°	50	50	50	50	50	50

Note :– above data are cyclic : period 180°.—" L. C."

Answer to Question No. 1195 (*awarded* 5*s.*).—The factor governing the efficiency of rotary converters is one which has important relation to all electrical machinery, viz., the heating of the armature. It is proposed, therefore, to show how this factor varies in rotaries whose armatures have different numbers of phases, and in doing so a solution will be found for the question, " Why is a six-phase rotary converter more efficient than a three-phase ? "

Alfred Hay, in his text-book " Alternating Currents," gives useful data regarding this question, and some of the following extracts used have been taken from this reference.

Heating of converter having N slip-rings. (Power factor unity assumed.)

Let N = number of slip rings, *i.e.*, N phases on armature.
" V = continuous volts between brushes.
" I_N = max. current in each phase.

Then max. volts of each phase = $V \sin \frac{n}{N}$ .....(1)

and power supplied to machine per phase

$$= \tfrac{1}{2} V.I_N \sin \tfrac{n}{N} \quad ....(2)$$

Total " " " $= \frac{N}{2} V.I_N \sin \frac{n}{N}$ ...(3)

If I = current on D.C. side. Then neglecting losses and equating equation (3) to output, we obtain

$$\tfrac{N}{2} V.I_N \sin \tfrac{n}{N} = V.I$$

$$i.e.\ I_N = \frac{2I}{N \sin \frac{n}{N}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

In the Fig. X and Y are points of connection of 2 adjacent slip-rings, and B, B_2 is the line of brushes, making at time t an angle pt = θ with OY.

If i_N = instantaneous alternating current supplied to phase XY, we may write

$i = I_N \sin (\theta + \alpha)$, where α is as yet unknown.

Now the phase voltage and current are a maximum when T (middle point) is in line with the middle of pole piece, *i.e.*, when line of brushes is at rt. angles (as shown dotted) to O T.

We, then, have $i_N = I_N$ or $\sin (\theta + \alpha) = 1$, and since at this instant

$$\theta = \tfrac{n}{N} + \tfrac{n}{2} \text{ it follows that } \alpha = \overset{\smile}{\ } \tfrac{n}{N}$$

$$\therefore\ i_N = I_N \sin (\theta - \tfrac{n}{N})$$

Considering any portion of X Y say at P, let Y O P = ρ

Then so long as $\theta < \rho$, the current at P is expressed by

$$i_N + \tfrac{1}{2}I = \tfrac{1}{2}I + I_N \sin (\theta - \tfrac{n}{N}) \quad \ldots\ldots\ldots\ldots\ldots (5)$$

Also when $\theta > \rho$ current at P is

$$i_N - \tfrac{1}{2}I = -\tfrac{1}{2}I + I_N \sin (\theta - \tfrac{n}{N}) \quad \ldots\ldots\ldots\ldots\ldots (6)$$

The square of the current, *i.e.*, $i^2 = \tfrac{1}{4}I^2 + I_N^2 \sin^2 (\theta - \tfrac{n}{N})$

$$+ I.I_N \sin (\theta - \tfrac{n}{N}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

that is $i^2 = \tfrac{1}{4} I^2 + \tfrac{1}{2} I_N^2 - \tfrac{1}{2} I^2 \cos (2\theta - \tfrac{2n}{N})$

$$\pm I.I_N \sin (\theta - \tfrac{n}{N}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

since $\sin^2 (\theta - \tfrac{n}{N}) = \tfrac{1}{2} \left[1 - \cos 2 (\theta - \tfrac{n}{N})\right]$

Thus to obtain the mean rate of heat production at P, it is necessary to find the mean value of i^2 during half period, i.e., between θ = o and $\theta = n$.

Considering (8) the first two terms vanish when considering average value of i^2, and the remaining term $\pm I.I_N \sin (\theta -) \frac{n}{N}$ is considered, the + sign being understood so long as $\theta < \rho$ and the — when $\theta > \rho$.

Thus the mean value of i^2 over the period under consideration is given by

$$\frac{II_N}{n} \int_o^{\rho} \sin (\theta - \tfrac{n}{N})\, d\theta - \int_{\rho}^{n} \sin (\theta - \tfrac{n}{N})\, d\theta$$

(if the term is plotted as a function of θ)

$$= -\frac{2II_N}{n} \cos \rho - \tfrac{n}{N}$$

Thus we obtain for the mean value of i^2 at P

$$\tfrac{1}{4} I^2 + \tfrac{1}{2} I_N^2 - \tfrac{2}{n} I.I_N \cos (\rho - \tfrac{n}{N}) \ldots\ldots (9)$$

This expression shows that the heating is greatest at X and Y, the points of connection to the slip rings, and least at T, the point half-way between X and Y. The expression also shows that i^2, and, consequently, the heat produced is decreased as the value of N is increased.

Effect of Number of Slip-rings on Output of Converter :—

The mean rate of heat generated in the coils between 2 slip-rings is given by

$$\tfrac{1}{4} I^2 + \tfrac{1}{2} I_N^2 - \tfrac{2}{n} 2\, II_N.\, N \sin \tfrac{n}{N} \quad (10)$$

which is obtained by integrating the last term of (9) and obtaining the mean value of the expression.

Substituting the value of I_N from (4), (10) becomes

$$\left(\frac{2}{N^2 \sin^2 \frac{n}{N}} - \cdot 1553\right) I^2$$

That is the mean rate of heat produced in the armature is the same as if each coil was traversed by a direct current of amount $\sqrt{K}.I.$ where $K = \frac{2}{N^2 \sin^2 \frac{n}{N}} - \cdot 1553 \ldots\ldots (11)$

or as if the armature was generating a direct current of $2\sqrt{K}.I.$

If it is assumed that the limit of output is fixed by the permissible rise of temperature, and if V.I. = maximum output of armature when acting as a converter, then its output as a D.C. generator = $2\sqrt{K}$ V.I.

That is converter output $= \frac{1}{2\sqrt{K}}$ times the D.C. generator output

Using this repression with (11), the following relative figures are obtained—D.C. generator = 100.

N	2	3	4	6	12
Relative output	85·2	133	162	193	219·5

It has thus been shown mathematically that by increasing the number of slip-rings on a rotary converter increases its output, this being due to the latter machines offering a better neutralization of the currents in their armatures, and, consequently, reducing the resultant C^2R loss in proportion. From the above figures it will be seen that the outputs obtained from a three-phase as compared with a six-phase rotary are in the proportion of 133 to 193, about 69%.—" X."

Answer to Question No. 1195 (*awarded* 5*s.*).—To consider the question of comparative efficiency of three and six-phase rotary converters necessitates investigation of the current variations in the coils of the rotary windings. This examination will show that the coils nearest to the connectors from the windings to the slip rings are subjected to much higher currents than those coils situated midway between two such connectors. Again, it will be found that the maximum current in any coil situated next to one of these connections differs considerably according to the number of slip rings on the machine, *e.g.*, whether three or six—the greater the number of rings the smaller this maximum value will be.

To properly realise this last point, consider the concrete case of a machine the output of which is to be 100 ampéres at 100 volts direct current. Assume that the power factor is unity and that there are no losses—reactance, resistance or mechanical.

Now if the rotary is supplied with three-phase current, the voltage of supply will have to be

$$\frac{\sqrt{3}}{2\sqrt{2}} \times 100 = 61{\cdot}23$$

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this value being fixed, since the voltage ratio is fixed. The virtual current per phase to give the required output of 10 kw. will therefore be

$$\frac{10000}{61{\cdot}25 \times \sqrt{3}} = 94{\cdot}3 \text{ ampères.}$$

And, assuming a sine distribution of flux, the maximum value will be $94{\cdot}3 \times \sqrt{2} = 133{\cdot}33$ amps.

Now in the case of a six-phase machine of exactly the same dimensions, and assuming the same conditions as the above, the line volts will be

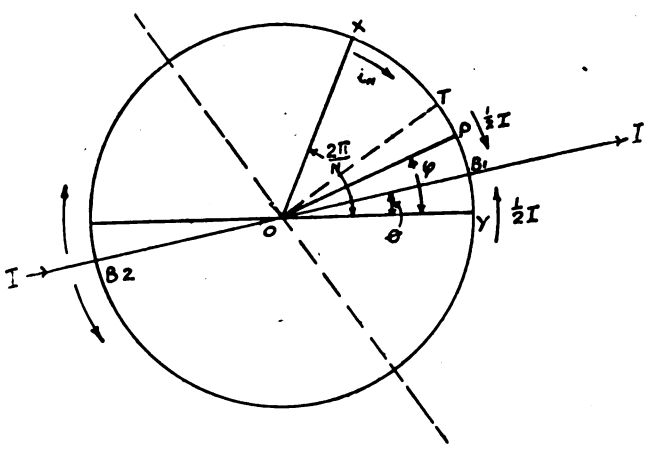
$$\frac{1}{2\sqrt{2}} \times 100 = 35{\cdot}35.$$

The current per phase being $\frac{10000}{35{\cdot}35 \times 6} = 47{\cdot}2$ amps.

Maximum current becoming $47{\cdot}2 \times \sqrt{2} = 66{\cdot}66$ amps.

From these figures, it is obvious that the piling up of the current near any connector in the case of a six-phase machine cannot be so great as in a three-phase.

Now the adverse effects of such piling up are two-fold—heating and commutating. The former is greater the more unevenly it is divided, and since the heating is proportional to the square of the current, the more unevenly the current is distributed round the windings, the greater will be the heating effect. From this point of view, the six-phase machine has a distinct advantage.



Since the current in the coils near the connectors have also to be reversed during commutation from "clockwise" maximum to a "counter-clockwise" value, which will be comparatively low (or *vice versa*), the machine which gives the least difference between these values will have the easiest and more satisfactory commutation. Investigation will show that this difference is much less in the case of a six-phase machine than in a three-phase. This point can be more clearly illustrated by superimposing instantaneous values of the currents taken by the machine as an A.C. motor and the current given out as a D.C. generator.

Reverting to the question of heating, it will be remembered that the current traversing the windings of a converter armature at any moment is the *difference* between the motor and generator currents. Obviously, therefore, if the power factor is other than unity this difference will be considerably greater, with consequent increase of heating and loss of efficiency.

It is a well-known fact that the reactance in a six-phase machine is less than in a three-phase one; therefore, the machine with the larger number of phases has a distinct advantage from the point of view of the above.

The concrete case mentioned above is used merely to simplify explanations, but the actual cases met in practice can be explained on the same basis by allowing for the various losses and value of cos ϕ, etc.

To fully go into the question raised would take up too much space, but further information on the matter can be obtained by reference to L. P. Thompson's dynamo and electric machinery, from which the method of super-imposing values of the two currents can be obtained.

All of the above remarks have been confined to the rotary, as this is the part of the apparatus which is really affected by the difference in the number of phases—the efficiency of the transformer being practically constant.

The above considerations entirely outweigh the slightly increased prime cost involved by the larger number of slip rings, etc., and especially in cases of large rotaries, the six-phase type is strongly to be recommended.—"KOIL."

COMPANIES' MEETINGS AND REPORTS.

LANARKSHIRE TRAMWAYS.

At the meeting of the Lanarkshire Tramways Co., Mr. A. R. Monks, who presided, stated that the revenue for the half-year was £32,199 and the expenses £17,686. They were paying a dividend at the rate of 5½% per annum. Owing to continued trade depression there was a decrease in the traffic receipts of £1,764, compared with the corresponding half of 1908, but the expenses showed a reduction of £1,306, mainly owing to less mileage being run, to the price of coal being considerably lower, and the fact that this half-year no legal expenses had been incurred in connection with Parliamentary Bills.

ISLE OF WIGHT CENTRAL RAILWAY.

The report of the Isle of Wight Central Railway for the half-year ended June 30 last shows a decrease in receipts of £88 and an increase in expenditure of £174. The balance of net revenue amounts to £4,432, which, with the credit balance brought forward, has enabled the directors to pay the rent charges, the minimum guarantee to the Newport, Godshill and St. Lawrence Railway Co., and six months' interest on the "A," "B" and "C" Debenture stocks, and to carry forward a credit balance. The directors have appointed Mr. Edward James Martin to the Board.

LIVERPOOL OVERHEAD RAILWAY.

At the half-yearly meeting of the Liverpool Electric Overhead Railway Sir W. B. Forwood, who presided, said he regretted to have to report a further shrinkage in revenue, and that notwithstanding substantial economies there would again be no dividend for the ordinary shareholders. Owing to the competition of the municipal tramways, which were worked upon popular lines rather than business principles, he could not hold out any hope of restoring their fares to their former level, but he was more hopeful as to recovering their lost traffic. They could not shut their eyes to the fact that the railways denied to Liverpool the full benefit of her geographical position; and they would feel this more and more as trade no longer followed their ships, but ships must follow the trade and go where inland rates of carriage were lowest. Liverpool ought long since to have shaken off the heavy yoke put upon them by railway companies and had her own independent lines to the great manufacturing centres of Lancashire and Yorkshire. This might yet be forced upon them. Sometimes he thought the City Fathers would be wise to consider the making of Liverpool a manufacturing centre, which would employ the surplus population and render them less dependent upon the railways, and make their shipping supremacy more secure; but this would never be brought about by starting municipal enterprises in opposition to the private trader.

The report and accounts were adopted.

WELLINGTON (N.Z.) ELECTRIC TRAMWAYS.

The Wellington (New Zealand) Electric Tramway Co., during the yeor ended March 31, carried 21,679,902 passengers, an increase of 1,574,179 upon the number for the previous year. The net surplus on the year's business was £5,934 or £366 more than in the previous year.

DIRECT SPANISH TELEGRAPH.

The directors of the Direct Spanish Telegraph Co., Ltd., announce an interim dividend at the rate of 4 per cent. per annum, free of income-tax, on the Ordinary shares for the half-year ended June 30.

ELECTRIC SUPPLY CO. OF VICTORIA.

The accounts of the Electric Supply Co. of Victoria, Ltd., for the year ended March 31, 1909, show, after payment of Debenture and other interest, a credit balance of £7,760, to which has to be added the £8,582 brought forward, making a total of £16,342. From this amount has been deducted £7,800 for the Preference dividend to March 31, 1908, and £3,962, for Debenture stock redemption account, leaving £4,581. The dividend on the Preference shares due March 31, 1909, would amount to £8,250.

CONSOLIDATED ELECTRICAL CO.

The Consolidated Electrical Co., Ltd., has declared a dividend of 3% (7 1-5d. per share), less income-tax, on the ordinary shares for the past year, and carried £7,385 forward.

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BRIGHTSIDE FOUNDRY AND ENGINEERING CO.

The directors, in their tenth annual report, state that the operations of the year, after providing for depreciation and all charges, have resulted in a profit of £3,801 13s. The amount brought forward from last year was £814 18s. 10d., making a total of £4616 11s. 10d. After deducting the interim dividend of £1,125, at the rate of 5% per annum for the first half-year on £45,000 5% preference shares, a balance of £3,491 11s. 10d. was left. The half-year's Preference dividend to June 30 has absorbed £1,125, leaving £2,366 11s. 10d. to be disposed of. The directors recommend a dividend of 5% free of income-tax on 40,000 £1 Ordinary shares, which absorbs £2,000. This leaves to be carried forward a balance of £366 11s. 10d. The retiring directors are Messrs. Benjamin Freeborough and Thomas Wilkinson, who are eligible for re-election. Mr. J. W. Best, the retiring auditor, is also eligible for re-election. For the previous year the profit was £4,896 17s. 11d., and a dividend of 5% was paid; and for 1906–7, the profits were £6,276 6s. 3d., and the dividend 7½%.

COMPANIES REGISTERED.

METALLURGIQUE MOTORS, LTD.—Registered August 4. Capital £1,000, in £1 shares. Objects: To carry on the business of manufacturers of and dealers in motor-cars, motors, cycles, flying machines, etc. Private company.

CHARLES E. GOAD, LTD.—Registered July 26. Capital £6,000, in £1 shares. Objects: To take over so much of the business of making surveys and preparing plans for insurance companies, survey and plan work generally, and civil and electrical engineering carried on by C. E. Goad from 53, New Broad-street, E.C., and elsewhere, except Canada and Newfoundland. Private company. Registered office, 53, New Broad-street, E.C.

STASSANO ELECTRO STEEL AND FURNACE CO., LTD.—Registered July 14. Capital £1,000, in £1 shares. Objects: To adopt an agreement between A. Reiner and A. Hobbs, being an assignment of an agreement or option by the Forni Elettrici Stassano Societa Anonyma with or to A. Reiner, to grant to the said A. Reiner or his nominees, subject as therein expressed, the sole right to purchase certain patents relating to Stassano Patent Furnaces, and to carry on the business of steel manufacturers and merchants, etc. Private company. Registered office, 68, Queen Victoria-street, E.C.

CONTRACTS OPEN.

HOME.

LEEDS.—Corporation.—One, two, or three years' supply of paper insulated cables (£8,000 to £10,000 per annum). (Spec., £1 1s., Manager, 1, Whitehall-road).

LEYTON (Essex).—Urban Council.—Public lighting lanterns with clock switches for incandescent electric lamps, for the Leyton Urban District Council. Specification, with schedule and from of tender attached, can be obtained by deposit of £1 1s. from Mr. F. Harman Lewis, electrical engineer to the Council, Electric Light and Power Works, Cathall-road, Leytonstone, London, E. Duplicate copies of specification can be obtained by the deposit of 10s. 6d. for each copy. Sealed tenders, on the form attached to the specification, and enclosed in specially endorsed envelopes supplied with the form, must be delivered at the meeting of the Council to be held at the Town Hall, Leyton, on September 7, at 7 p.m. Deposits are returnable one month after the receipt of *bona fide* tenders and return of specifications in respect of which deposits have been made. Sureties will be required.

LONDON, E. (Poplar).—Guardians.—Annual supply of electrical supplies. (Part., Clerk, 45, Upper North-street, Poplar, E.). September 8.

LONDON, S.W.—London County Council.—Tenders are invited for roadwork and platelaying for reconstruction of tramway in Highgate-hill. Length equivalent to about 1·4 mile of single track. The track rails, fastenings, the slot rails and conductor rails, and special work for the junctions, cross-overs, etc., will be provided by the Council, remaining metal work and other materials is included in the contract. Spec., Chief Engineer, County Hall, Spring-gardens, S.W. Dep., £5. September 7.

PLYMOUTH.—Corporation.—Tenders are invited for the following works in connection with the electricity works, viz.: Contract No. 27, steam turbo-dynamo, etc. Contractors may not tender for a part of any contract. Copies of the conditions, specification, and form of tender, bound up together, may be obtained from Mr. E. G. Okell, borough electrical engineer, Prince Rock, Plymouth, on deposit of £1 1s., for each copy, which will be returned on receipt of a *bona fide* tender upon the prescribed form, and within the stated time. Should a contractor withdraw his tender the amount of his deposit will be forfeited. Sealed tenders, endorsed "Contract No. 27," must be delivered to the Electrical Engineer by September 2.

OVERSEAS.

BELGIUM.—At the Bourse de Bruxelles, Brussels—To supply subterranean electric cables for the Brussels-Dilbeek and the Rouppe-Roue light railways, September 8.—At the offices of the Société National des Chemins de Fer Vicinaux, Brussels—To supply subterranean continuous current electric cables, September 8.

BELGRADE.—Electrical equipment of the mines at Segna, including two centrifugal pumps (2,000 litres per minute each), one pump (500 litres per minute), four electrical conduits, five signalling apparatus, one apparatus for coal mining, etc. (Part., Direction Générale des Chemins de fer de l'Etat Serbe).

BRAZIL.—At the Municipal Offices, Corumba-Matto Grosso—Instal the electric light, October 5.

HANOVER.—Prussian State Railway Offices. To supply 67,16 kilogrammes cast-iron pipes and 505 tons Portland cement September 4.

NEW SOUTH WALES.—At Petersham telephone exchange.—Supply, delivery, and erection of a branching metallic multiple magneto switchboard. November 10.

NORTH SYDNEY TELEPHONE EXCHANGE.—Supply, delivery, and erection of common battery switchboard, also supply and delivery of apparatus for use on subscribers' premises. Jan. 10, 1910.

SYDNEY.—Commonwealth of Australia.—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, for the supply and delivery at the Departmental Stores, Sydney, of 2,550 common battery telephones (2,000 wall sets, 500 table sets, and 50 party-line sets), in accordance with Schedule N.S.W. E. 28109. Tenders, registered and endorsed "Tenders for Common Battery Telephones," should be addressed to the Deputy Postmaster-General, Sydney. A deposit, or receipt for deposit, must be enclosed with each tender, of 5% on the amount thereof up to £1,000, and 2½% on the amount over that sum. Schedules, etc., may be obtained at the General Post Offices, Sydney, Melbourne, Adelaide, Brisbane, Perth, and Hobart. Tender forms, specification, etc., may be obtained, and preliminary deposits paid, at the Commonwealth Offices in London, 72, Victoria-street, S.W. A copy of the specification, etc., may be seen by British firms interested on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C. October 6 (by 2.30 p.m.).

VENEZUELA.—Libertad (Belijoque-Trujillo).—Telephone installation between two towns. (Part., Ayuntamiento Constitucional).

RESULTS OF TENDERS.

HOME.

DARLINGTON.—The tender of the Whessoe Foundry Co. has been accepted by the Council for the supply and delivery of pipe work required for the new turbo generator, and that of Messrs. Farranti, Ltd., of Hollinwood, for the supply and delivery of the switchboard in connection therewith.

DUNDEE.—Messrs. Maxwell, Son, & Co., electrical engineers, St. Andrew's-street, Dundee, have secured the contract to instal electric light throughout the premises taken over by the Admiralty at the Harbour. The contract comprises the illumination of the officers' quarters, out-buildings, lavatories, and extra lights surrounding the dry dock.

BUSINESS NOTES.

LIGHTING AND GENERAL—Home.

ACTON.—The accountant's annual report states that the total debt on the electric light undertaking at the end of the year was £61,633.

AMBLE.—The question of electric lighting is under the consideration of the Urban Council.

BANGOR.—The Council have agreed to apply to the Local Government Board for sanction to a loan of £1,000 for future requirements of expenditure on electricity mains and services.

BARNSLEY.—Some inconvenience and alarm were caused to residents and at works in certain parts of Barnsley owing to a mishap in the electricity supply. There was violent fusing of cables which cut off the supply in several instances. In three cases the machinery was stopped by the motors being disconnected, and instances are reported where the fusing of the wires did considerable damage in houses, and the residents had a severe fright. The officials were quickly at work, and restored the light with all speed.

BRAY.—The Local Government Board have written to the Urban Council with reference to an application for a loan of £2,600 for the purpose of carrying out extensions to the electric lighting system of the township. The Board stated that with regard to the excess expenditure, making up the sum of £1,162, accounts had not been kept, while payments in respect of the

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works were made, and the engineer was not able, at the time of the inquiry, to say what were the exact works necessitating the extra cost. Regarding the sum of £460 for a new switchboard, the Board had again to point out that capital sums amounting to £407 6s. had already been sanctioned for this work, of which £200 did not appear to have been applied for the purpose for which the borrowing was sanctioned. If so, it must have been applied towards the cost of other works. The switchboard obtained for the sum of £203 5s. was afterwards sold by the Council for £30, and a new switchboard provided. Such replacement must be regarded as a work of maintenance, for which a loan could not be sanctioned. In the circumstances, the Board were unable to alter the decision conveyed in their previous letter, which sanctioned a loan of £1,000, for procuring a gas-producing plant, disconnecting boxes, etc. The Council marked the letter "read."

BRISTOL.—A statement has been issued by the Electrical Engineer (Mr. H. Faraday Proctor) to the effect that in actual practice those who have used the metallic filament lamps have, as shown by a list, picked haphazard from the register, effected a saving of 50%. As such reductions must obviously enormously decrease revenue, advertising this lamp would at first appear to the disadvantage of the electrical undertaking; on the contrary, the engineer is convinced that consumers who are combining with such economy the benefits as regards health, convenience, and immunity from damage to decorations and stock, will undoubtedly convince other householders interested that electricity, far from being a luxury only, is an economical necessity, and that hence the undertaking, as well as the consumers, will eventually benefit by this invention. Large areas of the city are still without cables.

BRUMBY.—To the Brumby and Frodingham Urban Council the Lighting Committee presented a scheme for lighting the district with electricity. They had an offer from the Frodingham Iron and Steel Co. to supply them with light at 1½d. per unit. The cost of an installation would be about £2,500, and they would be able to supply it to consumers at 6d. per unit, the Council to put in all the fittings to the houses. Mr. Instone was in favour of the scheme, and said it compared very favourably with the cost of gas, especially if they got it from Scunthorpe. The question was referred to a special meeting of the Council.

BURTON.—The abstract of accounts shows that the gross profit for the past year at the Corporation Electricity Works was £5,849, of which £5,072 was absorbed in loan charges and £805 went to the Renewals Fund, which now stands at £3,094. The capital expenditure during the year was £1,108, including £686 on mains and services. To date the total outlay is £82,579, including £32,478 on plant and machinery, £25,629 on mains and services, and £11,799 on buildings.

COWDENBEATH (Scotland).—A resolution has been passed by the Council in favour of applying for a Provisional Order for the extension of the burgh and for electric lighting. The burgh has at present an electric light installation, but they have no powers to sell light. The Fife Electric Power Co. have proposed to apply for a Provisional Order to supply electric light within the burgh, and the Council have decided to ask the company to withdraw the name of Cowdenbeath from their application.

DARLINGTON.—New feeder mains are to be laid from the Corporation electricity works to York-street, Albert-hill, and John-street.

DARLINGTON.—The Local Government Board have sanctioned a loan of £2,817 for the provision of a new turbo generator at the Electricity Works.

DUBLIN.—For the purpose of extending the electric lighting undertaking, the Corporation has arranged a loan of £18,650.

DUDLEY.—Mr. W. A. Ducat, on behalf of the Local Government Board, held an enquiry relative to the application of the Town Council for sanction to borrow further loans, amounting to over £11,000, for the purposes of the municipal electricity undertaking. The Council in April last decided to increase the capacity of the plant at the electrical power station by the provision of a storage battery, booster, and motor generator, with all electrical appliances and connections, together with buildings and erecting, at an estimated cost of £6,000. The actual tenders, however, for the carrying out of the work amounted to £5,872, which amount it was now proposed to borrow. A sum of £5,639 was also required for cables in connection with the undertaking.

GLASGOW.—The electricity report and accounts, details of which appeared in our last issue, have received the approval of the Council. Deputy River Bailie J. W. Stewart observed that the revenue was rather less than last year, but that arose from causes which were easily explained. The Committee desired that the light should be introduced to the dwellings of the poor, as it would decrease the vitiation of the atmosphere and improve the general health of the community. With regard to competition, he thought they would be able to hold their own, and they were glad to think there was a prospect of securing from the Board of Trade protection against undue competition. Mr. Cosh criticised the prices of electricity. He felt it was a very great injustice that wealthy people who required electricity for power should be supplied with this commodity at a price which was considerably less than cost, and that shopkeepers should have to pay 3½d. for what cost 1½d., while other people got it for less than a penny. Mr. W. F. Anderson adduced statistics in the endeavour to prove that the people who consumed most for the Department were the shopkeeping and office classes, who, therefore, deserved better treatment.

GRAVESEND.—Sanction has been received from the Local Government Board in respect of the borrowing by the Council of £3,250 in respect of the excess of expenditure on their electric light undertaking up to March, 1908; £1,800 to defray expenditure on mains from April 1, 1908; and £700 ditto for services. The Board have suggested that should there be any proposal to extend the present system of public lighting, the Town Council should carefully consider the comparative cost of lighting by electricity and by gas.

HAY.—The Urban Council referred the question of electric lighting for consideration by a committee.

HULL.—The annual accounts of the Kingston-upon-Hull Electricity Department, for the year ended March 31, shows that the revenue amounted to £49,501 8s. 6d. and the expenditure £26,958 1s. 5d. Allowing for loan and interest charges, the net balance for the year was £1,165 8s. 5d. In his report, the City Electrical Engineer (Mr. H. Bell) states that the units sold for lighting purposes have actually fallen to a lesser figure than the previous year, and the total income has only been maintained by reason of the largely increased sale for power purposes. Turning to the analysis of costs, it is satisfactory to note that there is still a reduction under practically all heads, showing that proper attention is being given to that most important question—cost of production, and that before long Hull will have reached a figure quite comparable with the larger towns of England, which have no traction or public lighting supply. During the year they have completed the installation of a large amount of new plant to replace unreliable or obsolete machinery, but there were still certain dynamos at the works which, he was told, it would be desirable to replace when favourable opportunity arises. They had also put down a Calvert's economiser out of revenue, and replaced a very considerable amount of obsolete and unreliable mains. An information bureau and showroom had been inaugurated. On capital account, they had laid down during the year a further 500 kw. high tension steam dynamo, and opened up two new sub-stations, each with 180kw. of plant capacity, at Buckingham Street and Beverley Road (Blundell's), and all these will be in every sense completed for the coming winter.

KING'S LYNN.—In the early hours of Saturday morning the town was plunged into darkness through the failure of the electric light. Mr. J. Pilling (the Electrical Engineer), who was away on holiday, was hastily summoned back by telegraph.

LONDON.—The lighting of most of the main thoroughfares by electric arc lamps was continued throughout the year, states the City Engineer (Mr. Frank Sumner, M.Inst.C.E.), in his report on the works executed by the Public Health Department of the Corporation of London during the year 1908. The number of the original type "open" electric lamps in lighting at the end of the year, at a cost of £26 each, was 398, being a decrease of two, accounted for, he says, by the substitution of the new and cheaper flame arc on the new rest in Aldersgate-street, and the abandonment of one lamp on the Blackfriars Bridge Approach by the Royal Hotel, the latter being no longer required. In addition to this number, there were 34 "Oliver" flame arcs (mostly experimental), and 18 "Reason" enclosed arcs (experimental), in lighting during the year. These lamps were lighted on 23 days during the year when fog or unusual darkness occurred, at a total additional cost of £146 19s. 2d. The number of defective electric lamps reported during the year was 71. The returns of these defects are made daily by the police; and the City of London Electric Lighting Co. were fined for each failure, the amount deducted from their account in fines during the year being £15 18s. 7d. During the year the flame arc lamp on the footpath by the Royal Hotel, Blackfriars Bridge Approach, was removed, the light from the adjacent high-pressure gas lamp proving sufficient to light this part of the thoroughfare. Owing to a new rest being constructed in Aldersgate Street, at the western end of Falcon Street, the column lamp at the corner of the latter thoroughfare was removed on to the rest, and an "Oliver" flame arc lamp, costing £17 10s. per annum, was substituted for the "open" type of lamp, costing £26. The City of London Electric Lighting Co. substituted an "Oliver" flame arc lamp for an "open" type of lantern on the rest at the northern end of Blackfriars Bridge. There were in lighting at the end of the year 398 original type "open" lamps at £26 each per annum, 23 "Oliver" flame arcs (partly experimental) at £17 10s., and 18 "Reason" enclosed arcs (experimental), Farringdon-street, at £12 10s., all from the City of London Electric Lighting Co., and 11 "Oliver" flame arcs (experimental), Cannon-street, at £17 10s. from the Charing Cross Co. The 4 "Flame" arcs at Blackfriars Bridge Approach and the 4 at the Mansion House area, put up by the City of London Co. for their own experiment, are charged at £26 each per annum

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during the year. In accordance with the resolution of the Court of Common Council of July 25, 1907, whereby the two Electric Lighting Companies having statutory powers in the City, were permitted to experiment with the newest form of electric lamps for street lighting in the thoroughfares of Holborn, Holborn Viaduct, Old Bailey (part of), Farringdon-street, Newgate-street, and Cannon-street (between St. Paul's Churchyard and Dowgate Hill), the Charing Cross and Strand Electricity Supply Co. have continued the lighting of their portion, viz., Cannon-street, with 11 magazine "Flame" arcs, centrally hung, being suspended over the roadway by wires attached to the buildings on either side at a height of 28 ft. above the roadway; these wires were subjected to a very severe test, by dead weight and a drop weight, considerably heavier than the lamp. The lamps were put into lighting on November 1, 1907. The City of London Electric Lighting Co. have also continued their experiment with 21 "Oliver" flame arcs for a similar number of the original open arcs, adapting the existing columns in Holborn, Holborn Viaduct, and part of Old Bailey 20·5 ft. above the roadway, whilst in Farringdon-street 18 enclosed arcs of the "Reason" type, fitted up on special short columns 14 ft. above the roadway in lieu of the 12 open arc lamps and columns in that thoroughfare, have been maintained during the year. The installation of this area was completed by November 20, 1907, and £17 10s. per lamp per annum is the price paid. The maintenance cost of the "Oliver" flame arcs in the Holborn area is £17 10s. each per annum, being equivalent to the charge for similar lamps in Cannon-street, and the cost of the enclosed arcs in Farringdon-street is £12 10s. each per annum.

LONDON.—Royal assent has been given to the London County Council (Tramways and Improvements) Act, 1909. The measure provides for the construction of four new lines of tramway, together with the reconstruction of three-horse traction lines. Of the new tramways, one is situate north of the Thames, two are south, and the last connects districts north and south of the river. The northern one is the shortest, running from the existing terminus in Farringdon-road to a point where Charles-street crosses the road. The Mitcham-lane extension, the longest of the four lines authorised, will begin from the junction of the Southcroft and Mitcham roads at Amen-corner, Tooting, and skirting the country boundary will proceed through Southcroft-road to Mitcham-lane, along which thoroughfare it will be laid to a junction with the existing tramways in Streatham High-road, opposite St. Leonard's Church. Battersea and Chelsea will be linked up by a new tramway, and the fourth fresh line authorised will extend the existing Deptford lines to the Greenwich tramways. The lines to be reconstructed comprise: Tooley-street and Deptford, Woolwich-road and Highgate-hill. The Bill also sanctions the extensions of the Harrow-road trams to Edgware-road by the Metropolitan Electric Co.

LONDONDERRY.—The Electrical Engineer (Mr. R. Macrory) reported to the Corporation Lighting Committee the receipt of an application for a large supply of power and possibly lighting also, for the new locomotive works of the Lough Swilly Railway Co. at Pennyburn. In order to deal with this supply, it would be necessary to extend the cable system at an estimated expenditure of £889. Owing to the steady increase of consumers, he anticipated that a considerable extension of generating plant would be required next year, and, as their capital was now almost exhausted, should the Corporation decide upon any cable extensions, it would be necessary to also provide for cost of plant extension. The Committee directed the Engineer to prepare a specification of the amount of extra capital required and the probable number and revenue from new consumers.

MANSFIELD.—From the Electricity Committee the Council have received a recommendation in favour of an alternative flat rate of 4d. being charged for lighting, from October 1. The Mayor (Alderman T. Taylor) observed that their customers would increase in numbers now that a flat rate had been adopted.

MIDDLESBROUGH.—Electric light standards have recently been erected in Corporation and Newport-roads from the top of Marton-road to Harris-street. It is understood that should this experiment prove successful the Corporation will adopt an extensive scheme of street lighting by electricity in the main thoroughfares of the town. The erection of these lamps in Corporation and Newport-roads, has been completed by the contractors, Messrs. Crompton & Co., Ltd., Arc Works, Chelmsford, Essex, and the Borough Electrical Engineer (Mr. H. M. Taylor) made a test run before taking them over on behalf of the Corporation. The installation is up-to-date in every way. There are 20 standards placed from 60 to 80 yards apart and fixed on each is an arc lamp for lighting up to midnight and two incandescent electric lamps for use thereafter. The arc lamps are run 10 in series on 440 volts, and each takes 8 amperes. Therefore each lamp consumes only ·35 of a unit per hour.

OLDHAM.—The Electricity Committee have decided to reduce the price of energy to the Tramways Committee from 1½d. per unit to 1¼d. per unit on all energy consumed over three million and a half units. This reduction, should the Tramways Committee require as much energy as last year, will mean a saving of several hundred pounds. The agitation for a reduction has been going on for some time, and the Tramways Committee have been assiduous. The fact that the Electricity Committee have had a successful year has enabled them to favourably consider the matter.

PAIGNTON.—The question of lighting the streets by electricity has been considered by the Council. Paignton Electric Light and Power Co. made an offer to alter and adapt existing gas lanterns for 50 c.p. lights for £2 10s. per annum for each lamp, the contract to be for not less than three years. Mr. Sarson pointed out to the Council that the Electric Light Co. were prepared at their own cost to give a 100 c.p. light at any selected place for a fortnight as a trial. Mr. Ham observed that if the Gas Co. were prepared to give the same light he could not understand why they had not done it before there was opposition. The Electric Light Co.'s offer was accepted.

PENSHAW.—It has been decided to light with electricity the main road between Penshaw and Shiney-row.

PORTSMOUTH.—The accounts of the electrical undertaking for the year ended March 31, show a total revenue of £48,631, and an expenditure of £24,442 2s. 10d., leaving a balance carried to net revenue account of £24,188 18s. 10d., as compared with £21,733 8s. 1d. in the previous year. Allowing for instalments of principal and interest, there remains a surplus of £3,930 3s. 4d. to go to the Appropriation account. The general supply of current shows a decrease of £487 9s. 3d., but this was more than compensated for by an increase of £869 7s. 5d. in the public lighting sales under contract and slot metres. The figures for cost of production indicate a satisfactory reduction. The quantity sold totalled 3,476,730 units.

REDDITCH.—To the Electricity Committee the Works Manager submitted a scheme for supplying electrical articles at a cheap rate, in which scheme the Council had been invited to join. The matter was referred to a sub-committee for consideration. Accounts sent out for the June quarter amounted to £1,152 6s.6d., being a decrease of £55 6s. 11d. as compared with the figures for the corresponding period of last year.

SCULCOATES.—The Works Committee of the Sculcoates Board of Guardians have appointed Messrs. Stebbings and Sissons to interview the Hull Electric Lighting Committee or the chairman (Mr. E. Hanger) with a view to a better offer being obtained for a stand-by supply of electricity for flighting purposes. An offer by Mr. H. Bell, the electrical engineer, to supply at a cost of £4 per kilowatt per annum for the maximum kilowatts demanded, plus a charge of ½d. per unit for every unit used was conisdered too high.

SHEFFIELD.—A point of interest to contractors was raised at a meeting of the Education Committee. The Training College managers had invited tenders for providing and fixing the necessary appliances for lighting the new hostel for men students at Southbourne, Clarkehouse-road, by electricity. Thirteen tenders were received, and eventually that of the Corporation Electric Supply Department, amounting to £155, was recommended for acceptance. Alderman Marsh moved, as an amendment, that the work should be given to Messrs. Hall & Matthews, of Sheffield, whose tender came to £127, or £28 less than that of the Corporation Department. Alderman Styring urged that, in the circumstances, a sum of £28 might very well be spent in giving the work to the Department rather than to an outside contractor. Councillor Bennett, the Chairman of the Committee, took the side of his Department. He could have understood the amendment, he said, if it had been that they should take the lowest tender. In further discussion it transpired that the highest tender was £328, and the lowest £94. Councillor Neal advocated an arrangement under which every Department of the Corporation was bound to serve any other Department at cost price, plus a small reasonable percentage for profit. The amendment was carried.

STOCKTON.—There was cause for congratulation in the report of the Electricity Committee. At the July meeting it was proposed to supply Messrs. Head, Wrightson & Co. with a day load of electricity at ⅝d. per unit, which was below cost price, but this figure was altered to ¾d. per unit, notwithstanding the opposition of the chairman and other members of the committee, who protested that the firm would not pay ¾d. The committee now reported the receipt of a letter from Messrs. Head, Wrightson & Co., in which they stated, "we are prepared to accept your offer to supply electricity to Stockton Forge Works for a further period of two years, dating from the 20th June, 1909, at the price of ¾d. per unit, otherwise subject to the terms of the existing agreement." Alderman Tompkins intimated that there was an increase in the amount of consumption, and a decrease in the cost during the past quarter, owing to the extra load taken by the Stockton Forge.

TAUNTON.—During the past quarter the connections to the mains were 548 8 c.p. lamps, or a net gain of 528.

TODMORDEN.—At an estimated cost of £1,000, a new generating set is to be provided at the electricity works by the Council.

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LIGHTING AND GENERAL—Overseas.

BILBAO.—The British Consul (Mr. A. Maclean) reports that in the heavy electrical trades the tendency is for orders to go elsewhere in preference to the United Kingdom, and this is probably due to the fact that foreign manufacturers were first in the field. It is worth while, however, to call attention to the fact that the use of electricity is constantly extending, and that the key to the Spanish electrical trades is cheapness. In nearly all branches of Spanish trade local representation is advisable. Good firms who undertake agencies, however, are generally fully engaged, and few of them will take on new business, unless it contains the potentialities of considerable profit. There are a number of men ready to offer their services, but they are not always suitable, particularly when, as is generally the case, business is not on a cash basis.

BRAZIL.—The *Diario Official* of July 21 contains a copy of a decree transferring to the Companhia Brazileira de Energia Electrica the concessions granted to Señores Guinle and Cia. for the installation of electrical works at Alberto Torres, and the appropriation for electrical purposes of the water of the Rio Itapanhau in the State of Rio de Janeiro.

CALCUTTA (INDIA).—Mansfield's incandescent lamps, a speciality of Messrs. Mansfield & Sons, Ltd., Calcutta, have been installed by the Oudh and Rohilkhand State Railway for lighting the locomotive running shed at Lucknow. Mansfield's oil gas installations are largely in use on this railway for lighting stations and other purposes.

JAMAICA.—The revenue from telegraphs for the financial year 1907-8 amounted to £6,489 8s. 8d., being £489 8s. 8d. in excess of the estimate. The cost of official telegrams totalled £414 4s. A sum of £832 was expended on the maintenance of telegraph lines.

MELBOURNE.—The Melbourne City Council's electrical refuse destructor will have a capacity of 150 tons per day, thus allowing for a slight increase upon the present average daily collection. The plant is of the Horsfall top-feed type, and consists of 3 units, each of 2 cells. Three Babcock & Wilcox water-tube boilers, one for each unit of the plant, have been built in, and a star has been made with the clinker-crusher. The steam generated in the destructor furnaces will be utilised in the electric supply works adjoining, to which it is expected to prove worth about £2,000 per annum. The cost of plant and buildings is estimated at about £25,000.

MERCEDES.—Electrical energy is being used for pumping from the Rio Grande the water for the great system of canals and ditches of the Mercedes, Tex., irrigation system. The power is supplied from a central power plant, situated in the town of Mercedes, 7 miles from the pumping station. The Mercedes enterprise will be one of the largest electrical pumping irrigation propositions in the world. Water will be supplied for more than 200,000 acres of land, situated in the valley of the lower Rio Grande. The central power plant at present generates at 6,600 volts, the three-phase currents being transmitted to the pumping station, situated upon the bank of the river, 7 miles distant, and operating an induction motor-driven pump, which has a capacity of 60,000 gallons per minute. The equipment of the central power plant consists of two generators of 300 kw. each, and a 15 kw. lighting set for the town of Mercedes, when the main set is shut down.

MONTREAL.—A very substantial reduction in the rate for electric light has been decided upon. In the past, householders have been paying 15 cents per kw. (one Board of Trade unit). Under the new arrangement, which comes into effect on October 1, they will get their light at 10 cents per kw.

RIO DE JANEIRO.—The United States Consul-General, in his report on telephones in Brazil and the scope for development, states that an American company which is constructing a system for the State of Rio de Janeiro secured its concession about three ago months, and has the construction of the system well under way. One of the chief objects of the enterprise is to afford communication by telephone between the City of Rio de Janeiro and the country surrounding it, including Petropolis, the summer capital of the country, Nictheroy, the capital of the State of Campos, and other important points. There is great need in Brazil of telephone service in many parts of the country not reached by the Government telegraph system or in which the telegraph system does not meet the requirements of business. Although Brazil has 20 States and a territory substantially the same as that of the United States, it has no inter-State telephone line, and, by reason of the inter-State restriction, it has few telephone lines serving rural districts within the several States themselves. The telephone business in Brazil is little developed in either extent or service. According to official returns, there exists in Brazil a total of 39 telephone systems, ranging from 22 to 2,503 subscribers, of which, at the time the statistics were prepared, last year, 15 were Berliner, 9 Kellog, 3 Bell, 4 American, and the others German, Swedish, Norwegian, and French. The total number of subscribers in all the systems is 9,200. The capital of the companies ranges from $900 to $1,190,000. Of these companies only 5 have more than 500 subscribers—viz., Bahia, Rio de Janeiro, Pernambuco, Pelotas, and San Paulo.

SIMLA.—The Simla hydro-electrical scheme has already been sanctioned under the supervision of a Public Works Department expert, Mr. J. Rowan Wilson, an Executive Engineer of the Punjab.

SOUTH AFRICA.—Sea Point is to have the advantage of an unique electric lighting installation, so far as the Peninsula is concerned, according to the *Cape Argus*, of Cape Town. In other words, they will be able to accommodate the candle power of their lamps to their requirements, and by this means considerable saving will be effected. The reason is that as the district to be served extends to some distance from the generating station, alternating current will have to be employed instead of a continuous current. The City Electrical Engineer (Mr. W. F. Long), in an interview, explained that a sub-station will be erected at the back of the municipal offices in Hall-road, and here there will be a transformer by means of which the current coming in from the electric lighting works in the Dock-road at a voltage of 2,200 is reduced, and distributed to customers in that neighbourhood at a voltage of 110. Similarly other transformers will be placed along other parts of the Main-road to reduce the pressure in those areas. But in addition it will probably be found advisable for most consumers to have a transformer of their own. What has not so far been manufactured is a high voltage low candle power lamp. As soon as electrical science has mastered that difficulty, Cape Town, in common with other places, will derive considerable advantages in the matter of its lighting.

SWEDEN.—The British Consul at Stockholm, in his report for 1908, refers to the electric smelting of iron ore in Sweden, and remarks that it will still remain a question whether it will pay better to smelt great quantities of iron ore in Sweden and export it as pig iron than to continue exporting ore as hitherto, unless, of course, Sweden can use the pig iron herself. Even if Sweden by this process can produce pig iron much more cheaply than hitherto, he states, it does not follow that such pig iron would be cheaper than pig iron produced from Swedish ore in other countries. Again, the total power to be developed from Swedish waterfalls is only estimated at 4,000,000 h.p., and naturally much of this is not situated conveniently to the ore, so that additional transport must be considered. Another problem concerns the proportion of the electrical h.p., which, in view of other industries, can be profitably expended on producing pig iron.

VADO (Italy).—The British Consul at Milan (Mr. S. J. A. Churchill, M.V.O.) has forwarded an extract from the *Sole* (Milan), announcing that the Executive Council of the Italian State Railways have sanctioned the proposal to erect a central electric generating station at Vado, on the Ventimiglia-Savona line, at a cost of 1,500,000 lire (£60,000).

TRACTION—Home.

CAMBORNE.—Colonel Druitt, R.E., held a Board of Trade inquiry into the complaints lodged against the Urban Electric Supply Co. by the County Council and by the Redruth and Camborne Urban Councils. Colonel Druitt met the various representatives at Redruth, and proceeded on foot to Camborne, making a close inspection of the trams. The Inspector subsequently adjourned to the Camborne Council Chambers, where Mr. Cowlard, on behalf of the County Council, explained the nature of the various complaints. Mr. Cowlard also read the correspondence between the parties concerned, in which they were unable to come to any agreement. It had been, therefore, decided to leave the matter in the hands of the Board of Trade.

DOVER.—The Board of Trade have confirmed the Dover, St. Margaret's and Martin Mill Light Railway Order, 1909, authorising the construction of Light Railways in the borough and rural district of Dover.

HIGHGATE.—The cars on the Highgate-hill Steep Grade Tramway ceased running on Monday, the line having been purchased by the London County Council, who are going to electrify it and link it up with their northern system. The line, which was opened on May 29, 1884, was the first cable tramway in Europe.

HULL.—Having received a deputation from the residents of Hessle, discussion has arisen in the Corporation with regard to an extension of the Hessle-road route of the electric car service. It is suggested that the service be continued to "The Granby," Hessle (2½ miles beyond the present terminus), making the route 4½ miles in length. The estimated cost for laying the rails and widening the road is £30,000, this price being exclusive of power, plant, and cars.

TRACTION—Overseas.

GUADALAJARA.—An American Consul, in commenting on the mandate which orders all electric cables in Guadalajara, Mexico to be placed underground, states that this work will be accomplished by the union of two strong local corporations:—La

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Compañia de Tranvias, Luz y Fuerza de Guadalajara, with La Empresa Irrigadora y de Produccion Electrica de Guadalajara. The first company holds a monopoly of the electric current for power and lighting purposes in the city, and the second company holds concessions from the State of Jalisco and the Government of Mexico, by which it controls the right to irrigate a large tract of land, to utilize the water power of the neighbouring rivers, and to take electric feeders into Guadalajara. It is stated that offers of materials for the conduits and for the underground cables, addressed to either of the above companies, would receive consideration.

JAPAN. The *Japan Chronicle* publishes a report that the Middle District Railway Office has decided to dispense with steam engines on the Hachioji-Kofu line and to use electric motors. Fifteen motor carriages have been ordered from the Osaka Railway Carriage Manufacturing Co. It is stated that the time taken by the motor carriages will be less than by steam propulsion, the journey being done in 3 hours, instead of 4 hours and 10 minutes.

MONCTON.—From an American consular report it appears that the electrification of the Grand Trunk Pacific or National Transcontinental Railway from the St. Lawrence River to Moncton is now under the serious consideration of the railway company, the Dominion Government, and the New Brunswick Cabinet. Electrical engineers who have given the subject consideration, declare the conditions to be entirely favourable. The distance between the St. Lawrence and Moncton is about 460 miles, and for a considerable part of the distance the road passes through dense forests of spruce and fir in Lower Quebec and Northern New Brunswick, as well as through the rich farming country along the upper St. John Valley. At the Grand Falls on the St. John River, 170 miles from the St. Lawrence and 160 miles from Moncton, there is water power sufficient to develop electrical energy for working the whole road. At this point the river has a natural fall of about 130 ft., and a flow that it is estimated will be sufficient to furnish from 100,000 to 125,000 h.p. continuously.

NEW SOUTH WALES.—The New South Wales Board of Examiners of Enginedrivers appointed under the Mines Inspection Act, 1901, have submitted their report on the examinations for certificates of competency as electric motor drivers, held at Sydney and Cobar, on Friday, May 14 last. Nineteen candidates attended, and the following passed: Sydney, A. J. Henry; Cobar, S. J. McPhail, C. G. Pearce, W. G. Smith.

ONTARIO.—A party of the Hydro-Electric Power Commission's men, under Engineer Clark, of Toronto, are here laying out the line between London and Stratford. In connection with the new Hydro-Electric power line the construction of the stations at Dundas and Niagara is already proceeding, and it is anticipated that they will be completed by December. The towers and telephone lines on the right-of-way of the transmission line are being rapidly put up. Two construction gangs are now working on the erection of towers and a third will be added next week, when it is expected that it will be possible to erect 15 towers per day.

ONTARIO.—A new electric railway will soon be commenced from Morrisburg to Ottawa, reports the Consul for Cornwall, Ontario (Mr. John E. Hamilton). The company has been incorporated with a capital of £200,000. The power plants will be located at Morrisburg and Billings Bridge, Ottawa. Another line contemplated called the Belt Line Electric Railway, covers practically the same route; but the Corporation of Metcalfe, in Carleton County, proposes to give the right of way to the company that begins work first.

SANTIAGO DE CHILI.—It is reported that the Government of Chili has decided on the electrification of 1,150 kilometers of railway, beginning, as an experiment, with 184 kilometres.

ST. PETERSBURG.—Contrary to the report that the offers made a few months ago to the St. Petersburg Municipality by an international syndicate regarding the reorganisation of the tramway system had been definitely rejected, it is now stated on reliable authority (says the *Financial News*), that the negotiations are being actively pursued. The syndicate includes, besides the German General Electrical Co. and Messrs. Siemens & Halske, the English Westinghouse concern, and is being backed by the Deutsche Bank, together with the Société Générale. In brief, the scheme consists in the purchase from the city of all the lines, with the rolling stock and the municipal electrical works, at the price of 20,000,000 roubles; also the extension of the system, for which purpose another sum of 30,000,000 roubles would be reserved. The tramways would subsequently be worked by a company to be promoted by the syndicate, and the municipality would share in the net profits up to a maximum of 7½ per cent.

SWATOW (China).—From the report by the British Consul (Mr. P. F. Hausser) on the trade of the Swatow district in 1908, which will shortly be issued, the *Board of Trade Journal* quotes the following:—There is a scheme on foot to construct an electric tramway from Swatow to the district city of Cheng-Hai, a distance of about 10 miles. According to the prospectus, the capital is to be $300,000, in $5 shares; the latter, however, are not being taken up readily. Two large river branches would require to be bridged, but otherwise the construction of the line should present no difficulties.

ELECTRICAL ENGINEERS' NEW HOME.

Apropos of the provision of the new home of the Institution of Electrical Engineers on the Victoria Embankment, it may be mentioned that the authority to purchase the property for £50,000 was given last year; and the purchase money has been provided by taking £24,000 from the accumulated funds of the Institution, and by a mortgage on the building amounting to £26,000. The entrance hall to the building is to be enlarged and improved, and the theatre is to be entirely rebuilt. There is to be a total expenditure of about £18,000 on the alterations to the building, and the equipment and furnishing of the library. The new theatre will, it is stated, be a very handsome one, and appreciably larger than that of the Institution of Civil Engineers, in which for some time the Electrical Engineers have been holding their meetings.

PERSONAL.

Mr. Frank Stuart-Milne, who some time ago left the Newcastle-on-Tyne Electric Supply Co., Ltd., to take up an important appointment in the Argentine in connection with the electrical department of the State railways, has commenced business in Buenos Aires as commercial engineer and agent for British railway, mechanical, and electrical engineering firms. Associated with him as British engineer and secretary is Mr. J. A. Seager, A.M.Inst.C.E., A.I.E.E., Emerson-chambers, Newcastle-on-Tyne.

Mr. Jens Orten-Boving, M.I.M.E., hydraulic engineer, has taken into partnership Mr. Douglas Spencer and Mr. P. R. Cobb. The style of the firm will henceforth be Jens Orten-Boving & Co. The address of the firm is 9½, Union Court, Old Broad-street, London, E.C.

We are requested by Mr. Vincent S. Allpress, M.I.C.E., to announce that in future all letters and correspondence, etc., should be addressed to him at 39, Victoria-street, Westminster, or to Southwick, Sussex.

SOME CONTRACTS.

A satisfactory contract has been entered into by the Dolcoath Mine, Ltd., with the Cornwall Electric Power Co. and the Urban Electric Supply Co. for the pumping power required at their Williams' shaft, and also for driving the new 12 heads of pneumatic stamps, orders for which have been placed.

The Bengal-Nagpur Railway Co. have ordered for trial purposes a hundred cells from the Chloride Electric Storage Co, Clifton Junction, near Manchester.

The Key Engineering Co., Ltd., of London, has obtained another order for an Ehrhardt and Schmer large gas engine. The Electrolytic Alkali Co., Ltd. have placed an order with this company for a 500 h.p. Ehrhardt and Schmer gas engine for driving an electric generator at their works.

ALTERED CABLE ROUTE.

The Telegraph Construction and Maintenance Co., of London, have laid a portion of a new Atlantic cable for the Commercial Cable Co. The old cable stretched from Waterville to Canso, and from Canso to New York. The altered and new route is from Waterville to St. John's, and from there on to New York. The new portion extends for about 276 miles from St. John's outwards, and this section gave the contractors the greatest trouble. The length of the cable between St. John's and New York is about 1,310 miles, very considerably shortening the former route. The operations have only taken a month.

PUBLICATIONS RECEIVED.

"Journal of the Institution of Electrical Engineers," for August. (E. and F. N. Spon. Price 5s.).

Messrs. Donovan & Co., of Birmingham, have brought out a price-list of their non-association cables, real insulators, live insulators and tubes, etc.

MEXICO TRAMWAYS. Coupon No. 6, due 1st proximo on the General Consolidated First Mortgage 50-Year Gold bonds, will be paid on and after that date at the Bank of Montreal, 47, Threadneedle-street, E.C., and at their offices in New York and Montreal, also at the agents in Brussels, Basle and Berlin.

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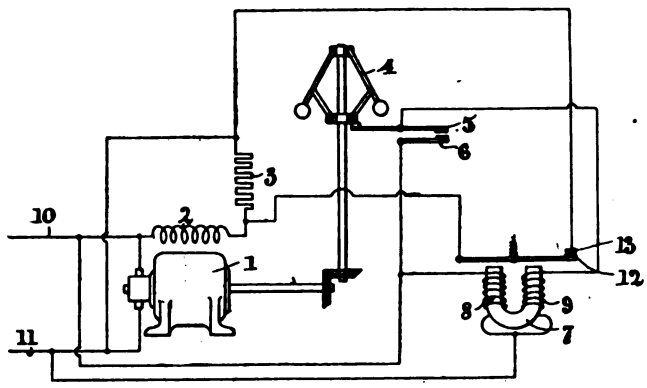
PATENTS.

Regulation of Electric Motors.

14700.—1908. British Thomson Houston Co., Ltd., London. This is an improved regulator which causes the motor to run at a nearly constant speed, notwithstanding variations in the line voltage of supply. In the diagram 1, is the motor, the speed of which is to be regulated. This motor is provided with a shunt field 2 having a resistance 3 in series therewith. Driven from the motor shaft is a centrifugal governor 4, the collar of which controls a movable contact 5 adapted to engage with a contact 6. The differentially wound relay 7 is provided with coils 8 and 9, adapted to receive current from the mains 10 and 11. The circuit of coil 8 is permanently closed but that through coil 9 is adapted to be completed when the contacts 5 and 6 are in engagement. The relay 7 controls a movable contact 12 adapted to engage with the stationary contact 13 which contacts when in engagement are adapted to close the shunt circuit



of low resistance about the resistance 3. At normal speeds the governor 4 holds the contacts 5 and 6 apart. These contacts being in the circuit of coil 9 prevent this coil from being energised, consequently the coil 8 which is permanently energised, holds the contact 12 away from contact 13, and the resistance 3 remains in the field circuit of the motor. If, however, the speed of the motor rises, then the governor causes the contact 5 to engage the contact 6; this completes the circuit of relay coil 9, and, as the relay is differentially wound, the effect of coil 8 on the movable contact 12 is neutralised. Contact 12, therefore, engages contact 13 and the shunt circuit about the resistance 3 is closed, thereby allowing a greater amount of current to pass through the field 2 so that the speed of the motor is reduced. When the speed of the motor falls sufficiently, the governor again separates the contacts 5 and 6 and the coil 8 again holds the contacts 12 and 13 apart. The governor controlled contacts may be operated by the sliding sleeve actuated by the centrifugal weights.

Magnetic Clutches.

14530.—1908. H. W. Ravenshaw, Hanwell. This is an improvement in magnetic clutches of the type in which the electro-magnetic element consists of a single annular trough mounted upon a spider, the trough holding an annular energising coil. In clutches of this type it is usual to wind the energising coil upon an insulating casing. The employment of such a casing, however, has the disadvantage in practice that, if it be made of such size as to fit tightly on to the ring forming the inner limb of the U shaped trough, as it should be, it is a very difficult matter to get it slipped on to the ring. This is especially so in the case of clutches of large diameter. The object of the present invention is to obviate this drawback. Fig. 1 is a cross section of the annular U shaped trough of a clutch of the type indicated above. Fig. 2 is a detail view illustrating a modification. In these drawings the inner limb 1 and the yoke 2 of the U shaped trough are shown as being integral and mounted upon the spider 3. The outer limb 4 is shown as being separate and connected at its inner end to the yoke by screws 5. The ring constituting the limb 1 is turned down as indicated at 7 in Fig. 1 so as to form a shoulder extending all round the ring. To place the winding in the trough, the outer limb 4 being removed, a flat ring 8 of insulating material is placed on the inner limb 1 and pushed against the bottom of the trough as shown, and a second flat ring 9, also of insulating material, is placed on the limb 1 so that its outer face is flush with the shoulder 10. Over the turned down end of the limb 1, a flat brass retaining ring 11 is then placed (the opening in which is of such diameter as to just fit on to the turned down part), and then the metal from the corner 12 is knocked up so as to form a ridge 13, as shown in dotted line. This ridge holds the brass retaining ring 11 in position. The insulated wire for the energising coil is now wound on in the space 14, and the limb 4 is subsequently placed in position and secured by screws 5. If desired, a ring of insulating material indicated by the dotted line 1^a may be placed on the limb

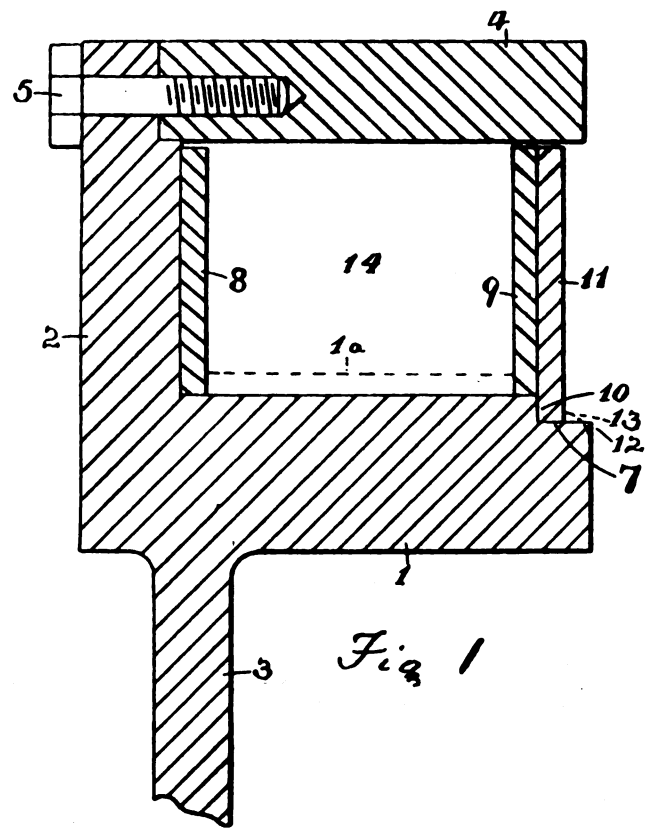


Fig 1

1 as shown in Fig. 1. In Fig. 2, the limb 4 is shown as being provided with an inwardly projecting flange 15 which overhangs the outside edge of the brass retaining 11, so that should the ring 11 have been pressed outwards at all by

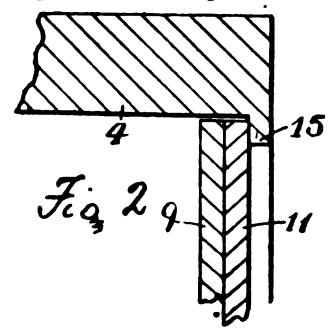


Fig 2

the winding, it will be forced back into its proper place when the limb 4 is placed in position and the screws 5 are tightened up.

Electric Signalling System.

27436.—1908. A. T. Blackall & C. M. Jacobs, Reading. According to this system a single wire circuit between two stations is so arranged that block telegraph indicators, one at each end of the circuit, giving three different indications, two independent on the direction of current passing through them, and one dependent upon no current passing through them, can be operated from one station (say A), while from the other station (say B) an indicator responsive to intermittent or momentary current can be operated at the first station (A) by such means as a single stroke bell.

Starting Switch for Electric Motors.

14513.—1908. D. Timar & C. von Dreger, Berlin, S.W. This improved started has an outer switch handle which, during the switching in movement, rotates a hub and lever in such a manner that the hub carries in its rotation a sleeve to which is secured one end of a spiral spring, the other end of which is connected to a switch arm. The arm rotates a lever coupled with a brake movement. The switching off movement of this handle returns the switch lever and the spring returns the lever of the brake piston as well as the brake piston itself through the intermediary of a radially arranged pin situated in the sleeve and bearing against the edge of a slot in the hub of the lever coupled with the brake piston.

Electro Magnetically Operated Switches.

16298.—1908. General Electric Co., Schenectady, U.S.A. The switch has an E shaped magnet field frame with an actuating coil surrounding the middle limb. This produces a magnetic field through the frame. An armature pivoted at one side, moves towards the field frame when the coil is energised. A movable contact operated by the armature, moves into engagement with a fixed contact when the armature is attracted.

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Portable Key for Electric Flash Signalling Purposes.

22345.—1908. A. C. DAVEY, London, E. The key consists of a tubular case in which are two contacts normally held apart, but which may be brought together by pressure upon a spring outside the case. One of the contacts is attached to a fixed insulating block and the other to a movable block. When the contacts are brought together, a light of long or short duration as desired is flashed from the signalling lamp.

Soldering Metallic Filaments for Electric Lamps.

14483.—1908. S. MARIETTI, Turin. The end of the electrode intended to receive the filament is of tubular form. A current of air is directed upon the soldering point opposite to the direction of the filament. This removes the hot gases from the filament produced by the voltaic arc which would cause oxidation of the filament even near the soldering point.

Electrical Resistance for Electric Heating.

6106.—1909. G. COOPER & F. C. SHARP, Moseley. This is a self-contained electrical resistance unit for heating purposes. The resistance member and an insulating strip are spirally wound on a bobbin in which the terminal for the inner end of the coil is formed by doubling the resistance diagonally across and then doubling the projecting part back on itself, forming a short projection on one side of the coil and a terminal strip extending outward from the other side. The bobbin has a groove for the projection and a slot for the terminal strip.

Measuring Alternating Electric Currents.

5413.—1909. DR. S. GIGGENHEIMER & C. GOSSEN, Nuremberg. In this apparatus the alternating electric current is measured by the action of thermo-electric couples arranged in a bridge connection traversed by the alternating current. Not more than two couples are used in each branch of the bridge. The couples of wires are of sufficient thickness to combine with comparatively small thermal capacity sufficient thermo electric power to produce the deflection of an ordinary galvanometer or like current indicating instrument.

Machines for Electrically Welding Chains.

2642.—1909. A. G. STAHLWERKE WEISSENFELS VORM GÖPPINGER & Co., Krain. While the chain link is still cold, it is employed for transmitting motion from a positively operated pusher to the opposite pusher, which is mounted on a spring controlled lever. Energy is thereby stored in the spring of this lever so that, when the link softens, the pusher connected to the lever moves in the manner known in machines of this kind, and effects the manipulation of the coupling between the driving and the working shaft.

Spark Distributors for Electrical Ignition Apparatus.

18812.—1908. E. DENIÉPORT, Suresnes, France. This is an improved distributor for use in electrical ignition apparatus for internal combustion engines of the class in which the primary and secondary brushes are mounted in the opposite faces of the same rotary member. A central brush is resiliently mounted in the stationary cover for conveying the ignition current to the secondary brush whilst the primary brush co-operates with four primary contact plugs on an angularly movable member by which means the ignition may be advanced or retarded. The general construction of the distributor is simple and such as to allow an easy replacing of all the various parts.

Heating Coil Protecting Devices for Weak Current Electrical Circuits.

8108.—1909. SIEMENS & HALSKE, Berlin. This is an improvement in protecting devices for telephone or other similar circuits with weak currents which consist of certain parts connected together with solder of low melting point. The solder is caused to melt in the protectors by means of a heating coil of wire, which surrounds the soldered parts when receiving current of sufficient strength to effect that purpose. These arrangements have the disadvantages that either the solder is pushed out by the movement of the parts or the whole arrangement is not simple enough for continuous working. In the present invention the protector is so arranged that it can movably be fixed in its holder in such a way, that on the melting of the solder the movable part is shifted by the pressure of a spring through such an angle that on again removing the protector from its holder and setting it back therein, after reversing it, it is again ready for use. In this arrangement however, the same drawback is found that exists in older known protectors, namely, the movement of the protecting parts take place very slowly and does not extend far enough to effect its purpose satisfactorily. This is avoided by providing that after the projecting part has completed a small part of its total movement, a circuit is closed which allows a stronger current of greater heating power to pass through the heating circuit, thus allowing more energetic movement of the movable portion of the protector into the position in which the protected circuit is interrupted with certainty.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last price. £
Alliance Electrical Co., 5 p.c. Cum. Pref., Nos. 1-70,000	1 ..	¼-¾
—— Ord., 1,125,000	1 ..	¼-¾
Aron Electr'ty Meter, 6 p.c. Cum. Pref. Sh's, 1-125,000	1 ..	¾-1
—— Ordinary, Nos. 1-125,000	1 ..	¾-1
British Aluminium Co., Ordinary, 1-40,000	5 ..	1-1⅛
—— 7 p.c. Cum. Pref., 1-40,000	5 ..	1⅛-1⅛
—— "A" 6 p.c. Cum. Pref., 1-20,000	5 ..	3-3⅛
—— 4 p.c. Funding Certificates, 1-20,000	5 ..	2⅛-3⅛
—— 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	82-87
—— 5½ p.c. Loch Leven Deb. (Reg.), Red., 1-3,000	100 ..	93-96
British Insulated and Helsby Cables, Ord. 1-100,000	5 ..	7⅛-7⅛
—— 6 p.c. Cum. Pref., 1-100,000	5 ..	6[illegible]
—— 4½ p.c. Mortgage Debentures	100 ..	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	91-96
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 275,001-475,000	3 ..	3/16-7/16
—— p.c. Mortgage Debenture Stock	100 ..	38-42
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	0-¼
—— Non. Cum., 6 p.c., Pref.	2 ..	0-¼
—— 4 p.c. 1st Debenture Stock	100 ..	43-48
—— 4½ p.c. 2nd Debenture Stock	100 ..	27-31
Callender's Cable, Debentures	100 ..	104½-106½
—— Ordinary	5 ..	10⅛-10⅜
—— 5 p.c. Pref.	5 ..	5¼-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7/16-9/16
Crompton and Co., Nos. 1-85,000	3 ..	½-1
—— 5 p.c. 1st Mort. Reg. Debs., Nos. 1-900 of £100, and 901-11,100 of £50, Red.	— ..	90-93
Dick, Kerr, and Co., Ordinary, 1,260,000	1 ..	1 1/16-1½
—— 6 p.c. Cum. Pref., 1-305,000	1 ..	1 3/32-1 7/32
—— 4½ p.c. Debenture Stock.	100 ..	100-103
Edison and Swan United, "A" Shares, 1-99,261	3 ..	½-¾
—— "A" Shares, 01-017,139	5 ..	1½-2½
—— 5 p.c. Debentures	100 ..	84-87
—— 4 p.c. Deb. Stock, Red.	100 ..	68-73
Electric Construction, Nos. 1 to 112,100	2 ..	7/16-½
—— 7 p.c. Cumulative Pref.	2 ..	1 7/16-1 11/16
—— 4 p.c. Perp. 1st Mort. Deb.	100 ..	63-67
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	71-77
General Electric Company (1900) 5 p.c. Cum. Pref.	10 ..	7½-8
—— 4 p.c. 1st Mort. Deb. Stock	100 ..	85-88
W. T. Henley's Telegraph Works, Ordinary	5 ..	12½-12⅝
—— 4½ p.c. Preference	5 ..	5⅛-5⅛
—— 4½ p.c. Debentures	100 ..	105½-107½
India Rubber, Gutta Percha, and Telegraph Works	10 ..	14½-15½
—— 4 p.c. Debentures	100 ..	99-101
National Electric Construction Co., 1-170,000	1 ..	¼-½
Telegraph Construction and Maintenance	12 ..	34½-36
—— 4 p.c. Bonds	100 ..	99½-101½
White, J. G., and Co., 6 p.c. Cum. Pref., 1-15,000	10 ..	9-10

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	5⅛-5⅛
Bournemouth and Poole, Ordinary	10 ..	9⅛-10⅛
—— 4½ p.c. Cum. Pref., 7,501-15,000	10	9 15 16-9 13/16
—— 6 p.c. Cum. Second Pref., 15,001-22,500	10 ..	10⅛-10⅜
—— 4½ p.c. Debenture Stock, Red.	100 ..	99-103 xd
Bromley (Kent) Electric Light and Power Co.	5 ..	4⅛-4⅜
—— 4½ p.c. 1st Debenture Stock, Red.	100 ..	93-96
Brompton and Kensington, Ordinary	5 ..	7⅛-8 xd
—— 7 p.c. Preference	5 ..	7⅜
Calcutta Electric Supply Corp., Ord., Nos. 1-100,000	5 ..	5⅛-6⅛
Cambridge Electric Supply Company, £10 Ord.	8 ..	12⅛-13⅛
Canadian General Electric Co., Common Shares	$100 ..	123-127
—— 7 p.c. Cum. Pref. Stock	$100 ..	116-118
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100 ..	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5 ..	4-4⅛ xd
—— 4½ p.c. Cum.. Pref., 1-80,000	5 ..	4⅛-5
—— 4 p.c. Debenture Stock, Red.	100 ..	96-99 xd
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5 ..	3⅛-4⅛
Chelsea Electricity Supply	5 ..	3⅛-4⅛
—— 4½ p.c. Debentures	100 ..	100-103 xd
City of London, Ordinary	10 ..	10⅜-10⅞
—— 6 p.c. Cumulative Pref.	10 ..	11⅛-12⅛
—— 5 p.c. Debenture Stock	100 ..	121-124
—— 4½ p.c. 2nd Deb. Stk., Red.	100 ..	99-102
Cordoba Light and Power Co., 1st Mt. Stl. 5 p.c. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	2⅛-3⅛
—— 5 p.c. Preference, 1-50,000	5 ..	3-3⅛
County of London Elec. Supply, Ordinary	10 ..	7⅛-8⅛
—— 6 p.c. Cum. Pref.	10 ..	10⅛-11
—— 4½ p.c. Debentures Prov. Certs. Al pd., Rd.	100 ..	103-106
—— 4½ p.c. 2nd Debentures Prov. Certs.	100 ..	100-103
Edmundson's Electricity Corporation, Ord., 1-80,000	5 ..	3/16-5/16
—— 6 p.c. Cum. Pref.	5 ..	⅛-¼
—— 4½ p.c. First Mort. Deb.	100 ..	58-61
Electrical Development Co. of Ontario, 5 p.c. 1st Mort. 30-year Gold Bonds, 10,751-15,750	— ..	84⅛-86⅛ p.c.
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100 ..	85⅛-88⅛ xd
Folkestone Electric Supply, Ord., Nos. 1-10,000	5 ..	4⅛-5⅛
—— 5 p.c. Cum. Pref., Nos. 1-10,000	5 ..	5-5⅛
—— 4½ p.c. First Deb. Stock, Red.	100 ..	97-100
Hove Electric Lighting, Ord., 1-13,000	5 ..	7⅛-7⅛
Indian Electric Supply and Traction Co., 6 p.c. Construction Deb. Stock, Red.	5 ..	1⅛-2
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100 ..	74-79
Kalgoorlie Electric Power and Lighting, 6 p.c. Cum. Pref., 1-150,000	1 ..	25/32-⅞
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	6⅛-6⅛ xd
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100 ..	95-98

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Name.	Amount paid. £	Last price. £
London Electric Ordinary	3 ..	1¼-2¼
—— 6 p.c. Pref.	5 ..	5¼-5⅜
—— 4 p.c. 1st Mortgage Debenture Stock, Red.	100 ..	93-97
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100 ..	76-80
Metropolitan Ordinary, 100,001-300,000	5 ..	4¼-4⅜ xd
—— 4½ p.c. First Mortgage Debenture Stock	100 ..	105-108
—— 4½ p.c. Cum. Pref.	5 ..	4⅜-5
—— 3½ p.c. Mortgage Debenture, Red.	100 ..	83½-86½
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,000 ($500) M 1-4,400 ($1,000)	— ..	82-84 p.c. 75
($500), 4,001-14,000 ($1,000)	— ..	88-89½
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	94-97
Newcastle-upon-Tyne Electric Supply, Ord., 1-87,500	5 ..	4⅛-5⅛
—— do. 87,501-137,500 (issued at £1 prem.). All paid (Prov. Certs.)	5 ..	4⅛-5⅛
—— do., 5 p.c. Pref., 1-87,500 (Prov. Certs.)	2 ..	4⅜-5⅛
—— 5 p.c. Pref., 87,501-137,500 (Prov. Certs.)	4 ..	4⅜-5⅛
Notting Hill Electric Lighting	10 ..	11⅛-12⅛
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6-6¼
—— 4 p.c. Debenture Stock	100 ..	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1 ..	1 5/16-1 7/16
—— 6 p.c. Non-Cum. Pref., 1-100,000	1 ..	1 1/32-1 5/32
—— 5 p.c. Debenture Stock, Red.	100 ..	102-105 xd
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5 ..	5⅛-6
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5 ..	5⅛-6
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100 ..	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	.. —	94-95½
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	9/16-13/16
South London, Ordinary	4 ..	2⅛-3
South Metropolitan Electric Light and Power, Ord.	1 ..	5/16-9/16
—— 7 p.c. Cum. Pref.	1 ..	1 3/16-1 5/16
—— 4½ p.c. 1st Mort. Deb.	100 ..	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	8½-9
—— 7 p.c. Pref.	5 ..	7-7½
—— 3½ p.c. Deb.	100 ..	84-88
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	½-1
—— 5 p.c. Cumulative Preference, 50,001-80,000	5 ..	1⅛-2
—— 4½ p.c. First Mort. Debenture Stock, Red.	100 ..	75-80
Westminster, Ordinary	5 ..	8½-9 xd
—— 4½ p.c. Cum. Pref., 110,101-138,251	5 ..	4⅛-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 10 p.c. Non-Cum. 2nd Pref., 260,008-280,007	5 ..	4⅛-4⅜
—— Permanent 6 p.c. Debenture Stock, 1888	100 ..	91-92
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	101-103
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	⅛-¼
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1 ..	9/16-11/16
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100 ..	87-91
Blackpool and Fleetwood Tramroad	10 ..	13⅛-13⅜
Bombay Elec. Supply and Trams. Co., 6 p.c. Cum. Pref.	10 ..	9⅛-10
—— 4½ p.c. Deb. Stock, Red.	100 ..	93½-95½
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	6⅛-6⅜
—— 5 p.c. Cum. Pref., Nos. 1-75,000	5 ..	5-5⅛
—— 4½ p.c. Deb. Stk., Red., Prov. Certs., all pd.	100 ..	100½-104½
British Columbia Electric Railway Co., Ord. Def.	100 ..	143-147
—— Ord. Pref.	100 ..	122-126
—— 5 p.c. Cum. Perpetual Pref. Stock	100 ..	107-110
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	102-104
—— 4½ p.c. Vancouver Power Deb.	100 ..	101-104
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10 ..	⅛-¼
—— 6 p.c. Cm. Pf., 30,001-60,000	10 ..	2⅛-2⅜
—— 5 p.c. Perpetual Debenture Stock	100 ..	86
—— 4½ p.c. 2nd Deb. Stock	100 ..	63-67
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	81-86
Buenos Ayres Gd. Nat. Trams. Co., 5½ p.c. Pref. Deb. Bonds, Red., 1-1,500	100 ..	102-107
—— 6 p.c. Deb. Bonds, Red., 1-2,275	100 ..	103-106
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	98½-97⅞
Calcutta Tramways, Ord., No. 1-137,610	5 ..	4⅛-4⅜
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5 ..	4⅜-5
—— 4½ p.c. 1st Deb. Stock, Red.	100 ..	99½
Cape Electric Tramways, Nos. 1-491,222	1 ..	⅛-¼
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5 ..	4⅜-5⅛
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	97-101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5 ..	5⅛-5⅜
—— 4 p.c. Deb. Stock, Red. (1985)	100 ..	98-101 xd
Colombo Electric Tramways and Lighting, 5 p.c. 1st Mortgage Debenture Stock, Red.	100 ..	98-101
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 p.c. Cum. Pref.	10 ..	12⅞-13⅛
—— 4 p.c. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13-14
—— 6 p.c. Pref., Nos. within 1-60,000	10 ..	12½-13½
—— 3½ p.c. Mort. Debs., 1-3,000 Red.	100 ..	90-95
Hastings & Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	75-80
Havana Electric Railway Consolidated Mort. 5 p.c. 50-year Coupon Bonds of 1952, 1-6,957	$1,000 ..	91-94
Imperial Tramways, Ordinary	all ..	18-19
—— 6 p.c. Cum. Pref.	all ..	14-14½
—— 4½ p.c. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 p.c. Cum. Pref., Nos. 30,001-60,000	5 ..	¼-1¼ xd
—— 4 p.c. 1st Mt. Db. Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/32-3/32
—— 5 p.c. "A" Deb. Stock	100 ..	90-93
—— 6 p.c. "B" Deb. Stock	100 ..	64-68
Kidderminster & District Lighting & Traction, Pref.	5	9 15/16-10 3/16
Lancashire United Tramways, Limited, 5 p.c Prior Lien Deb Stock, Red	100 ..	88½-90½
—— £296,500 2nd Mort Deb Stock	— ..	—
—— £83,330 Deferred Deb Stock (all fully paid)	— ..	—
Lisbon Elec Trams, Limited, Ord, Nos 1-594,188	1 ..	15/16-1 1/16
—— 6 p.c. Cum Pref, Nos. 1-425,553	1 ..	15/16-1 3/16
—— 5 p.c. Mort. Deb., 1-5,000, Red.	100 ..	96-100
London United Trys (1901) 5 p.c. Cum. Pref.	10 ..	2-2⅛
—— 4 p.c. 1st Mt. Db. Stock, Red.	100 ..	68-71
Madras Elec. Trams. (1904) 5 p.c. Deb. Stk., Red.	100 ..	93-96
Manila Elec. R.R. & Ltg. Corp., 5 p.c. 1st Lien & Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000 .	95-97
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5 ..	4⅛-5
—— 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	86-91
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	1/32-5/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1 ..	23/32-27/32
—— 4½ p.c. Deb. Stock, Red.	100 ..	95-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 p.c. Gold Bonds	.. —	97-96⅞
Milwaukee Electric Rail and Light, 5 p.c. 30-yr. Con. Mort. Bonds (1926) 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ p.c. Sterling Deb., 601-2,000 (1922)	100 ..	102-104
New General Traction, 6 p.c. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	⅛-¼
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100 ..	100½-103½
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	⅛-¼
—— 5 p.c. Cum. Pref., 300,001-545,000	1 ..	⅛-¼
—— 4½ p.c. Debenture Stock	100 ..	86-89
Provincial Tramways Co., Ordinary, 1-24,912	10 ..	4-4⅛
—— 6 p.c. Cum. Pref., 1-10,000	10 ..	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5 ..	5⅛-5⅜
—— 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	99-101
San Paulo Tramway, Light, and Power Co.	$100 ..	149-152
—— 5 p.c. 1st Mort Deb, Red. (1929) 1-12,000	$500 ..	101
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	⅛-¼
—— 4 p.c. Deb. Stock, Red. (1940)	100 ..	70-74
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red., 1-1,600	100 ..	82-86
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5 ..	⅛-¼
—— 6 p.c. Cum. Pref., 1-46,261	5 ..	1⅞-2⅛
—— 4½ p.c. 1st Deb. Stock, Red.	100 ..	82-86

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100 ..	62-64
—— 4 p.c. Pref.	100 ..	83-85
—— ,, ,, deferred	100 ..	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	99-101
City and South London, Consolidated Ordinary	100 ..	31-32
—— 4 p.c. Debenture Stock	100 ..	99-101
—— 5 p.c. Pref. Stock '91	100 ..	110-112
—— ,, ,, ,, '96	100 ..	106-109
—— ,, ,, ,, '01	100 ..	102-105
—— ,, ,, ,, '03	100 ..	94-97
Liverpool Overhead, 5 p.c. Pref.	10 ..	4½-5
—— Ordinary, 1-50,000	10 ..	⅜-⅝
—— 4 p.c. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 p.c. 4½ p.c. Bds.	— ..	89

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price £
Amazon Telegraph Co., 1-25,000	10 ..	2⅞-3⅛
—— 5 p.c. Debs., Red., within 1-1,069	100 ..	93-96
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000 ..	97-99
Anglo-American Telegraph Co., Ordinary	100 ..	60-61½
—— 6 p.c. Preferred Ordinary	100 ..	103-104
—— Deferred Ordinary	100 ..	20-20½
Anglo-Portuguese Telephone Co., 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	103-105
Chili Telephone Co., 1-44,000	5 ..	8-8⅛
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100 ..	90-92
Cuba Submarine Telegraph Co., Ordinary, 1 16,000	10 ..	8½-8⅞
—— 10 p.c. Preference, 1-6,000	10 ..	17-18
Direct Spanish Telegraph Co., Ordinary	5 ..	3-3⅛
—— 10 p.c. Cum. Preference	5 ..	8⅞-8⅞
—— 4½ p.c. Debs., 1 600	50 ..	99-101
Direct United States Cable Co.	20 ..	13-13½
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100 ..	99-101
Eastern and South African, 4 p.c. Mort. Debs., within 1-3,000 (1909)	100 ..	100-102
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	25 ..	103½-105½
Eastern Extension, Australasia and China, 1-300,000	10 ..	11½-11⅞
—— 4 p.c. Mort. Deb. Stock, Perp.	100 ..	102-104
Eastern Telegraph Co., Ordinary Stock	100 ..	129-132
—— 3½ p.c. Preference Stock	100 ..	84½-86½
—— 4 p.c. Mortgage Debenture Stock	100 ..	104½-106½
Great Northern Telegraph Co. (of Copenhagen)	10 ..	26½-27
Halifax and Bermudas Cable Co., 4½ p.c. 1st Mort. Debs., within 1-1,200, Red.	100 ..	99-101
Indo-European Telegraph Co.	25 ..	51⅛-53½
Marconi's Wireless Telegraph Co., Nos. 256,128-384,190	1 ..	23/32-25/32
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	13/16-15/16
—— 5 p.c. Preference, 1-86,492	1 ..	⅜-½
National Telephone, Preferred	100 ..	106½-107½
—— Deferred Stock	100 ..	123½-124½
—— 6 p.c. Cum. First Pref.	10 ..	10-10⅛
—— 6 p.c. Cum. Second Pref.	10 ..	10-10⅛
—— 5 p.c. Non. Cum. Third Pref.	5 ..	5⅛-5⅜
—— 3½ p.c. Deb. Stock, Red.	100 ..	98-100
—— 4 p.c. Deb. Stock, Red.	100 ..	99-101
Oriental Telephone and Electric Company	1 ..	1 5/16-1 7/16
—— 6 p.c. Cum. Pref.	1 ..	1 1/16-1 3/16
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100 ..	99-101
United River Plate Tele. Co., Ordinary, 1-100,000	— ..	6 15/16-7 3/16
—— 5 p.c. Cum. Pref., 1-40,000	5 ..	5⅛-5⅜
—— 4½ p.c. Debenture Stock, Red.	100 ..	102½-104½
Telephone Co. of Egypt, 4½ p.c. Deb. Stock, Red.	100 ..	99-101
West African Telegraph Co.	10 ..	12½-13½
West Coast of America, 1-30,000 and 53,001-53,008	2½ ..	1⅛-1⅛
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	99-101
West India and Panama Telegraph Co., Ordinary	10 ..	⅛-¼
—— 6 p.c. Cum. 1st Preference	10 ..	8-8½
—— 6 p.c. Cum. 2nd Preference	10 ..	—
—— 5 p.c. Debs., Red., 1-800	100 ..	101-103
Western Telegraph Co., 1-207,930	10 ..	13⅛-13⅞
—— 4 p.c. Debenture Stock, Red.	100 ..	90-92

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1909.	1908.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Aug. 18	1,758	1,598	+ 159	— 505	27¼	27¼	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940,	5·93
Ayr Corporation	„ 21	506	487	+ 18	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	„ 7	2,770	2,650	+ 120	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	„ 1	1,073	1,108	— 35	— 492	13·52	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	July 31	6,446	6,326	+ 120	—	56·792	—	—	—	—	—	—	—	—	—
Blackburn Corporation	Aug. 11	1,407	1,215	+ 191	— 711	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	„ 19	2,752	2,961	— 212	+ 685	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,329	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	„ 1	2,210	2,500	— 290	— 990	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·59
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29¼	29¼	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Aug. 14	5,425	4,846	+ 579	+ 1,671	98	98	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	„ 22	1,282	1,172	+ 110	+ 806	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	„ 20	5,986	5,014	+ 972	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	„ 21	1,308	1,287	+ 21	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	„ 22	280	279	+ 1	—	10	10	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·65
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Aug. 21	4,473	6,528	— 2,055	—14,050	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	„ 7	3,695	3,515	+ 180	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	„ 22	3,059	2,883	+ 176	+ 1,259	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 19	— 811	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Aug. 19	549	554	— 5	—	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	„ 6	2,050	—	+ 152	+ 122	11¼	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	„ 13	305	282	+ 23	— 202	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	July 31	258	336	— 78	— 478	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Aug. 20	167	173	— 6	—	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	„ 20	6,199	5,807	+ 392	+ 817	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	„ 4	1,162	1,220	— 58	— 613	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	„ 21	1,022	924	+ 98	+ 2,905	13½	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	July 17	15,961	17,286	— 325	— 2,745	185½	179	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Aug. 18	321	308	+ 13	+ 525	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	„ 7	4,430	4,480	— 50	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	„ 21	1,741	1,645	+ 96	+ 771	28½	28½	„ 31	84,704	16,200,020	1,960,320	1·29	10·37	2,421	5·10
Hull Corporation	„ 21	2,650	2,400	+ 250	+ 1,219	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	July 31	487	498	— 11	+ 687	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Aug. 19	151	147	+ 4	— 202	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	„ 18	291	285	+ 6	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	„ 18	1,547	1,728	— 181	— 148	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	„ 7	7,994	7,551	+ 443	+ 497	107½	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	„ 21	2,288	2,183	+ 105	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	July 24	11,088	11,403	— 315	— 3,07	104	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Aug. 1	1,452	1,481	— 29	— 72	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	„ 7	38,585	38,216	+ 369	+21,641	124	121½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	„ 17	216	258	— 42	— 743	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Aug 21	211	218	— 7	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	July 31	14,874	16,424	—1,550	— 2477	181	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Aug. 21	8,475	8,131	+ 344	—	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	„ 22	13,951	13,839	+ 112	+ 1,658	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	„ 21	145	140	+ 5	— 102	2½	2½	Mar. 31	7,362	2,060,712	204,7 0	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	July 31	3,860	3,850	+ 10	— 1,416	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	„ 31	672	713	— 41	— 382	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,430	1·10	10·15	—	—
Reading Corporation	Aug. 19	681	667	+ 14	— 79	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Aug. 2	4,551	5,379	— 825	— 3,017	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	July 18	5,718	5,528	+ 190	— 1,112	68½	66½	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	„ 28	1,123	1,267	— 144	— 586	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	„ 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Aug. 18	170	157	+ 13	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	„ 19	554	526	+ 28	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	„ 21	992	1,012	— 20	+ 523	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	„ 12	2,449	2,175	+ 274	+ 2,636	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	„ 17	877	874	— 3	— 876	20½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train miles. *b* Half-year's figures.

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THE
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NOTES.

SUNBEAM ELECTRICITY.

Harnessing the sun, or the conversion of solar rays to motive power, is by no means a new idea. It is on record that a machine something like an inverted giant mushroom has actually developed a donkey power or so somewhere in South America. But the subject has cropped up again and has been discussed by the British Association. At the Winnipeg meeting, Sir Joseph Thomson has been romancing scientifically of the untapped energy derivable from the sun. According to the measurements of Langley, he says, under a high sun and clear sky, the heat derived from the sun is equivalent to about 7,000 h.p. per acre, and though this is not utilised at present Sir Joseph has not the slightest doubt that ultimately it will be. Then when coal is exhausted and our water-power is inadequate, it may be that the centres of industrial activity will be transferred to the burning deserts of the Sahara, where the sunbeams can be trapped better. Unfortunately, however, these theoretical measurements have a way of shrinking woefully in practice. It is difficult to conceive how even an eighth of an acre of sunlight could be concentrated, and if it were accomplished it is more than probable that the horse-power developed would prove to be a mere fraction of the theoretical yield. Moreover, if motive power and heat were all that is necessary to convert the desert into an industrial centre, dynamos and motors are simplicity itself as compared with cumbrous sun engines. With a fine confusion of ideas one of the daily papers remarks that "The useful sunbeam and the desert peppered with factory shafts are terrible to contemplate if one is sentimental." If one is matter of fact, however, one reflects that the tall chimney disappears before either the useful sunbeam or electricity. The desert would not be peppered with factory shafts, but salted with inverted mushrooms.

ELECTRICITY AND THE PROBLEMS OF LIFE.

A note read by Professor W. M. Thornton, D.Sc., before the British Association, dealing with the opposite electrotaxis of animal and vegetable cells is full of significance. Trying the effect of direct electric currents on minute bodies suspended in liquids, he found that elongated organisms orienteted, as do inorganic filaments, into line with the current; but—and here is the point of extreme interest—he also noticed two movements of translation, several animal cells moving against the current towards the positive pole, while vegetable cells moved towards the negative poles. These phenomena were constant and observed during one and the same experiment. The movements were entirely due to the electric current. "The effects," observed the Professor, "were so well marked that one is led to hazard the speculation whether the essential difference between animal and vegetable matter is that animal cells are on the whole negatively electrified (and so move to the positive pole), and vegetable cells positively electrified." The Professor also suggests that the difference may extend to the protoplasm, and in support of this points to the fact that the electrical required current in an animal skin is opposite in sign to that in a vegetable skin, the one being ingoing and the other outgoing, which naturally suggests an essential difference between the internal electrical states. He carried out his experiments with non-motile cells and an electrical current of about 50 volts per centimetre through a thin film of liquid, taking care that the glass of the slides should not be electrified. Such experiments juxtoposed with those described by Professor E. Rutherford, F.R.S., on radiography, in his presidential address before the mathematical and physical section, may lead to great discoveries. He showed how the phenomenon of the α rays of radium being deflected by both magnetic and electric fields enabled the number of α particles in a grain of radium to be counted by means of the needle of an electrometer.

THE DOUBTING PHILOSOPHER.

But the necessary note of doubt and caution, that salutory function of the *advocatus diaboli*, comes from Professor H. E. Armstrong, F.R.S., who is still sitting on the fence, refusing to subscribe to the hypotheses of electrons and ions. At all events, in chemistry he distrusts their introduction to estimate valency, for he suspects them of being little more than figments of the imagination. We may feel somewhat restive under the expression of such a non-receptive mental attitude. But it will serve its purpose if we take to heart the really essential truths lying under the following weighty words which he uttered in his presidential address before the chemical section. "In my opinion," said Dr. Armstrong, "the experimental evidence is in no way satisfactory. It appears to me to be desirable that in studying the phenomena of electric discharge in gases, and especially in vapours of complex substances, the horrible pitfalls should be taken into account with which the field of work is studded; unless every precaution to secure purity—precautions such as Baker and Dewar have taught us to use—be taken at every step, the conclusions based on all such observations must be open to grave doubt." This cautionary reasoning is what is important to remember.

ELECTRIC TRANSMISSION ON SHIPBOARD.

Mr. R. M. Neilson discusses the above subject thoughtfully in the course of an article in the current number of *Cassier's Magazine*. He acknowledges that the topic is arousing much interest, but does not seem very hopeful of results as far as propulsion for large ships is concerned. Yet he says: "This turbo-electric scheme has already been tried, but only to a very limited extent. It has, for example, been applied to fireboats at Chicago, in which case it offered special advantages. The turbo-electric drive also appears to be specially advantageous in the case of certain kinds of dredges, salvage vessels, repair ships, etc., in which the power required for propulsion does not bear such a high ratio to the power required for other purposes as is common in cargo, passenger and war vessels." Great movements such as are here in question cannot be carried through in a day, and the success chronicled by Mr. Neilson, in our opinion, is full of encouragement as to the future. Steam propulsion had made far less progress than this in the early stage.

DRY ACCUMULATORS.

From Christiania come vague rumours of what may prove to be a triumphant forward movement in electrical technics. It is said that a local electrician has invented that long sought after *desideratum*, a dry accumulator. So far, it appears, his apparatus has a capacity of 60 volts and a motive efficiency of one quarter i.h.p., but he is in hopes of increasing this to 100 volts and over one half i.h.p. As was to be expected, there is an enormous saving

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of weight, the accumulator only weighing a little over 2½ lbs., while its prime cost and maintenance charges are correspondingly reduced. It is said to be most easy to manipulate. There is certainly a great future before such an invention, if practical, and we shall all (not omitting the very many who have been devoting years to the solution of the problem) wait further news with interest.

PRUSSIAN MAIN-LINE ELECTRIFICATION.

Another point of great interest is the 24 miles of the main line between Bitterfeld and Dessau, for it is here that a section is to be experimentally electrified, at a cost of two million marks. The overhead trolley system is to be adopted, and if all goes well, the electrification will be extended in both directions, to Leipzig and Mageburg, with ultimate extension to Berlin, and also on the branch line from Bitterfeld to Halle. The experiment will be carried out under the best auspices, for it is a central and very busy line, going through a country where good brown coal, and so cheap power, can be obtained in plenty, and should any breakdown occur, the traffic may be diverted to parallel lines with the minimum of inconvenience. The current transmitted to the motors will be 60,000 volts, 15 period single-phase. It will be generated at a central station, equipped with a turbo-generator, horizontal type, capacity 3,000 kw. The 3,000 volts current will be transmitted through a transformer station, where it will be stepped up to a tension of 60,000 volts. This is the first move in a scheme of general electrification, which will involve an outlay of twenty million marks. Careful comparison is to be made between this section and the Hamburg railway, which is also an overhead trolley railway, but worked by a single-phase current with a periodicity of 25. This higher frequency involves a lower capital expenditure, but is said to wear out the motors much more rapidly. Our own electrification schemes pale before the magnitude of this German undertaking. It is said, however, that the military authorities look upon the new move with some suspicion.

LICENSING WIREMEN.

That go-ahead body, the Electrical Association of Victoria, is moving in an important direction, having decided to back up the suggestion for the licensing of wiremen. Australian electricians, like their brethren in other parts of the world, have had much trouble owing to bad wiring, and it is felt that both for the sake of the profession and the public, wiremen ought to be compelled to pass a test examination and then to be licensed during good (professional) behaviour. Mr. H. R. Harper, the president, at a recent meeting, pointed out that the greatest difficulty lay in preventing mishaps in installations which ought to be inspected once a week, not merely at the end of the job. As a remedy, he suggested that the Government should provide electrical inspectors, whose salaries might be partly covered by fees paid by contractors. The scheme for licensing seems to meet with general favour in Australia, both professionals and traders being at one on the subject. It would be interesting to know how such a policy would be received in this country. But if "Registered Plumbers," why not registered electrician tradesmen of all degrees?

ELECTRICITY AND AGRICULTURE.

The sodium nitrate industry of Chili, founded within the recollection of many now living, by a steam-plough engineer, Colonel G. T. North, presents such remarkable figures that a few of them may be worth quoting. In 1830 the value of the nitrate deposits on the waterless plateau of Chili was first recognised, and 935 tons were mined. In 1860 its value as a manure was proved, and immediately it boomed, so that in 1875 the output was half-a-million tons, and in 1907 1¾ million tons. During the last 20 years more than four times as much saltpetre has been exported from Chili as during the preceding 20 years, and if the output goes on increasing at its present rate the output will be over 5 million tons per annum. These figures show the great possibilities that lie before an industry in touch with agriculture, and the electrical engineering profession, may now congratulate itself on being in that fortunate position through the new artificial manures, calcium nitrate and cyanamide. Señor Bertrond, a Chilian Government official, has stated that the amount of saltpetre in Chili is 220 million tons, and assuming that the consumption goes on at the present increasing rate, an arithemetical sum shows that the whole lot will be cleared out before 1960. When that happens we shall be practically dependent on the nitrogen of the air, and for the fixing of that gas the world is indebted to electrical engineers. Just as traction and power transmission were big steps from the somewhat petty electric lighting work of 15 and 20 years ago, so will electric metallurgy be as great a step from traction. It is, in fact, going to be the most remarkable industrial feature of the first half of this century.

POWER FOR CONDENSING WATER.

The power taken to raise water to the top of a cooling tower, and the power for driving fans in one type of tower is quite an appreciable amount, and may go a long way towards nullifying the advantages gained by such towers. At Southend, for example, two separate cooling towers and condensers have been taken out and replaced by a Ledward evaporative condenser. One of the old plants required about 75 b.h.p to run it, the water being raised to about 28 ft. Whereas the new combined condenser and tower (which an evaporative really is), only requires 22 b.h.p. The output of the new condenser is more than double the capacity of the old, but the water has only to be raised 14 ft. During the hours of light load the air circulating round the pipes is sufficient and the power is then only that sufficient to drive the air pump, namely, 9 b.h.p. In this connection it may be interesting to give particulars of a home-made cooling tower at Durban, in Natal. Mr. Roberts, the City electrical engineer, installed a cooling tower fitted with fans, but he soon found that the power required to drive the fans was making a big hole in his profits. He therefore set to work to build a chimney type cooling tower of his own design, about twice the size of the old one, and instead of using rough sawn boards he simply filled the interior with bundles of brushwood. The result has been that in a few years the saving of the power taken by the fans has paid for the new tower, and the vacuum has been much better. The prevailing winds in Durban are in two certain definite directions. The tower was therefore set down to catch them on each side, and special shutters were provided which raised and lowered each morning and evening to meet these conveniently regular breezes.

PENALTY AND BONUS.

The question of whether penalties should be enforced for late delivery and low efficiency etc., is always cropping up, and on several occasions firms in this country have been rather badly bitten over penalty clauses. Of course, firms, like individuals, are liable to err at times, and no doubt they would not mind the penalties so much if there were possibilities of recouping on other jobs by bonuses. In the building of new machines the designer frequently allows a good margin for contingencies, and it thus happens that the purchasers are given a much better machine than they bargained for. In some cases this better machine might not be of much advantage, but in most cases it would, and it seems only equitable that the maker should benefit a little also. He would have no legal claim, of course, if no provision for a bonus had been made in the contract, but at the same time a little sentiment in business does good. In the United States a penalty cannot be enforced by law, unless an equivalent bonus has also been agreed upon, and this surely is the right and fair way to look at the matter! Of course, there should be a neutral zone above and below, when the penalties and bonuses would come into operation. Thus, for output rating and for efficiency, a margin of 2½ per cent., that is, 1¼ above and below the guaranteed figures might be allowed. For example, say an efficiency of 80 per cent. is guaranteed at full load, then if it falls below 79 per cent. the penalty, or if above 81 per cent. the bonus, clauses should operate. In fixing times for delivery of goods for shipment, it is necessary to specify it as being the boat sailing nearest to the time stated. Most machinery goes by cargo boats, and it is impossible to state months ahead just when a cargo boat will sail.

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PROGRESS IN ELECTRICITY.

BY PROFESSOR SIR J. J. THOMPSON, M.A., LL.D., D.Sc., F.R.S.

The study of this all-pervading substance is perhaps the most fascinating and important duty of the physicist.

On the electromagnetic theory of light, now universally accepted, the energy streaming to the earth travels through the ether in electric waves; thus practically the whole of the energy at our disposal has at one time or another been electrical energy. The ether must, then, be the seat of electrical and magnetic forces. We know, thanks to the genius of Clerk Maxwell, the founder and inspirer of modern electrical theory, the equations which express the relation between these forces, and although for some purposes these are all we require, yet they do not tell us very much about the nature of the ether.

The interest inspired by equations, too, in some minds is apt to be somewhat Platonic; and something more grossly mechanical—a model, for example, is felt by many to be more suggestive and manageable, and for them a more powerful instrument of research, than a purely analytical theory.

Let us consider some of the facts known about the ether. When light falls on a body and is absorbed by it, the body is pushed forward in the direction in which the light is travelling, and if the body is free to move it is set in motion by the light. Now it is a fundamental principle of dynamics that when a body is set moving in a certain direction, or, to use the language of dynamics, acquires momentum in that direction, some other mass must lose the same amount of momentum; in other words, the amount of momentum in the universe is constant. Thus when the body is pushed forward by the light some other system must have lost the momentum the body acquires, and the only ether system available is the wave of light falling on the body; hence we conclude that there must have been momentum in the wave in the direction in which it is travelling. Momentum, however, implies mass in motion. We conclude, then, that in the ether through which the wave is moving there is mass moving with the velocity of light. The experiments made on the pressure due to light enable us to calculate this mass, and we find that in a cubic kilometre of ether carrying light as intense as sunlight is at the surface of the earth, the mass moving is only about one-fifty-millionth of a milligramme. We must be careful not to confuse this with the mass of a cubic kilometre of ether; it is only the mass moved when the light passes through it; the vast majority of the ether is left undisturbed by the light. Now, on the electro-magnetic theory of light, a wave of light may be regarded as made up of groups of lines of electric force moving with the velocity of light; and if we take this point of view we can prove that the mass of ether per cubic centimetre carried along is proportional to the energy possessed by these lines of electric force per cubic centimetre, divided by the square of the velocity of light. But though lines of electric force carry some of the ether along with them as they move, the amount so carried, even in the strongest electric fields we can produce, is but a minute fraction of the ether in their neighbourhood.

This is proved by an experiment made by Sir Oliver Lodge in which light was made to travel through an electric field in rapid motion. If the electric field had carried the whole of the ether with it, the velocity of the light would have been increased by the velocity of the electric field. As a matter of fact no increase whatever could be detected, though it would have been registered if it had amounted to one-thousandth part of that of the field.

The ether carried along by a wave of light must be an exceedingly small part of the volume through which the wave is spread. Parts of this volume are in motion, but by far the greater part is at rest; thus in the wave front there cannot be uniformity, at some parts the ether is moving, at others it is at rest—in other words, the wave front must be more analogous to bright specks on a dark ground than to a uniformly illuminated surface.

The place where the density of the ether carried along by an electric field rises to its highest value is close to a corpuscle, for round the corpuscles are by far the strongest electric fields of which we have any knowledge. We know the mass of the corpuscle, we know from Kaufmann's experiments that this arises entirely from the electric charge, and is therefore due to the ether carried along with the corpuscle by the lines of force attached to it.

A simple calculation shows that one-half of this mass is contained in a volume seven times that of a corpuscle. Since we know the volume of the corpuscle as well as the mass, we can calculate the density of the ether attached to the corpuscle; doing so, we find it amounts to the prodigious value of about 5×10^{12}, or about 2,000 million times that of lead. Sir Oliver Lodge, by somewhat different considerations, has arrived at a value of the same order of magnitude.

Thus around the corpuscle ether must have an extravagant density: whether the density is as great as this in other places depends upon whether the ether is compressible or not. If it is compressible, then it may be condensed round the corpuscles, and there have an abnormally great density; if it is not compressible, then the density in free space cannot be less than the number I have just mentioned.

With respect to this point we must remember that the forces acting on the ether close to the corpuscle are prodigious. If the ether were, for example, an ideal gas whose density increased in proportion to the pressure, however great the pressure might be, then if, when exposed to the pressures which exist in some directions close to the corpuscle, it had the density stated above, its density under atmospheric pressure would only be about 8×10, or a cubic kilometre would have a mass less than a gramme; so that instead of being almost incomparably denser than lead, it would be almost incomparably rarer than the lightest gas.

I do not know at present of any effect which would enable us to determine whether ether is compressible or not. And although at first sight the idea that we are immersed in a medium almost infinitely denser than lead might seem inconceivable, it is not so if we remember that in all probability matter is composed mainly of holes. We may, in fact, regard matter as possessing a bird-cage kind of structure in which the volume of the ether disturbed by the wires when the structure is moved is infinitesimal in comparison with the volume enclosed by them. If we do this, no difficulty arises from the great density of the ether; all we have to do is to increase the distance between the wires in proportion as we increase the density of the ether.

Let us now consider how much ether is carried along by ordinary matter, and what effects this might be expected to produce.

The simplest electrical system we know, an electrified sphere, has attached to it a mass of ether proportional to its potential energy, and such that if the mass were to move with the velocity of light its kinetic energy would equal the electrostatic potential energy of the particle. This result can be extended to any electrified system, and it can be shown that such a system binds a mass of the ether proportional to its potential energy. Thus a part of the mass of any system is proportional to the potential energy of the system.

The question now arises, Does this part of the mass add anything to the weight of the body? If the ether were not subject to gravitational attraction it certainly would not; and even if the ether were ponderable, we might expect that as the mass is swimming in a sea of ether it would not increase the weight of the body to which it is attached. But if it does not, then a body with a large amount of potential energy may have an appreciable amount of its mass in a form which does not increase its weight, and thus the weight of a given mass of it may be less than that of an equal mass of some substance with a smaller amount of potential energy. Thus the weights of equal masses of these substances would be different. Now, experiments with pendulums, as Newton pointed out, enable us to determine with great accuracy the weights of equal masses of different substances. Newton himself made experiments of this kind, and found that the weights of equal masses were the same for all the materials he tried. Bessel, in 1830, made some experiments on this subject which are still the most accurate we possess, and he showed that the weights of equal masses of lead, silver, iron, brass did not differ by as much as one part in 60,000.

The substances tried by Newton and Bessel did not, however, include any of those substances which possess the marvellous power of radio-activity; the discovery of these

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came much later, and is one of the most striking achievements of modern physics.

These radio-active substances are constantly giving out large quantities of heat, presumably at the expense of their potential energy; thus when these substances reach their final non-radio-active state their potential energy must be less than when they were radio-active. Professor Rutherford's measurements show that the energy emitted by one gramme of radium in the course of its degradation to non-radio-active forms is equal to the kinetic energy of a mass of 1-13th of a milligramme moving with the velocity of light.

This energy, according to the rule I have stated, corresponds to a mass of 1-13th of a milligramme of the ether, and thus a gramme of radium in its radio-active state must have at least 1-13th of a milligramme more of ether attached to it than when it has been degraded into the non-radio-active forms. Thus if this ether does not increase the weight of the radium, the ratio of mass to weight for radium would be greater by about one part in 13,000 than for its non-radio-active products.

I attempted several years ago to find the ratio of mass to weight for radium by swinging a little pendulum, the bob of which was made of radium. I had only a small quantity of radium, and was not, therefore, able to attain any great accuracy. I found that the difference, if any, in the ratio of the mass to weight between radium and other substances was not more than one part in 2,000. Lately we have been using at the Cavendish Laboratory a pendulum whose bob was filled with uranium oxide. We have got good reasons for supposing that uranium is a parent of radium, so that the great potential energy and large ethereal mass possessed by the radium will be also in the uranium; the experiments are not yet completed. It is, perhaps, expecting almost too much to hope that the radio-active substances may add to the great services they have already done to science by furnishing the first case in which there is some differentiation in the action of gravity.

The mass of ether bound by any system is such that if it were to move with the velocity of light its kinetic energy would be equal to the potential energy of the system. This result suggests a new view of the nature of potential energy. Potential energy is usually regarded as essentially different from kinetic energy. Potential energy depends on the configuration of the system, and can be calculated from it when we have the requisite data; kinetic energy, on the other hand, depends upon the velocity of the system. According to the principle of the conservation of energy the one form can be converted into the other at a fixed rate of exchange, so that when one unit of one kind disappears a unit of the other simultaneously appears.

Now in many cases this rule is all that we require to calculate the behaviour of the system, and the conception of potential energy is of the utmost value in making the knowledge derived from experiment and observation available for mathematical calculation. It must, however, I think, be admitted, that from the purely philosophical point of view it is open to serious objection. It violates, for example, the principle of continuity. When a thing changes from a state A to a different state B, the principle of continuity requires that it must pass through a number of states intermediate between A and B, so that the transition is made gradually, and not abruptly. Now, when kinetic energy changes into potential, although there is no discontinuity in the quantity of the energy, there is in its quality, for we do not recognise any kind of energy intermediate between that due to the motion and that due to the position of the system, and some portions of energy are supposed to change *per saltum* from the kinetic to the potential form. In the case of the transition of kinetic energy into heat energy in a gas, the discontinuity has disappeared with a fuller knowledge of what the heat energy in a gas is due to. When we were ignorant of the nature of this energy, the transition from kinetic into thermal energy seemed discontinuous; but now we know that this energy is the kinetic energy of the molecules of which the gas is composed, so that there is no change in the type of energy when the kinetic energy of visible motion is transformed into the thermal energy of a gas—it is just the transference of kinetic energy from one body to another.

If we regard potential energy as the kinetic energy of portions of the ether attached to the system, then all energy is kinetic energy, due to the motion of matter or of portions of ether attached to the matter. I showed, many years ago, in my "Applications of Dynamics to Physics and Chemistry," that we could imitate the effects of the potential energy of a system by means of the kinetic energy of invisible systems connected in an appropriate manner with the main system, and that the potential energy of the visible universe may in reality be the kinetic energy of an invisible one connected up with it. We naturally suppose that this invisible universe is the luminiferous ether, that portions of the ether in rapid motion are connected with the visible systems, and that their kinetic energy is the potential energy of the systems.

We may thus regard the ether as a bank in which we may deposit energy and withdraw it at our convenience. The mass of the ether attached to the system will change as the potential energy changes, and thus the mass of a system whose potential energy is changing cannot be constant: the fluctuations in mass under ordinary conditions are, however, so small that they cannot be detected by any means at present at our disposal. Inasmuch as the various forms of potential energy are continually being changed into heat energy, which is the kinetic energy of the molecules of matter, there is a constant tendency for the mass of a system such as the earth or the sun to diminish, and thus as time goes on for the mass of ether gripped by the material universe to become smaller and smaller; the rate at which it would diminish would, however, get slower as time went on, and there is no reason to think that it would ever get below a very large value.

Radiation of light and heat from an incandescent body like the sun involves a constant loss of m ss by the body. Each unit of energy radiated carries off its quota of mass, but as the mass ejected from the sun per year is only one part in 20 billionths (1 in 2×10^{13}) of the mass of the sun, and as this diminution in mass is not necessarily accompanied by any decrease in its gravitational attraction, we cannot expect to be able to get any evidence of this effect.

As our knowledge of the properties of light has progressed, we have been driven to recognise that the ether, when transmitting light, possesses properties which, before the introduction of the electro-magnetic theory, would have been thought to be peculiar to an emission theory of light and to be fatal to the theory that light consists of undulations.

Take, for example, the pressure exerted by light. This would follow as a matter of course if we supposed light to be small particles moving with great velocities, for these, if they struck against a body, would manifestly tend to push it forward, while on the undulatory theory there seemed no reason why any effect of this kind should take place.

Indeed, in 1792, this very point was regarded as a test between the theories, and Bennet made experiments to see whether or not he could find any traces of this pressure. We now know that the pressure is there, and if Bennet's instrument had been more sensitive he must have observed it. It is perhaps fortunate that Bennet had not at his command more delicate apparatus. Had he discovered the pressure of light, it would have shaken confidence in the undulatory theory and checked that magnificent work at the beginning of the last century which so greatly increased our knowledge of optics.

As another example, take the question of the distribution of energy in a wave of light. On the emission theory the energy in the light is the kinetic energy of the light particles. Thus the energy of light is made up of distinct units, the unit being the energy of one of the particles.

The idea that the energy has a structure of this kind has lately received a good deal of support. Planck, in a very remarkable series of investigations on the Thermodynamics of Radiation, pointed out that the expressions for the energy and entropy of radiant energy were of such a form as to suggest that the energy of radiation, like that of a gas on the molecular theory, was made up of distinct units, the magnitude of the unit depending on the colour of the light; and on this assumption he was able to calculate the value of the unit, and from this deduce incidentally the value of Avogadro's constant—the number of molecules in a cubic centimetre of gas at standard temperature and pressure.

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This result is most interesting and important because if it were a legitimate deduction from the Second Law of Thermodynamics, it would appear that only a particular type of mechanism for the vibrators which give out light and the absorbers which absorb it could be in accordance with that law.

If this were so, then, regarding the universe as a collection of machines all obeying the laws of dynamics, the Second Law of Thermodynamics would only be true for a particular kind of machine.

There seems, however, grave objection to this view, which I may illustrate by the case of the First Law of Thermodynamics, the principle of the Conservation of Energy. This must be true whatever be the nature of the machines which make up the universe, provided they obey the laws of dynamics, any application of the principle of the Conservation of Energy could not discriminate between one type of machine and another.

Now, the Second Law of Thermodynamics, though not a dynamical principle in as strict a sense as the law of the Conservation of Energy, is one that we should expect to hold for a collection of a large number of machines of any type, provided that we could not directly affect the individual machines, but could only observe the average effects produced by an enormous number of them. On this view, the Second Law, as well as the First, should be incapable of saying that the machines were of any particular type: so that investigations founded on thermodynamics, though the expressions they lead to may suggest—cannot, I think, be regarded as proving—the unit structure of light energy.

It would seem as if in the application of thermodynamics to radiation some additional assumption has been implicitly introduced, for these applications lead to definite relations between the energy of the light of any particular wave length and the temperature of the luminous body.

Now a possible way of accounting for the light emitted by hot bodies is to suppose that it arises from the collisions of corpuscles with the molecules of the hot body, but it is only for one particular law of force between the corpuscles and the molecules that the distribution of energy would be the same as that deduced by the Second Law of Thermodynamics, so that in this case, as in the other, the results obtained by the application of thermodynamics to radiation would require us to suppose that the Second Law of Thermodynamics is only true for radiation when the radiation is produced by mechanism of a special type.

Quite apart, however, from considerations of thermodynamics, we should expect that the light from a luminous source should in many cases consist of parcels, possessing, at any rate to begin with, a definite amount of energy. Consider, for example, the case of a gas like sodium vapour, emitting light of a definite wave length; we may imagine that this light, consisting of electrical waves, is emitted by systems resembling Leyden jars. The energy originally possessed by such a system will be the electrostatic energy of the charged jar. When the vibrations are started, this energy will be radiated away into space, the radiation forming a complex system, containing, if the jar has no electrical resistance, the energy stored up in the jar.

The amount of this energy will depend on the size of the jar and the quantity of electricity with which it is charged. With regard to the charge, we must remember that we are dealing with systems formed out of single molecules, so that the charge will only consist of one or two natural units of electricity, or, at all events, some small multiple of that unit, while for geometrically similar Leyden jars the energy for a given charge will be proportional to the frequency of the vibration; thus, the energy in the bundle of radiation will be proportional to the frequency of the vibration.

We may picture to ourselves the radiation as consisting of the lines of electric force which, before the vibrations were started, were held bound by the charges on the jar, and which, when the vibrations begin, are thrown into rhythmic undulations, liberated from the jar and travel through space with the velocity of light.

Now let us suppose that this system strikes against an uncharged condenser and gives it a charge of electricity, the charge on the plates of the condenser must be at least one unit of electricity, because fractions of this charge do not exist, and each unit charge will anchor a unit tube of force, which must come from the parcel of radiation falling upon it. Thus a tube in the incident light will be anchored by the condenser, and the parcel formed by this tube will be anchored and withdrawn as a whole from the pencil of light incident on the condenser. If the energy required to charge up the condenser with a unit of electricity is greater than the energy in the incident parcel, the tube will not be anchored and the light will pass over the condenser and escape from it. These principles that radiation is made up of units, and that it requires a unit possessing a definite amount of energy to excite radiation in a body on which it falls, perhaps receive their best illustration in the remarkable laws governing Secondary Röntgen radiation, recently discovered by Professor Barkla. Professor Barkla has found that each of the different chemical elements, when exposed to Röntgen rays, emit a definite type of secondary radiation whatever may have been the type of primary, thus lead emits one type, copper another, and so on; but these radiations are not excited at all if the primary radiation is of a softer type than the specific radiation emitted by the substance; thus the secondary radiation from lead being harder than that from copper; if copper is exposed to the secondary radiation from lead the copper will radiate, but lead will not radiate when exposed to copper. Thus, if we suppose that the energy in a unit of hard Röntgen rays is greater than that in one of soft, Barkla's results are strikingly analogous to those which would follow on the unit theory of light.

Though we have, I think, strong reasons for thinking that the energy in the light waves of definite wave length is done up into bundles, and that these bundles, when emitted, all possess the same amount of energy, I do not think there is any reason for supposing that in any casual specimen of light of this wave length, which may subsequent to its emission have been many times refracted or reflected, the bundles possess any definite amount of energy. For consider what must happen when a bundle is incident on a surface such as glass, when part of it is reflected and part transmitted. The bundle is divided into two portions, in each of which the energy is less than the incident bundle, and since these portions diverge and may ultimately be many thousands of miles apart, it would seem meaningless to still regard them as forming one unit. Thus the energy in the bundles of light, after they have suffered partial reflection, will not be the same as in the bundles when they were emitted. The study of the dimensions of these bundles, for example, the angle they subtend at the luminous source, is an interesting subject for investigation; experiments on interference between rays of light emerging in different directions from the luminous source would probably throw light on this point.

I now pass to a very brief consideration of one of the most important and interesting advances ever made in physics, and in which Canada, as the place of the labours of Professors Rutherford and Soddy, has taken a conspicuous part. I mean the discovery and investigation of radio-activity. Radio-activity was brought to light by the Röntgen rays. One of the many remarkable properties of these rays is to excite phosphorescence in certain substances, including the salts of uranium, when they fall upon them. Since Röntgen rays produce phosphorescence, it occurred to Becquerel to try whether phosphorescence would produce Röntgen rays. He took some uranium salts which had been made to phosphoresce by exposure, not to Röntgen rays but to sunlight, tested them, and found that they gave out rays possessing properties similar to Röntgen rays. Further investigation showed, however, that to get these rays it was not necessary to make the uranium phosphoresce, that the salts were just as active if they had been kept in the dark. It thus appeared that the property was due to the metal and not to the phosphorescence, and that uranium and its compounds possessed the power of giving out rays which, like Röntgen rays, affect a photographic plate, make certain minerals phosphoresce, and make gases through which they pass conductors of electricity.

Niepce de Saint-Victor had observed some years before this discovery that paper soaked in a solution of uranium nitrate affected a photographic plate, but the observation excited but little interest. The ground had not then been prepared, by the discovery of the Röntgen rays, for its reception, and it withered and was soon forgotten.

Shortly after Becquerel's discovery of uranium, Schmidt

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found that thorium possessed similar properties. Then Monsieur and Madame Curie, after a most difficult and laborious investigation, discovered two new substances, radium and polonium. possessing this property to an enormously greater extent than either thorium or uranium, and this was followed by the discovery of actinium by Debierne. Now the researches of Rutherford and others have led to the discovery of so many new radio-active substances that any attempts at christening seems to have been abandoned, and they are denoted, like policemen, by the letters of the alphabet.

Mr. Campbell has recently found that potassium, though far inferior in this respect to any of the substances I have named, emits an appreciable amount of radiation, the amount depending only on the quantity ot potassium, and being the same whatever the source from which the potassium is obtained or whatever the elements with which it may be in combination.

The radiation emitted by these substances is of three types known as α, β and γ, rays. The α rays have been shown by Rutherford to be positively electrified atoms of helium, moving with speeds which reach up to about one-tenth of the velocity of light. The β rays are negatively electrified corpuscles, moving in some cases with very nearly the velocity of light itself, while the γ rays are unelectrified, and are analogous to the Röntgen rays.

The radio-activity of uranium was shown by Crookes to arise from something mixed with the uranium, and which differed sufficiently in properties from the uranium itself to enable it to be separated by chemical analysis. He took some uranium, and by chemical treatment separated it into two portions, one of which was radio-active and the other not.

Next Becquerel found that if these two portions were kept for several months, the part which was not radio-active to begin with regained radio-activity, while the part which was radio-active to begin with had lost its radio-activity. These effects and many others receive a complete explanation by the theory of radio-active change which we owe to Rutherford and Soddy.

According to this theory, the radio-active elements are not permanent, but are gradually breaking up into elements of lower atomic weight; uranium, for example, is slowly breaking up, one of the products being radium, while radium breaks up into a radio-active gas called radium emanation, the emanation into another radio-active substance, and so on, and that the radiations are a kind of swan's song emitted by the atoms when they pass from one form to another; that, for example, it is when a radium atom breaks up and an atom of the emanation appears that the rays which constitute the radio-activity are produced.

Thus, on this view the atoms of the radio-active elements are not immortal, they perish after a life whose average value ranges from thousands of millions of years in the case of uranium to a second or so in the case of the gaseous emanation from actinium.

When the atoms pass from one state to another they give out large stores of energy, thus their descendants do not inherit the whole of their wealth of stored-up energy, the estate becomes less and less wealthy with each generation; we find, in fact, that the politician, when he imposes death duties, is but imitating a process which has been going on for ages in the case of these radio-active substances.

Many points of interest arise when we consider the rate at which the atoms of radio-active substance disappear. Rutherford has shown that whatever be the age of these atoms, the percentage of atoms which disappear in one second is always the same; another way of putting it is that the expectation of life of an atom is independent of its age—that an atom of radium one thousand years old is just as likely to live for another thousand years as one just sprung into existence.

Now this would be the case if the death of the atom were due to something from outside which struck old and young indiscriminately; in a battle, for example, the chance of being shot is the same for old and young; so that we are inclined at first to look to something coming from outside as the cause why an atom of radium, for example, suddenly changes into an atom of the emanation. But here we are met with the difficulty that no changes in the external conditions that we have as yet been able to produce have had any effect on the life of the atom; as far as we know at present the life of a radium atom is the same at the temperature of a furnace as at that of liquid air— it is not altered by surrounding the radium by thick screens of lead or other dense materials to ward off radiation from outside, and what to my mind is especially significant, it is the same when the radium is in the most concentrated form, when its atoms are exposed to the vigorous bombardment from the rays given off by the neighbouring atoms, as when it is in the most dilute solution, when the rays are absorbed by the water which separates one atom from another. This last result seems to me to make it somewhat improbable that we shall be able to split up the atoms of the non-radio-active elements by exposing them to the radiation from radium; if this radiation is unable to affect the unstable radio-active atoms, it is somewhat unlikely that it will be able to affect the much more stable non-radio-active elements.

The evidence we have at present is against a disturbance coming from outside breaking up of the radio-active atoms, and we must therefore look to some process of decay in the atom itself; but if this is the case, how are we to reconcile it with the fact that the expectation of life of an atom does not diminish as the atom gets older? We can do this if we suppose that the atoms when they are first produced have not all the same strength of constitution, that some are more robust than others, perhaps because they contain more intrinsic energy to begin with, and will therefore have a longer life. Now if when the atoms are first produced there are some which will live for one year, some for ten, some for a thousand, and so on; and if lives of all durations, from nothing to infinity, are present in such proportion that the number of atoms which will live longer than a certain number of years decrease in a constant proportion for each additional year of life, we can easily prove that the expectation of life of an atom will be the some whatever its age may be. On this view the different atoms of a radio-active substance are not, in all respects, identical.

The energy developed by radio-active substances is exceedingly large, one gramme of radium developing nearly as much energy as would be produced by burning a ton of coal. This energy is mainly in the α particles, the positively charged helium atoms which are emitted when the change in the atom takes place; if this energy were produced by electrical forces it would indicate that the helium atom had moved through a potential difference of about two million volts on its way out of the atom of radium. The source of this energy is a problem of the deepest interest; if it arises from the repulsion of similarly electrified systems exerting forces varying inversely as the square of the distance, then to get the requisite amount of energy the systems, if their charges were comparable with the charge on the α particle, could not when they start be further apart than the radius of a corpuscle, 10^{-13} cm. If we suppose that the particles do not acquire this energy at the explosion, but that before they are shot out of the radium atom they move in circles inside this atom with the speed with which they emerge, the forces required to prevent particles moving with this velocity from flying off at a tangent are so great that finite charges of electricity could only produce them at distances comparable with the radius of a corpuscle.

One method by which the requisite amount of energy could be obtained is suggested by the view to which I have already alluded—that in the atom we have elecrified systems of very different types, one small, the other large; the radius of one type is comparable with 10^{-13} cm., that of the other is about 100,000 times greater. The electrostatic potential energy in the smaller bodies is enormously greater than that in the larger ones; if one of these small bodies were to explode and expand to the size of the larger ones, we should have a liberation of energy large enough to endow an α particle with the energy it possesses. Is it possible that the positive units of electricity were, to begin with, quite as small as the negative, but while in the course of ages most of these have passed from the smaller stage to the larger, there are some small ones still lingering in radio-active substances, and it is the explosion of these which liberates the energy set free during radio-active transformation?

The properties of radium have consequences of enormous importance to the geologist as well as to the physicist or chemist. In fact, the discovery of these properties has entirely altered the aspect of one of the most interesting

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geological problems, that of the age of the earth. Before the discovery of radium it was supposed that the supplies of heat furnished by chemical changes going on in the earth were quite insignificant, and that there was nothing to replace the heat which flows from the hot interior of the earth to the colder crust. Now when the earth first solidified it only possessed a certain amount of capital in the form of heat, and if it is continually spending this capital and not gaining any fresh heat it is evident that the process cannot have been going on for more than a certain number of years, otherwise the earth would be colder than it is. Lord Kelvin in this way estimated the age of the earth to be less than 100 million years. Though the quantity of radium in the earth is an exceedingly small fraction of the mass of the earth, only amounting, according to the determinations of Professors Strutt and Joly, to about five grammes in a cube whose side is 100 miles, yet the amount of heat given out by this small quantity of radium is so great that it is more than enough to replace the heat which flows from the inside to the outside of the earth. This, as Rutherford has pointed out, entirely vitiates the previous method of determining the age of the earth. The fact is that the radium gives out so much heat that we do not quite know what to do with it, for if there was as much radium throughout the interior of the earth as there is in its crust, the temperature of the earth would increase much more rapidly than it does as we descend below the earth's surface. Professor Strutt has shown that if radium behaves in the interior of the earth as it does at the surface, rocks similar to those in the earth's crust cannot extend to a depth of more than 45 miles below the surface.

It is remarkable that Professor Milne from the study of earthquake phenomena had previously come to the conclusion that rocks similar to those at the earth's surface only descend a short distance below the surface; he estimates this distance at about 30 miles, and concludes that at a depth greater than this the earth is fairly homogeneous.

Though the discovery of radio-activity has taken away one method of calculating the age of the earth it has supplied another.

The gas helium is given out by radio-active bodies, and since, except in beryls, it is not found in minerals which do not contain radio-active elements, it is probable that all the helium in these minerals has come from these elements. In the case of a mineral containing uranium, the parent of radium in radio-active equilibrium, with radium and its products, helium will be produced at a definite rate. Helium, however, unlike the radio-active elements, is permanent and accumulates in the mineral; hence if we measure the amount of helium in a sample of rock and the amount produced by the sample in one year we can find the length of time the helium has been accumulating, and hence the age of the rock. This method, which is due to Professor Strutt, may lead to determinations not merely of the average age of the crust of the earth, but of the ages of particular rocks and the date at which the various strata were deposited; he has, for example, shown in this way that a specimen of the mineral thorianite must be more than 240 million years old.

The physiological and medical properties of the rays emitted by radium is a field of research in which enough has already been done to justify the hope that it may lead to considerable alleviation of human suffering. It seems quite definitely established that for some diseases, notably rodent ulcer, treatment with these rays has produced remarkable cures; it is imperative, lest we should be passing over a means of saving life and health, that the subject should be investigated in a much more systematic and extensive manner than there has yet been either time or material for. Radium is, however, so costly that few hospitals could afford to undertake pioneering work of this kind; fortunately, however, through the generosity of Sir Ernest Cassel and Lord Iveagh a Radium Institute, under the patronage of his Majesty the King, has been founded in London for the study of the medical properties of radium, and for the treatment of patients suffering from diseases for which radium is beneficial.

The new discoveries made in physics in the last few years, and the ideas and potentialities suggested by them, have had an effect upon the workers in that subject akin to that produced in literature by the Renaissance. Enthusiasm has been quickened, and there is a hopeful, youthful, perhaps exuberant spirit, abroad which leads men to make with confidence experiments which would have been thought fantastic 20 years ago. It has quite dispelled the pessimistic feeling, not uncommon at that time, that all the interesting things had been discovered, and all that was left was to alter a decimal or two in some physical constant. There never was any justification for this feeling, there never were any signs of an approach to finality in science. The sum of knowledge is at present, at any rate, a diverging not a converging series. As we conquer peak after peak we see in front of us regions full of interest and beauty, but we do not see our goal, we do not see the horizon; in the distance tower still higher peaks, which will yield to those who ascend them still wider prospects, and deepen the feeling, whose truth is emphasised by every advance in science, that "Great are the Works of the Lord."

HYDRO-ELECTRIC POWER IN CANADA.*

By SIR W. H. WHITE, K.C.B., Sc.D., F.R.S.

Canada has unrivalled resources in water-power, and its extent and possible utilisation have been made the subject of investigation by engineers for many years past. One of the most important memoirs on the subject was presented to the Royal Society of Canada in his Presidential Address of 1899 by Mr. Keefer, C.M.G. In recent times many other engineers have studied the subject and carried out important works. Exact knowledge of the total power represented by the water-falls and rapids of the Dominion is not available, nor can any close estimate be made of the power which may be employed hereafter in factories, mills or industrial processes, because profitable employment obviously depends upon commercial considerations, which must be governed largely by the localities in which water-power may be found, and the cost of works and of transmission of energy to places where it can be utilised. It has been estimated that on the line from Lake Superior through the chain of lakes and rivers leading to Niagara, and thence through the St. Lawrence, to the sea, 11,000,000 h.p. may be developed. Mr. Langelier has estimated that in the Province of Quebec the water-power aggregates more than 18,000,000 h.p.; other provinces all possess large resources of the same kind as yet untouched. The most striking example of the utilisation of water-power is that on the Niagara River, which the writer had the good fortune to visit in 1904, during his Presidency of the Institution of Civil Engineers; the works on the Canadian side were then in full progress, and at a stage which enabled one to realise completely their great difficulty and immense scale. The three companies whose works are near the Falls on the Canadian side have provided for a total ultimate development of over 400,000 h.p., and a fourth establishment lower down the river, intended chiefly for the use of Hamilton, is to develop 40,000 h.p. In the construction of the works, in the electric generating plant, the arrangements for transmitting power over long distances, and other features of importance, remarkable engineering skill and daring have been displayed. American capital and enterprise have had much to do with these undertakings, as they have with many other important Canadian enterprises; but it may be hoped that British capital will keep its lead and be freely employed in the development and utilisation of all the resources of the Dominion, including that magnificent asset—its water-power. The applications of water-power are already very numerous, including not merely the creation of electrical energy and its use for lighting and power in towns and factories situated at considerable distances from the Falls, but for manufactures and industrial processes carried on near the Falls. Amongst these manufactures, that of aluminium and carbide of calcium may be mentioned, while paper- and pulp-mills and saw-mills constitute important industries. Great advances have been made in the transmission of electrical power over long distances, and very high pressures are being used. Electric traction on railways and tramways also derives its power from the same sources, and is being rapidly developed. In 1901 there were 553 miles of electric railways, and in 1907, 815 miles

* Abstract of Presidential Address, Engineering Section, British Association Meeting, Winnipeg, 1909.

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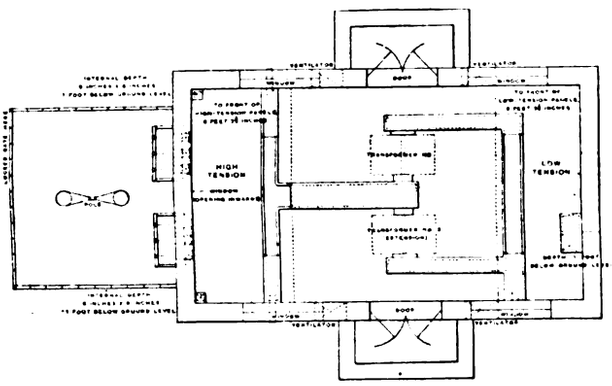
ELECTRICITY AT THE LOCHGELLY COALMINES.

Electrical power generation and distribution at the collieries of the Lochgelly Iron and Coal Co., Ltd., Fife, provided the theme of a paper read by Mr. John Paul before the Mining Institute, of Scotland, at Kilmarnock on June 12. The paper appears in the record of Transactions of the Institutions, from which we make the following abstract. Mr. Paul explained that on the coal field of the company there are ten pits, distributed over an area of about 16 square miles and raising an aggregate of one and a quarter million tons of coal per annum. Until the end of last year, electricity supply for both power and lighting was provided throughout this area by numerous isolated continuous-current plants of low and medium pressure. The more modern consisted of Belliss & Morcom high-speed vertical engines direct-coupled to generators, and the remainder of slow-speed horizontal engines connected to generators by belt-drives: these latter including several small combinations, supplying current at 200 volts for lighting the pit-heads. The increase in demand for electric drives of all kinds made it imperative for the company to consider the question of increasing the supply of electrical energy to several of the pits, and incidentally to weigh the relative advantages of providing extensions to the existing scattered plants, and the alternative of generating in bulk at high pressure at a convenient centre and distributing to the several consuming points. As a result of consultation with Messrs. James E. Sayers & Caldwell, of Glasgow, the choice fell upon the latter alternative, the prominent advantages of this scheme over the first named, briefly stated, being



given as follows:—(1) better load factor; (2) greater efficiency of larger generating units; (3) greater flexibility; the ability to transmit power easily to any part of the filed as occasion demanded; (4) economy in raising the whole of the steam required at a washery where dross and gum are available; (5) economy in labour, reducing the number of chargemen and attendants; (6) economy in and more efficient supervision; and (7) extensions simplified, and less costly.

Generation at a central power-house and overhead transmission of the electric power to distant pits by high-pressure three-phase current having been agreed to in principle, it was decided to instal, to begin with, plant sufficient to deal with five of the pits and the workshops: the pits being the Nellie, Mary, Newton, Jenny Grey, and Melgund; but to design the lay-out with a view to the ultimate inclusion of the whole field in the scheme. It was decided to provide in the first instance two generating units of about 450 kw. capacity each, and arrange accommodation in the power-house, in addition, for a third similar unit, and a 1,000 kw. exhaust or mixed-pressure turbo-generator; and also to so design and arrange the first portion of the equipment that no part would require modification if, and when, the forenoted extensions were made. The question of immediately utilizing the exhaust steam from the winding and other engines at the Nellie pit (the situation selected for the power-house) for generating electricity was considered carefully. As, however, the laying-down of a second winding-engine at this pit is contemplated, it was decided to leave this question for reconsideration if, and when, extensions become necessary; but the position of the power-house was arranged with a view to this development.

Examination of the relative advantages of turbines and reciprocating engines for the size of units required resulted in favour of the last named, both as regards cost per kw. capacity and steam consumption per kw. output, the quotations and guaranteed steam consumption appearing to be in favour of the reciprocator for units of 1,000 kw. capacity downwards. In this connection it may be stated that the very satisfactory experience with several Belliss & Morcom engines was not without weight in assisting the company in their decision. Condensing plant was included in the proposals, not entirely with a view to economy in fuel (this being worth at the most 2s. 9d. per ton handled), but in order to ensure good feed-water, and to reduce capital expenditure on boilers and engines. The recovery of the condensed steam for feed purposes being of great importance, owing to the indifferent character of the available supply of water at the Nellie pit, choice was restricted to the surface and exaporative types of condensers; and, as the quantity of circulating water required by an evaporative condenser is not more than 25 per cent. of that required for a surface-condensing plant, the former type was chosen. The adoption of any other type of condenser would have involved circulating arrangements of at least four times the capacity of the little set now in use for this duty, and, in addition, would have entailed the provision of cooling towers or ponds. It must be admitted that the vacuum obtained with the company's evaporative condenser is not more than 25 to 26 inches, but the advantage of a correspondingly hot feed is, of course, obtained. It must also be added that this type of condenser would be unsuitable for turbines, and especially so for exhaust turbines, where the highest possible vacuum is necessary in order to obtain efficient results. For the turbo-generator contemplated as a probable extension to the power-house, either surface or ejector condensing will be resorted to. For steam raising, boilers of the water-tube type were advocated, the reasons advanced being that their construction is more suitable for high pressures, and that there is not, with this class of boiler, the liability, after a few years' use, of having to reduce the working pressure, a contingency which has to be reckoned with in shell boilers of large diameter. Superheating and high velocity of steam in the main were also put forward as ensuring important economies, and of especial value in this particular instance, because of the boilers having to be nearly 200 ft. distant from the nearest generating unit. This rather excessive distance was inevitable, owing to the necessity of selecting a site convenient for the future collection of steam for the proposed exhaust turbo-generator; and, on the other hand, the necessity, for economic reasons, of placing the new boilers in line with the existing Lancashire boilers. In the spring of 1907, specifications were prepared and competitive offers obtained for the necessary works indicated herebefore, and also for the necessary transmission system, transformer sub-stations, shaft and inbye cables, switchgear, motors, and their accessories. The more important contracts were entered into shortly afterwards, and at the beginning of 1909 the power-house, transmission line, and transformer sub-station were put to work, and the changeover from the old direct-current drives to the new three-phase system was begun. This changeover is necessarily a slow process, as it is almost entirely confined to Sundays, and therefore this part of the work is still uncompleted.

Separate contracts were made for each portion of the scheme; and, except in the case of the transmission line, the several contractors provided a chargeman only, the company supplying all the other labour required. Recently the company has acquired the Dundonald colliery, and this has now been included in the area of the new supply, an extension of about two miles to the transmission line at the Jenny Grey transformer station now being in progress for this purpose.

Describing the completed works, Mr. Paul mentioned that there are four Babcock & Wilcox boilers, set in two batteries. Each boiler contains 2,531 square ft. of heating surface, and is composed of 14 sections of 4-inch tubes 18 ft. long; each section contains eight tubes, the tubes being surmounted by two steam-and-water drums 36 inches in diameter. Each boiler is fitted with a new type of chain-grate mechanical stoker. The grate is self-clinkering

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and allows of smokeless combustion, while at the same time hand firing can be easily resorted to in case of need. The links of the grate are closely spaced in order to reduce riddling to a minimum, and the whole of the grates are driven by a small steam engine. With reference to the steam pipes, a special feature of the design of the steam-main is the absence of suspension supports, these being avoided with a view to obviate any risk of vibration with the high velocity of steam arranged for. The whole of the system is heavily lagged with material specially adapted for the high temperature which it has to withstand, and all flanges are boxed in. There are two Belliss & Morcom self lubricating three-crank triple-expansion engines, direct coupled to two Bruce-Peebles three-phase 50-period alternators, having exciters on the same shaft. The engines are supplied with the makers' own system of forced lubrication; and the oil escaping from the bearings drains into the crank-pit to be used over again. The evaporative condenser consists of 336 corrugated pipes, built into 24 pipes each, while the feed-water purifier plant is so designed as to remove every trace of emulsified oil from the condensed water, and to discharge it into a feed tank ready for supply to the feed-pumps. In describing the high tension distributing system, he says all the cables and apparatus in connection with the overhead lines are protected from the effects of lightning and excessive pressures from other causes by spark gaps; and public roads and positions in the vicinity of the pits are guarded by adequate cradling. The transformer stations, erected by the company, are each designed to contain two 200 kw. transformers (0·8-power factor), and the necessary switch-gear, but at present have only half of their full equipment. The transformers are oil-cooled, and are wound to transform three-phase current from 3,000, 3,150, and 3,300 volts to 525 volts, the several ratios being arranged for compensation for varying line losses at the different consuming points dependent upon distance from the power-station. The full-load efficiency of these transformers on test was about 97 per cent. The switch-gear for the transformer chambers is of the Ferranti type, and comprises a high- and a low-tension panel for each transformer, with automatic oil-switches, indicating instruments, and an integrating wattmeter to measure the units of electrical energy supplied. The switch-gear is designed to cut out automatically a faulty transformer, and is generally in line with the apparatus in the power-house, which has already been described. On the high-tension side, space has been left for a high-tension feeder panel, in case it is desired to take high-tension circuits down the shafts. On the low-tension side, there are three circuits, each of 200 kw. capacity, for transmission of current at 525 volts for shaft-cables or other purposes. A very good general idea of the arrangements may be obtained from the plan accompanying the letterpress. As to the outlay, it may be taken that the generating costs, plus the capital charges, namely, interest on capital, and sinking fund to redeem the capital in 20 years, will enable the company by the equipment described to deliver electrical energy at any point in the coalfield for something less than 0·3d. per Board of Trade unit; and that with an increased load the cost per unit will be even cheaper, owing to the fact that much of the capital expenditure already incurred really belongs to these possible and probable extensions.

THE AVON INDICATOR.

A very useful arrangement for the registration of power loads has just been placed on the market by the Avon Electricity Meter, Ltd. (80a, Salisbury-road, Kilburn, London, N.W.). It is known as the Avon Maximum Demand Indicator, and consists of the "Avon" clock type meter—which is suitable for all systems, *i.e.*, two and three wire D.C. or A.C., three and four wire two-phase or three-phase—and an attachment indicating the maximum demand. Being a mechanical device driven by the counting train, it consumes no extra energy, requires no further electrical connections, and does not increase the size of the meter. It is equally accurate with the meter, and follows the same straight line law. Moreover, it is easily reset, registers energy, can be calibrated to read amperes if required, and can be arranged for any time of lag.

ENGINE-ROOM MANAGEMENT.*

BY C. R. BROSIUS.

(*Of the Columbus Railway and Light Co.*)

The man in charge of the power station should have a practical knowledge of his plant, should be informed on the practical possibilities of steam appliances and machinery and be able to search intelligently after sources of loss and chances for improvement, and should be a judge of material to know what is best for his requirements. He should never become attached personally to any of the men in his employ, otherwise he is not in a position to judge the value of their ability.

The two essential factors that he should maintain are discipline and system. It is a comparatively easy matter to enforce discipline where system is properly maintained. There is more to gain in an intelligent and economical use of engines and boilers than in any immediate improvement in the machine itself.

While designers and professors are discussing 2 or 3 per cent. savings the customers are buying engines so proportioned to their work and so little adapted to their requirements that many times 2 per cent. are wasted continually. The way to get the most work out of a steam plant is to find first in what particular the plant is lacking and then bring that part up to the standard. Find separately the efficiency of boilers and engines. If the boilers are inefficient it may be because the rate of combustion is too high or too low for the amount of heating surface. The setting may be faulty, the fireman wasteful, or any one or more of a dozen causes. The engine may be underloaded or overloaded, badly set or leaky. Find the trouble and then go systematically to work to remedy it.

Every engineer, no matter how small his station, should have organised a testing force and have piping arranged to determine what each unit is doing. Elaborate tests are not necessary. Engine tests should be simple, showing the water rate per kw. hour with indicator cards. After the water rate is obtained and found to be high, analysing the indicator diagrams will tell where the trouble is likely to be.

At 7 per cent. CO_2 in the flue gases enough unnecessary excess air is heated to keep a duplicate of the furnace plant going, and at 5 per cent. CO_2 the excess would almost keep two additional plants running.

Few concerns would think of putting as much money into any kind of business as is invested in the average power station without having a clerk or bookkeeper, or a number of them, to keep an intelligent record of all transactions. The auditing department takes care of the financial end, but that does not help the engineer keep track of operating figures. In the majority of plants to-day it is the common practice to depend largely on memory for records of the repairs made on station apparatus. The author then outlines a system of keeping track of repairs in large power stations in such a way that the chief engineer will be continuously informed as to what is going on, and records kept.

The clerical force can make money for the power station in various ways. For example, it usually costs from £20 to £25 to renew a furnace arch for a 350-h.p. boiler. There are fire brick of various grades, and while records are kept of when the arches are renewed, it requires time to follow up records and compare results obtained by the use of different brick. If brick could be found (and they can) which would last twice as long as a poor grade, more than half the expense for renewals of arches would be saved. The same thing applies to packing and other supplies. Every power station should have a set of rules and regulations for its employees.

ADVANTAGES OF THE ELECTRIC CAR.

The electric automobile has many advantages which should commend it to the public favour. In the campaign against the noise of city streets, remarks the *New York Electrical World*, the gasoline car is often a conspicuous offender, and it contrasts most unfavourably with the latest types of electric vehicles, which are almost noiseless. "Joy riders" make no use of the electric vehicle. The speed mania does not seize hold of those who manage the safe and sane electric car. The latter does not drip gasoline on the street, neither is it characterised by an offensive odour. Quietly, steadily, but with strength and power, electricity does its work whether in propelling the carriage which a woman or even a child may operate, or driving the attractive delivery wagon or the heavy truck. The opprobrium which attaches to the reckless driving of automobiles is directed almost entirely against the gasoline cars, and rightly so, for very few accidents are to be attributed to the easily controlled machines of the electric type. In a few places in this country automobiles are forbidden the privileges of the street within municipal limits; but it will be well for the exasperated city authorities to make a distinction in favour of the electric vehicle, for it is not that type of car that has brought reproach on automobilism.

* Abstract of Paper read before the Ohio Electric Light Association Convention at Toledo.

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ELECTRICITY AND CANADIAN MINING.

By JOHN ASHWORTH.*

We landed at Lewistown on the American side of the Niagara River, and proceeding up the gorge visited the rapids above the Falls on the American shore. The Canadian or Horse-shoe Fall is 9 feet lower on the lip than the American Fall, the first being 158 ft. and the latter 167 ft. high; the depth of the river-basin below the Falls is 180 ft. The face of the Canadian Fall is said to have been receding at the rate of from 4 to 5 ft. annually, but whether this rate of recession will continue, now that the various electrical production companies are abstracting a considerable volume of water from the rapids above, remains to be seen. In the process of erecting these works and the bays appertaining to them, the width of the lip of the Horse-shoe Fall has been reduced by about 150 ft. The first electrical works visited were those of the Canadian Niagara Power Co. The waste water from the turbines flows through a tunnel 23 ft. wide by 26 ft. high, which delivers it into the lower river. This tunnel is lined with 24 in. of granite at the outlet, and the rest with vitrified bricks, and is 2,200 ft. long. It is calculated to discharge 12,000 cu. ft. of water per second, the gradient being about 1 in 182. Over the wheel-pit, which is 165 ft. deep, 18 ft. wide, and 570 ft. long, there are eleven 10,000 h.p. electrical generators, driven by twin Francis vertical turbines of 12,500 h.p., delivering a three-phase alternating current. The establishment of the Electrical Development Co. of Ontario necessitated the erection of a coffer dam 2,200 ft. long, and extending 600 ft. into the river which thus laid bare 11 acres of the river bed. During construction, the velocity of the water was at times 30 miles per hour. The tail-race tunnel starts with two branches, each 1,260 ft. long, joining the main tunnel of 1,900 ft. long, and discharges under the Horse-shoe Fall. There is also on the Canadian side the Ontairo Power Co. of Niagara Falls, with similar arrangements for the production of power and the supply of electricity for all industrial purposes at practically any distance. The works are also provided with separate transforming stations. The Ontario Power Co. take their water supply out of the rapids above the Falls, and conduct it through a main ½-in. steel-plate conduit pipe, 18 ft. in diameter and 6,200 ft. long, to the works situated below the Falls. The maximum discharge from this pipe is about 4,000 cu. ft. per second, and as there are three of these conduits, the total quantity is about 12,000 cu. ft. per second. The total power now to be obtained from the water on the Canadian side is as under:—

	Electric h.p.
Canadian Niagara Power Company	100,000
Electrical Development Company	125,000
Ontario Power Company	180,000
Total	405,000

As to the influence of the electrical and other works using the river water above the Falls, it may be of interest to know that the total h.p. of the Falls is estimated at 3,200,000, and for low water at 2,600,000. At the present time the franchises granted to the various companies total up to 31,450 cu. ft. per second on the Canadian side, and to 27,200 on the American side, plus that abstracted by three canals, 12,300 cu. ft. per second, or a total of 70,950 cu. ft. per second. These franchises represent 40 per cent. of the mean low-water volume of February, 1902, which was 175,000 cu. ft. per second. The International Waterways Commission recommend the limitation to 36,000 for the Canadian side, and 18,500 for the United States side and the canals, or nearly 31 per cent. of the low-water discharge. The very great importance of these facts is that the use of the water will most seriously impair the navigation of the upper lakes. At the close of 1905, the total diversion of water was equivalent to lowering Lake Erie by 9 in., while as yet only a quarter of the franchise power had been brought into use. It is obvious, therefore, that if the navigation of the lakes is to remain open to future generations, the application or use of this water at the outlet must be very carefully safeguarded.

We visited the International Copper Co.'s smelter and mine. The copper-smelting plant is one of the most complete in the world. The whole of the plant is driven by electricity, obtained from the company's works at Spanish River, 27 miles away. The Cream Hill mine, from which the ore is principally obtained, is an open pit of about 200 ft. in diameter, 100 ft. deep, and with four underground stopes. About 12,000 tons of ore per month are shipped containing about 4 per cent. of copper and 2 per cent. of nickel. Some miles to the west or south-west of Winnipeg we passed the lignite coal-field of Souris, and reached Medicine Hat in the afternoon of September 13th, when we came into close touch with the Prairie lignite coal-field. Our call here had reference principally to the bore-holes put down for natural gas at a depth of 1,060 ft. The first 600 ft. of the boring was 10 in. in diameter, through water-bearing strata, and ended in a sandstone formation lying between blue shales. The diameter of the bore at the bottom was 4⅝ in. The blue shales readily disintegrate when exposed to water and air. The pressure of the gas is about 556 pounds per sq. in. and the yield about 1,500,000 cu. ft. per 24 hours. Although this supply has been drawn on for 24 years, it has not yet shown any reduction in the yield. The gas is used for all sorts of purposes, the price for domestic supply being 6¾d. (13½ cents), and for business purposes 2½d. (5 cents) per 1,000 cu. ft. at a pressure of 8 ounces per sq. in. The railway reservoirs are charged up to a pressure of 175 pounds per sq. in. This gas is used very extensively by the Canadian Pacific Railway Co. in their shops for all kinds of heating purposes, and has effected a saving of at least £12,320 ($60,000) per annum on an outlay for boring of only about £923 ($4,500 dollars). At Coleman we found that the miners use the Wolf lamp, with internal self-ignition; and Negro powder is used for blasting. The dip of the mine is about 30 degrees. No. 2 seam is a steam-coal, 14 ft. thick; No. 4 a coking coal, 7 ft. thick; and No. 5 a steam-coal, 14 ft. thick. The roofs and floors are rock, and the holing or mining is all done by hand. The extraction is by pillar and stall, the pillars measuring 60 by 60 ft. and the rooms being 15 ft. wide; 200 ft. on the higher side of the road is left in as support for the roadway. The output is about 2,000 tons per day, and an Ottuma box-car loader is in use. The mine ventilation is maintained by two Capell fans. The coke-ovens are of the beehive type. The ventilation of the Hosmer mine is effected by a Walker fan, 20 by 9 ft., which can be used either as an exhausting or as a blowing fan. The haulage is effected by compressed air locomotives. Wash-house, baths, and lockers are provided for the miners. The mine cars are constructed to hold 2 tons each. Two hundred and forty coke-ovens are calculated to give an output of 300 tons of coke per day. When at the city of Nelson we called at the Bonnington Falls to visit the West Kootenay Power and Light Co.'s plant. The electricity produced from four units of 8,000 h.p. each is carried off at a high tension to Rossland. Our next call was at the Rossland power smelter. Some 10 to 15 tons of lead piping is made here every day, the workmen being mostly Italians. The Trail smelter is the oldest copper-reduction works in the Kootenay district, having been erected in 1894. The lead from the furnaces is refined electrically. The electric current from the Bonnington Falls is received here at a pressure of 20,000 volts. The h.p. of the motors in use is 3,000. At the noted Le Roi mine at Rossland we inspected the 1,650-ft. level and stopes. The shaft is an inclined one, and the cage is fitted with a safety-catch arrangement to arrest its fall in case of the rope breaking. We also visited the Le Roi No. 2 or Josie mine, and descended to the 500-ft. level, where a diamond drill was at work boring down to the 700-ft. level. Following this visit, we also descended the Centre Star mine to the 1,650-ft. level, the mine having a total depth of 2,300 ft. The haulage machinery is strong enough to haul from 3,000 ft., at the rate of 1,000 ft. per minute.

* Abstract of Delegate's Report of the Summer Excursion Meeting (1908) of the Canadian Mining Institute, from the "Transactions of the Manchester Geological and Mining Society," Vol. X. and XI., Session 1908–1909.

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* ELECTRICITY AND FERTILISERS.

By F. KILBURN SCOTT, M.I.E.E.

The world is more indebted to the electrical engineers and chemists who have produced the manures calcium nitrate and calcium cyanamide than it at present has any idea of. For if these artificial manures had not come in the nick of time, there is no doubt that the prices of sodium nitrate from Chili and sulphate of ammonia from gas works would have gone soaring up. As it is, the prices have increased some 30% within the last few years.

And the reasons are not far to seek. First, the virgin soils of the world are being rapidly used up; there was a time, not long ago, when wheat could be grown nearly all over the United States without putting in manure, but it is not so now. The natural stores of nitrogen accumulated through the ages have been taken out by repeated cropping of wheat, and now American farmers are moving into the Canadian North-West.

The second reason is that more and more people in the world are becoming, like ourselves, wheat and meat eaters. The Japanese, for example, who have hitherto lived almost solely on rice, are now going in for wheat, and meat and proving an excellent market for Australia on that account.

This provision of nitrogen for the gluten in wheat and the fibrine in meat to build up the muscle and tissue of the human body was rapidly becoming the problem of this century, as Sir William Crookes pointed out in 1898, when without any fuss some electrical engineers and chemists called Birkeland and Eyde, Frank and Caro came forward with solutions.

Calcium Nitrate.

There is more nitrogen in the air over a square mile of the earth's surface than in all the saltpetre in Chili, and the first step towards fixing the nitrogen was made in 1773 by Dr. Priestly. He sent a series of electric sparks through air in a closed glass jar, and obtained a brownish coloured gas which was nitric oxide.

The principle of the process of making calcium nitrate at Notodden is based on Dr. Priestly's experiments, the sparks he used being replaced by a flaming arc disc shaped, and about 5 ft. in diameter. Six years ago Professor Birkeland and Mr. S. Eyde built their first furnace of 25 h.p. Two years later they had a plant of 2,500 h.p., and in 1907 the 40,000 h.p. plant at Notodden was set to work. The harnessing of the Rjukan Falls of 220,000 h.p. is now in hand, and by 1912 nearly half a million water h.p. will be used in manufacturing calcium nitrate and nitrite. The Birkeland and Eyde furnace is about 8 ft. in diameter and 3 ft. through, set on edge like a wheel. It is lined with refractory bricks, and has a disc shaped arc chamber about 5 ft. diameter by 3 in. Alternating current at 5,000 volts is fed across the two copper electrodes (cooled with water), and a flaming arc is continually being struck and blown out to the limits of the arc chamber by the repulsion of a powerful electro magnet.

Air is forced through the arc chamber under pressure, and is immediately burnt into nitric oxide, and this gas is then lead away to two sets of five towers, taking up another atom of oxygen on the way to form nitric peroxide. The first four towers are filled with pieces of quartz over which water and the nitric acid, already formed, trickles. The fifth tower is filled with ordinary bricks, with milky lime flowing over them. This quickly absorbs what nitrous gases remain, and is converted into calcium nitrate and nitrite. The first tower yields a 50% nitric acid, the second 25%, the third 15%, and the fourth 5%. The liquids from the fourth are raised by compressed air to the top of the third, and those from the third to the second, and so on, the acid thus travelling in a counter direction to the gas. Nitric acid and calcium nitrate are made in such quantities and sell so readily at good prices that the calcium nitrate might almost be considered the bye producer. The nitrogen in calcium nitrate is usually 13%, and is guaranteed at 12¾%, and compared on a nitrogen contents basis with Chili nitrate it is the cheapest manure of the two. Its present price delivered CIF English port is under £8 per ton.

Calcium Cyanamide.

Calcium cyanamide, or "nitroline," is made from carbide of calcium, and the inventors, Professor Frank and Mr. Caro, took the idea from Bunsen and Playfair, who obtained cyanides by passing nitrogen over a hot mass of carbon and alkalies. They first tried barum carbide, but since carbide of calcium has been produced in such great quantities for acetylene gas lighting it has become very cheap. When carbide of calcium is raised to 1,000° Cent., it fixes nitrogen directly without the aid of alkalies. Further, if the resulting cyanamide is mixed with water under pressure the nitrogen combines with the hydrogen to form ammonia. This naturally suggested the use of the material as a manure, and it has been so successful that there are now about a dozen factories in the various countries of Europe, in the United States, and even in Japan, turning out about 150,000 tons per annum. The nitrogen content is guaranteed at 18%.

The manufacture for this country is in the hands of the North-Western Cyanamide Co., and they have built a works at Odda on the Hardanger Fiord capable of turning out 12,000 tons per annum. The calcium carbide made by the affiliated concern, The Ally Carbide Co., is delivered in lumps. After being broken up fine in crushers and mills, it is fed by means of special hoppers with 196 electric resistance furnaces, each capable of holding about 6 cwts. The lids are fastened down air-tight, and nitrogen gas is forced through under pressure, the process being completed in about 45 hours. The nitrogen gas is made by the Lende process, in which air is led through white hot copper shavings. The copper at that temperature has a great affinity for the oxygen, so it takes it all up, leaving the nitrogen to be blown forward to the furnaces.

The various re-actions may be written down thus:

$Ca\,O + C_2 = CO + Ca\,C_2$ carbide of calcium.

$Ca\,C_2 + 2N = C + Ca\,CN_2$ cyanamide.

$Ca\,CN_2 + 3H_2O = Ca\,CO_3 + 2\,(NH_3)$, ammonia.

It will be noticed that when the ammonia gas is given up the lime is deposited in the soil. This also happens with the other manure, calcium nitrate, and therefore they both have this advantage over sodum nitrate from Chili. Soils short of lime are improved, whereas when sodium enters the soil it tends to make it "sad." It is not known how the nitrogen passes from the ammonia to the gluten in the wheat ear, but there is no doubt that certain bacteria in the soil plays an important part, and that the nitrogen passing through their bodies is one link in the chain.

* Abstract of a lecture delivered at the Wye Agricultural College.

AMERICAN NOTES.

(From our Correspondent.)

NEW YORK.

So far as concerns electrical industries generally, the concensus of opinion is that we are not much worse off under the Payne Tariff than we were under the Dingley law. Taking it "by and large," if we have not succeeded in securing the concessions for which so hard a fight has been put up, we have not been hurt in a vital place by new exactions. We have failed to carry the clause, fixing on electrical machinery a duty of 30 per cent. *ad valorem*, and it will pay 45 per cent. *ad valorem* as before, all specific reference to electrical apparatus and machinery having been submerged under the clause embracing "manufactures imposed wholly or in part of metal," the same rate is payable on incandescent lamps, cables, telephone wires and telegraph wires; but carbon electrodes, brushes, plates, and discs, pay 30 per cent. *ad valorem*, and 5 per cent. less than under the Dingley Tariff.

The Case of Carbons.

But carbons will pay a greatly enhanced duty, and this in rather curious circumstances, for there is in the new Act an apparent reduction. Carbons made entirely from petroleum coke are to pay 35 cents per 100 ft., and those "made chiefly from lampblack or retort carbon, 65 cents per 100 ft."—which at the first blush looks a better thing than the Dingley rate of 90 cents per 100 carbons. Here, however, is just where we find the fly in the amber. Something like 92½ per cent. of the carbons hitherto imported have been carbons for enclosed arcs, and the carbons have come here in 24 and 28½ inch lengths, and been cut here to the ordinary 12 inch length. Thus the 90 cents per 100 carbons has really meant 90 cents per 200 carbons, or 45 per cent. per 100 in 12 in. lengths. The "smart Alec," who found this out had the word "feet" inserted, and thus the duty goes up 20 cents and more per 100, and 24 in. carbons for flaming arcs will pay, not 90 cents as under the Dingley law, but 130 cents per 100. Mica will come in at a fractional reduction; tungsten, tantalum, and wolfram metal will pay the old duty of 20 per cent. *ad valorem* when valued at more than $200 per ton; but if of less value than $200 the rate will be 25 per cent.; telegraph, telephone, trolley, or electric light poles will pay 10 per cent. *ad*

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valorem instead of 20 per cent.; and zinc will come in at a slight reduction.

A Large Project.

Great interest is manifested in the proposal of the United States Government to carry out through its Reclamation Service an irrigation project in the Yakima Valley, Washington, at a cost approximating, in starting, £1,750,000. The scheme will convert into production a quarter-of-a-million acres of land in the "Great American Desert." As a result of this—and of earlier schemes now a splendid success—thriving towns are springing up along the Yakima river and the route of the Northern Pacific Railroad and all are linked up by the transmission lines of the Yakima Valley Power Co., which will be supplying nearly 7,000 kw. by the end of this year. The main power plant is on the Naches river, thirteen miles above the junction with the Yakima river at North Yakima. This plant contains a 750 kw. General Electric Alternator driven at 150 r.p.m. by a Pelton water wheel under a head of 149 ft. Two new units; one water-driven, the other steam-driven are now being installed; the former, a 3,000 kw. 2,300 volt type A. T. B. 14-pole General Electric three-phase alternator, driven by a Platt Iron Works' wheel, and the latter a turbo-generator set rated at 2,500 k.v.a., consisting of a type A. T. B. 4-pole generator and a Curtis steam turbine, operating at 160 pounds pressure. The present head of 149 ft. is to be raised to 208 ft. by a new pipe line delivering 450 sec. ft. Apart from the supply of light to these towns, considerable power will be used for irrigating the lands above the level of the canals. The Yakima Valley Power Co., also furnishes current to the Yakima Valley Transportation Co., which has three miles of standard gauge railway in North Yakima, with plans for an extensive system embracing the entire valley.

Electricity versus Petrol.

It is significant of the progress made by the electric automobile in this country that at the recent Convention of Automobile Engineers in Chicago, nearly half the papers read related to electrical subjects. The *Electrical World* has the following crisp comment on this circumstance:—"As a class, automobile engineers have paid comparatively little attention to electrical problems, and it is an encouraging indication of the manner in which the electric vehicle is gradually coming into its own when the professional society of the great automobile industry—and a high-grade society it is, too, fairly comparable in the quality of its work to the associations maintained in other branches of engineering—gives so large a proportion of one of its conventions to subjects related to the unobtrusive but attractive, reliable and serviceable electric automobile." It has often struck me as remarkable that the moderate-priced electric runabout has not made greater progress in the Old Country. A noiseless, easy-running, easily controlled, and above all, absolutely odourless motor car should be a tremendous boon.

A Chicago Contract.

A big deal has recently been concluded by the Commonwealth Edison Co., which has contracted to supply the Chicago Railways Co. with a large portion of the electrical energy needed to operate its cars. The contract calls for not less than 30,000 kw. and will cover a period of six years. The rate is $15 per kw. of maximum demand per year with an additional energy-consumption charge of 0·415 cent per kw.-hour until the end of January next, after which the energy-consumption charge will be 0·4 cent per kw.-hour for the remainder of the period. Under existing contracts at the time of maximum demand next winter the Commonwealth Edison Co. will, it is stated, be supplying about 80,000 kw. to electric railway corporations.

Storage Battery Problems.

Recurring for a moment to the matter of electrically-propelled cars, mention must be made of the somewhat pessimistic view of storage battery possibilities which was laid before the convention of Automobile Engineers at Chicago by Dr. Sokal, well-known in that city as a chemical engineer of some repute. His conclusion was that the possibility of obtaining a practical advantage by using a different chemical material than the lead battery is practically negligible, and he declared that the utmost limit which has been obtained by Mr. Edison, so far, is about 11 watt-hours per pound of element—a figure which can easily be exceeded by the lead storage battery. There has, he said, been no really fundamental progress since the days of Planté and Faure though the progress made in the art of manufacturing and operating storage batteries since the principle was discovered has been very considerable. He went on to say that variations of design may have a marked effect on the output per unit weight of the lead storage battery, and pointed out that while the United States standard storage-battery cells are kept within 9 to 12 watt-hours per pound of total element, cells are made in Germany which reach an output of 17 watt-hours per pound. Both the porosity and the thickness of storage-battery plates have an appreciable influence on the specific output, but Dr. Sokal did not care to go on record as advising generally the use of thin plates; the manufacturer has in each particular case to form a decision which will necessarily be in the nature of a compromise, as it is obviously impossible to unite all advantages in one type. His own proposal is to build vehicle cells having the positive and negative plates so divided that there will be one more positive than negative, since it is usually the positive plate which fails first, and he announced that he had succeeded in overcoming the difficulties in the way of artificial circulation of the electrolyte by constructing shallow or bottle-shaped electrodes, through the walls of which the circulation takes place. In this way, he said, a gain in specific output of from 50 to 100 per cent. may be obtained.

A Split-phase Motor.

An invention, of which more is likely to be heard, has just been patented here by Mr. Samuel Bergmann. It consists in a method of obtaining two windings of different inductive time-constants for use with a single-phase induction motor as a split-phase machine. The stator is arranged with open slots, the main winding being placed in certain of the slots and the starting winding in the remaining slots. Magnetic wedges are employed to close the slots occupied by the main winding, and non-magnetic wedges for the slots containing the starting winding. The starting winding is wound with smaller wire than the main winding and is placed in the tops of the slots, the bottoms of the slots being filled with pieces of wood or other non-magnetic material, thereby decreasing the reactance of the starting winding, and thus the main winding is of high reactance and low resistance, while the starting winding is of low reactance and high resistance, and yet the slots of the stator are of uniform size and equally spaced.

Electricity in the Home.

With reference to my article on this subject, manufacturers on your side of the Pond may be interested in an experiment now in progress by the Consolidated Gas, Electric Light and Power Company, of Baltimore. They have sent a small army of travellers out to make house-to-house calls among users of electric light and expound the advantages of heating units, especially in relation to the domestic iron. A sample 6 lb. iron, capable of doing all the ironing work of an ordinary household, is left for a months' free trial, at the end of which it is purchasable for about $3 or by instalments of a dollar a month for three months. Central station engineers are criticising this method of popularisation, but the Company is nevertheless doing a tremendous business, especially as the ordinary retail price of these irons is about $5.

New Hydro-Electric Stations.

Three hydro-electric generating stations to utilize the falls at Long Sault Rapids, which separate Ontario from New York State, are under preparation. The scheme involves the construction of a dam at the upper end of Barnhart's Island, the building of a lift lock, and the straightening out of the course of various channels of the river. It is claimed that fully 100,000 h.p. can be developed. The plant will probably be constructed and managed jointly by two companies—the Long Sault Development Co. on the New York side and the St. Lawrence Power Co. on the Canadian side.

Dresses by Electricity.

A remarkable exhibit has been made in Boston in the shape of a motor-driven shop for the manufacture of machine-made dresses at high speed. The raw materials were cut, up to a maximum of 250 thicknesses, by an Eastman electric cloth cutter, capable of doing the work of 20 operators, and supplied with energy from a 110 volt circuit. The installation was provided with a 1·5 h.p., 110 volt direct-current motor, driving the following machines in group: One skirt bander, one button-sewing machine, output 3,000 per day; one button-hole machine, output 400 per hour, against 40 by hand; one sleeve sewer, one tucking machine, making 3,500 stitches per minute; one waist machine, making 1,800 stitches per minute; one sleeve machine, and one skirt machine, making 3,000 stitches per minute. The individual machines were placed in and out of service by friction clutches operated by treadles. The exhibit was engineered by and for Messrs. W. Filene's Sons.

Railway Developments.

The New York Central and Hudson River Railroad has set aside for use during the year ending June 30, next, a sum of just under eight and a half million dollars for the electrification of suburban lines and the construction of a New York terminal—the Presidio and Ferries Electric Railway Co. of San Francisco has raised $300,000 for improving the road and equipment.—The Puget Sound Electric Railway has acquired the Pacific Traction lines in Tacoma for a sum approximating $5,000,000.—The Aroostook Valley Railroad Co., which is affiliated with the Canadian Pacific Railway Co., is to construct an electric road connecting Presque Isle and Washburn, Maine, with an extension to the St. John River, a distance of 110 miles. A 1,200-volt direct-current system will be installed, electricity for which will be furnished by the Maine and New Brunswick Power Co.'s plant at Aroostook Falls.—The Fort Wayne and Toledo Electric Railway Co. will begin on September 15, the construction of the new electric line from Fort Wayne and Maysville, Ind., to Hicksville, Bryan and Toledo, Ohio, a distance of 42 miles. The Keystone Construction Co., of Indiana, has the contract for building the road, and the railway will be operated by the overhead trolley system, electricity for which will be supplied by the Toledo and Indiana Railway Co.

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CONTENTS.

	PAGE
Notes	285
Progress in Electricity ..	287
Hydro-Electric Power in Canada	291
Electricity at the Lochgelly Coalmines	292
Engine-Room Management	293
Advantages of the Electric Car	293
Electricity and Canadian Mining	294
Electricity and Fertilisers	295
American Notes	295
Water Power Problems ..	297
Sources of Error in Electric Instruments	298
Electrical Signals in Mines	298
Distillation of Electricity	299
Improved Rails and Brakes	301
Tyneside Notes	303
Iron and Steel Institute Meetings	304
Correspondence	304
Electricity in the Home..	307
Electricity at Chopwell Mines	307
Non-Flammable Celluloid Substitute	308
Notes on Condensing and Water Cooling Plants..	310
Technical Problems, with Solutions by Practical Men	313
Companies' Meetings and Reports..	316
Personal	316
The Monterey Mines ..	316
Contracts Open	316
Lighting & General Notes	317
Traction Notes	318
Parliamentary	319
Patents	320
Institution of Mining Electrical Engineers	322
Companies' Stock and Share List	322
Traffic Returns	324

WATER POWER PROBLEMS.

It is all too generally assumed that water-power for the generation of electricity may be dismissed as outside practical discussion, if not for the United Kingdom, at least for England. This is not our way of looking at the matter. No doubt gigantic water schemes, such as those alluded to by Sir William White before the British Association, gathered on the shores of the splendid Winnipeg lake, and within easy reach of grand rivers and great falls, are altogether out of the question for us. These big things are reserved for countries having watersheds on an altogether larger scale than is the case in this country. But the streams wandering through our fair land capable of generating power through the intermediary of suitable turbines, and if for the service of private establishments or small towns, even waterwheels, are many. We are glad to see an optimistic article on the power to be derived from running streams appearing in the September issue of *Cassier's Magazine*. Mr. Sylvester Stewart, in the course of his remarks, justly observes that "a running stream may be compared to an endless driving belt, only awaiting connection to the machinery it is capable of driving, but it has not been appreciated because we have become so familiar with it; if it had suddenly been discovered, doubtless it would have been harnessed immediately." This is quite truly observed. Moreover, we have to reckon with the innate conservatism of persons possessing vested interests. They are only too often wilfully blind. Circumstances may compel attention. As Mr. Stewart says, "coal smoke mars a town, but hydraulic machinery is not unsightly; coal is passing away, but water flows continuously. A hundred thousand horse-power may be taken from a river and its place is still filled, but the coal vein, once emptied, is emptied for ever." We cordially endorse the observation that though "the great waterfalls are limited in

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number, and many of them remote from civilization, the power in the running streams is available and at hand." The early realisation of the soundness of this argument would make our industrial future all the brighter and more secure. We are culpable spendthrifts in our dealings with national resources, a characteristic failing with selfish mankind, but a failing which the governments of other countries are doing their best to check in their own peoples. We see this in the United States, with its Joint Committee of Conservation, which, while turning its attention to questions of forest domains, is also keeping a close watch on water-power. On the Continent of Europe the governments of France, Italy, Germany and Austria take a paternal interest in the exploitation of these native streams for purposes of power production, and now comes evidence of the importance of the subject from Norway. Indeed, that democratic country, with its strongly developed appreciation of what constitutes the commonweal, has somewhat startled the industrial world with its latest law for the conservatism of natural riches. This measure has been enacted to regulate the future management of water-power. All waterfalls of a capacity of 1,000 h.p. or more are declared national property, and can only be utilised under a concession, granted for from 60 to 80 years. After the expiry of the concession, the waterfall, together with all engineering and mechanical regulating works are taken over by the State without compensation. There is a permissive clause which makes it possible for it to be decreed that power stations and their equipment shall also be taken over by the State without compensation, while other works connected therewith may be acquired on valuation, or their removal imposed by a certain stipulated date. Efforts were made to alter the figure in the Act from 1,000 h.p. to 3,000 h.p., but unsuccessfully, while others endeavoured to cover all forms of water-power. It is a somewhat hard law. But it demonstrates the immense importance attached to the subject by a people who have of late made wonderful strides in the industrial world, and not the least in the electrical side of enterprise. It should induce us to turn our attention more seriously to what water-power we do possess.

SOURCES OF ERROR IN ELECTRIC INSTRUMENTS.

Attention is drawn by J. F. van Lonkhuyzen in the *Elektrotechnische* to a simple source of error in electric instruments which is frequently overlooked, though quite understood. It is the static charge of the cover-glass of the instrument. The longer the pointer, the nearer it is to the glass, the drier the atmosphere, and the feebler the directive force of the instrument, the greater will be this error. By drawing a piece of soft leather across the glass of a galvanometer Lonkhuyzen produced deflections up to 5 per cent. In a dry warm room instruments went wrong by as much as 20 per cent. when touched with the dry hand. These deflections are not lasting, of course, but it may be an hour before the pointer indicates correctly again. When making comparisons with mirror instruments the error may become pronounced, because the glass is cleaned to wipe off the dust. Particular care has to be exercised in this respect in the workshop, especially with suspended instruments. There is, fortunately, an easy preventive—breathing upon the glass. Faulty indications may also result when the instrument is joined to the secondary of an insulated transformer. The secondary may have a static charge sufficient to upset the instrument.

ELECTRICAL SIGNALS IN MINES.

Messrs. A. A. Atkinson (Chief Inspector of Coal and Oil-Shale Mines), and W. Humble (Chief Inspector of Collieries), New South Wales, describe in the *Australian Mining Standard* a system of signalling installed in the South Bulli Colliery by Mr. Sellers, the manager.

The usual signals for an underground endless ropeway system where coal is attached to a rope at a number of landing stations requires the use of a code embracing the provision that when it is desired to stop the rope, the wires must be brought in contact, and so maintained for the whole time that it is necessary to stop the rope.

A long stop at any one station requires the Leclanché batteries to yield current during all this time, in order to maintain the continuous ringing of the signal bells. This rapidly reduced the battery, and the renewal of the cells was frequently necessary. Of greater importance from a safety standpoint was that the weakening of the battery in this manner destroyed the efficiency of the system, and often, in consequence of derailments and other things incidental to mining haulage, the more or less constant ringing of the bells reduced the battery power to such an extent as to render it unable to transmit signals from the far end of the systems, the terminus of which is about $2\frac{1}{2}$ miles from the engine or motor houses. In practice, despite considerable care and testing of these batteries, some failures were experienced, due to the sal ammoniac solution creeping up the zinc poles and eating the connection between the poles and the line wires, etc. The contact tips of the bells gave frequent trouble in consequence of becoming carbonised from the unavoidable sparking when contact was made between the wires to operate the bells, the renewal of these tips was expensive, as platinum was required.

Apart from these defects in actual working, perhaps the weakest point in the system, is that in consequence of the varying power of the batteries, it is not possible to instal a tell-tale apparatus which would enable the engineman to know at which landing or other point the haulage ropes had been stopped. In common with other mines using endless ropes, boys are employed for the purpose of clipping and unclipping the skips or tubs to and from the ropes. These boys, from devilment or a desire for practical joking, can, and sometimes have, occasioned almost endless bother to the officials in tracing the cause of the stoppage, and, of course, this entails great loss of output—all that requires to be done to stop the rope is to bring the wires into contact. To get rid of these irregularities, consideration was first given to the question of installing a small direct current generator capable of yielding a constant pressure of about 15 volts, and thus replacing the batteries. But this scheme was set aside for what has proved to be a most effective and reliable application of alternating currents with a self-recording dial, indicating from which station the signal has been given, and is now in use for underground signalling purposes.

Current at 2,300 volts 60 cycles is generated at the power-house, and this is transformed down to 230 volts near the main tunnel mouths for the operation of motors and lights in the vicinity of the bank head. Two of the three wires of this three-phase supply at 230 volts are then tapped into a small transformer wound for a ratio from 220 volts primary to 15 volts secondary. The 15 volts pressure wires are led thereon to a 3 in. diameter alternating current bell and a voltmeter shunted off the same two lines on the transformer side of the signalling bell. A pilot light is wired between the mains going into the bell, and is placed near to it, and in the direct line of vision of the engine attendant. The principal advantage of an alternating current bell over those used from direct current lies in the fact that there are no contacts liable to get out of adjustment and repair. The system being charged with a supply current of constant value, and the signalling wires not being connected at any station underground, a condition which exists during the whole time the rope is moving, and the engine driver has before him a pilot light burning with the ordinary intensity due to 15 volts, and this is an incandescent lamp of 5 c.p. In the event of a breakdown at the main generating house—which has never yet happened—this pilot light would cease burning, when the

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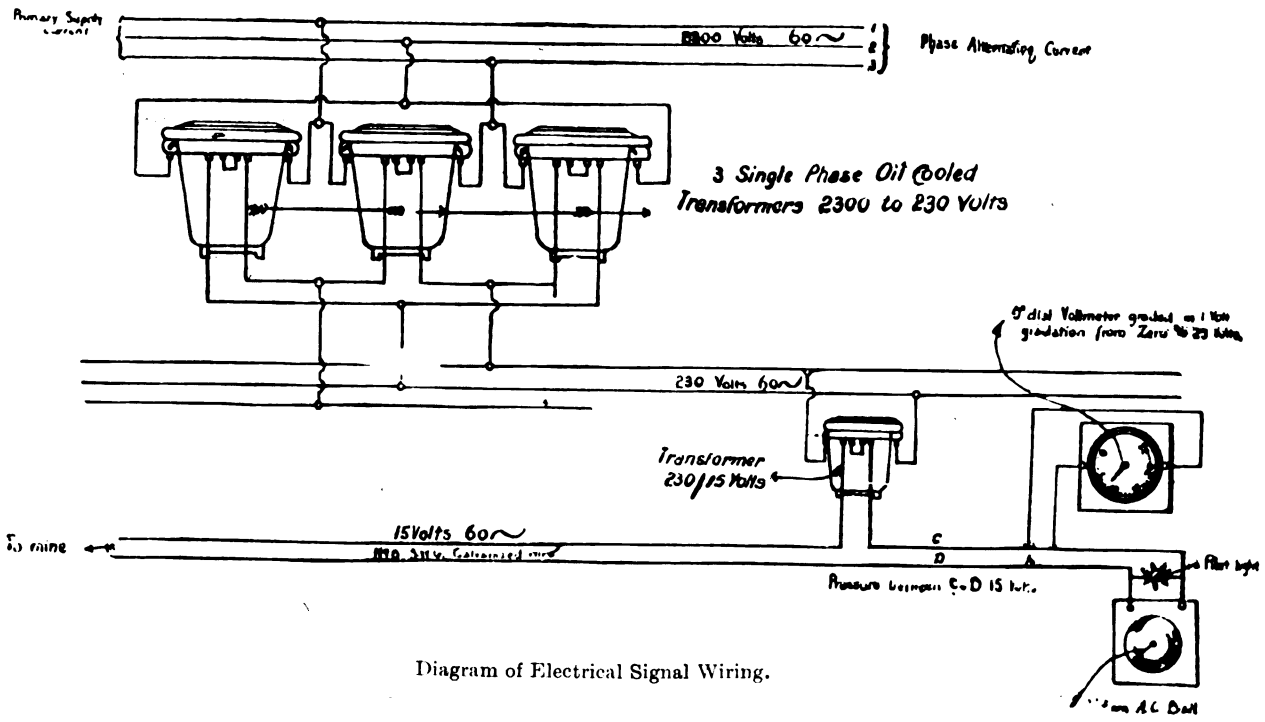

Diagram of Electrical Signal Wiring.

driver, knowing that his signal system had ceased to be operated, would stop his engine or motor immediately. The voltmeter shunted off the mains has a 9 in. dial and is graduated from zero to 25 volts.

The distance between each division on the voltmeter is fully ¼ in., so that unit volt readings are very legible. The signalling wires in use on all trunk systems is one pair of No. 6 standard gauge galvanised wire strung on insulators, and is for all practical purposes of uniform sectional area. The dial of the voltmeter just referred to has been marked at the colliery with certain points between zero and 15 volts indicative of the position that the needle of the voltmeter would be deflected to when the wires are brought into contact at the various landings, for the purpose of signalling to the engine driver. In the event of the patrol man on the system having to stop the rope at any point between any of the ordinary clipping on or landings in the mine, the swing of the voltmeter needle between such marked stations enabled the engine driver to know within very close limits the exact point where the signalling wires have been crossed and brought into contact for the purpose of stopping the rope. Five months' operation of this signalling system has demonstrated its reliability. Unnecessary stoppages of the rope have been very materially reduced, and the opportunities of lads to cause this are not now availed of as with the old system from the fear of detection and punishment.

The cost of the apparatus is rather more than the first cost of a Leclanché battery system. Taking into account that its upkeep is practically nil, and that its use involves no wear and tear, it is economically as well as practically a decided success.

The accompanying sketch shows diagrammatically the three wires carrying primary supply current from the main generators at 2,300 volts. These wires are brought into three transformers at this pressure. Current issues from the low tension side of the transformers at 230 volts for supply to mains and incandescent and arc lamps electric lighting at bank head. Two of the three wires of the low tension wiring, 230 volts, are brought into the small transformer, in which that pressure is, however, reduced to 15 volts to comply with the provisions of the special rules dealing with the use of electricity in mines, which require that the pressure in signal wires shall not exceed 15 volts in certain mines. The diagram shows the connection between the low tension side of this transformer "B" on sketch to the alternating current bell, and also the voltmeter.

During a storm the telephone bells in many business houses at Redhill were set ringing by the lightning.

DISTILLATION BY ELECTRICITY.

A novel application of electricity has recently been made at Vancouver, British Columbia, under the direction of Mr. F. T. Snyder, a Chicago engineer, in the installation of apparatus for the distillation of turpentine from the wood of fir trees. At Vancouver, says a correspondent to the *Times Engineering Supplement*, a considerable supply of fuel was available in the form of saw-mill refuse, while electrical energy was available at a low cost from the abundant water power. Following some experiments with a small plant, a commercial plant was erected, and has been in operation for two years, the capacity of which is three cords of wood per day. Mr. Snyder gives the following description of the plant and its operation. The wood supply is brought in by barge from neighbouring saw-mills and landed at a dock adjoining the plant. The wood is packed into cans which are wheeled into the plant, picked up by an overhead crane, and dropped into a brick retort, forming one of several others, which are placed together in order to avoid radiation. The top of the can forms a flange which fits into a groove around the top of the retort. This groove is filled with tar and forms a gas seal. Electricity at 110 volts is carried through wrought iron strips threaded through the brickwork on each side of each retort. The current supply for each retort is controlled by an ordinary switchboard which carries direct-reading pyrometers, which register the temperature outside the can and also at the centre, thus showing the *maximum* and *minimum* temperature conditions. The connexions of the pyrometers are flexible, and may be changed from can to can. The turpentine vapour is taken from the retort through a removable copper pipe leading to a condenser, consisting of an upright copper pipe down which a spray of water is passed through the ascending turpentine vapour, and terminating in a tank at the bottom. This serves as a separator for the condensed turpentine and water, the turpentine floating on the surface.

When a can is inserted the temperature of the brickwork is about 250 deg. C. Heat is rapidly absorbed, and the temperature is maintained by a current of 400 amperes, which is passed through for about two hours. When the temperature of the outside of the can has reached 150 deg. C. and the middle of the can about 295 deg. C., the turpentine has been substantially removed. In the process the pitch runs off and is collected in the bottom of the retorts. The greater heat in the middle of the can is due to the decomposition of hydro-carbons in the wood. At this stage the can is lifted and placed in the adjoining retort, and its place is filled by another canful of raw wood. The can from which the turpentine has been removed is then connected to another condenser, the temperature rises steadily without further application of electricity, and the decomposition gives off a product known commercially as tar oil. Another product is wood tar, which is collected in the bottom of the retort and drawn off continuously. At the end of three hours the oil and tar are extracted, the can is removed and allowed to cool on a sand floor, making an air seal. At this stage the contents of the can consist of charcoal. There are thus obtained five products from the wood waste, in about the following proportions per can of 1,000 lb. of wood:—Turpentine, 6·7 gallons; rosin, 168 lb.; tar oil, 5·1 gallons; tar, 68 lb.; and charcoal, 323 lb. The charcoal, having been cooled out of contact with the air, is tough and suitable for special purposes. The electricity used amounts to about 90 kw. hours per can and costs, at Vancouver, 9d. per can of wood. The plant is operated on two 12-hour shifts per day, one man to each shift.

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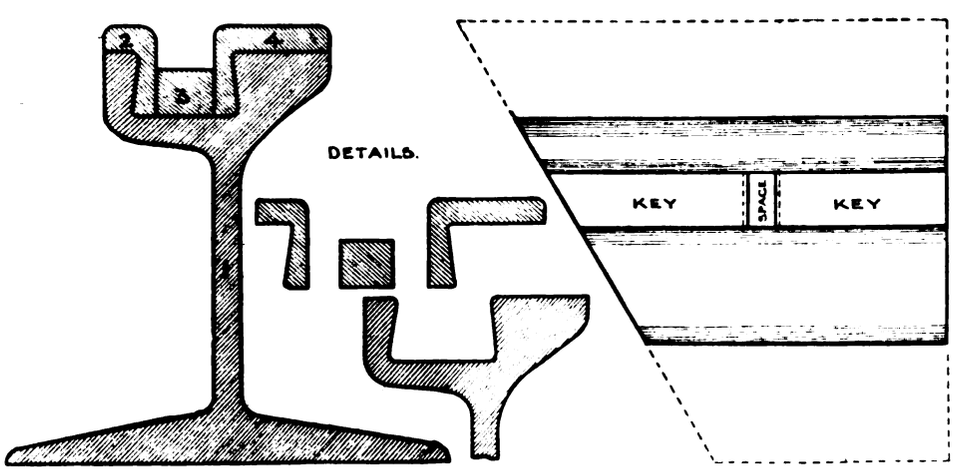
PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

IMPROVED RAILS AND BRAKES.

With the rapid development of tramway enterprise, the problems of reducing the cost of permanent way renewals and perfecting brakes have naturally claimed much attention in engineering circles. Two very interesting and ingenious inventions in these directions have come under our notice, and merit description.

The first is a new method devised for reducing the cost of repairs and simplifying the existing arrangements for the removal and renewal of defective rail (or rails) without materially disturbing the road, street, or other surfaces, or surfaces employed in or forming the construction of the permanent way as well as preventing interference with or stoppage of traffic. This end is attained by the employment of an interlocking and interchangeable rail built up in sections. By reference to the accompanying sketch, it will be observed that the rail is built in four sections, the part lettered 3 being a key securely fastening together the component parts of the built up rail.



The details, as shown, will make this clear and illustrate how the rail is constructed. The key marked 3 is inserted after the parts 2 and 4 have been fixed in position. The key is made in suitable lengths, and between each such length a space is left, as shown, to enable a crow-bar or lever to be inserted in order to remove the key in case of renewals or repairs. The rail joint is cut at an angle, as it is thought that in actual practice this will be conducive to smooth running and less vibration than would be the case if the ordinary straight joint was adopted. It is claimed that with the adoption of this system the present high charges for permanent way renewals would be reduced to a minimum. In addition, a tremendous amount of time and labour would be saved with little or no interruption of traffic, or disturbance of road surface, which is involved in carrying out the present system. Patent rights for this invention has been applied for by Mr. Thomas Lister Patchett, architect and surveyor, and Mr. Arthur Imbery, electrical engineer, of 34, St. Albans-avenue, Halifax, who are prepared to enter into negotiations with suitable firms for the exploitation and commercial development of this ingenious idea.

The other invention with which Mr. Imbery is interested relates to an improved slipper brake, patented by Mr. Nathan Greenwood, of Woodside Place, Akroydon, Halifax. The object of the invention is to construct the shoes of slipper blocks so as to dispense with the present means of attachment, and form the shoe and block, so that the shoe or shoes may be taken out and replaced by the driver or conductor when necessary. Another feature claimed for this system is that the durability of the shoe is greatly increased. The slipper block and shoe are so mounted upon the car that its supporting and operating machinery is out of the way of any obstacle, and is more direct and quicker in its action; consequently, it has greater power, dispenses with the present levers, rods and pins, angle plates and shafts, prevents side play or twisting of the slipper block, keeps the same parallel with the rail, and allows the shoe to accommodate itself to the gradient of the track. A set of these brakes has been tested on a car with satisfactory results by the Electric Railway & Tramway Carriage Works, Ltd., of Preston, and no fewer than 25 tram drivers in the employ of the Halifax Corporation report that they have used Mr. Greenwood's patent brake and found its work "very satisfactory." In the illustrations accompanying the description, Fig. 1 represents a side elevation of this improved shoe and slipper block, showing them attached to the plunger arm. Figs. 2 and 3 are a plan and transverse section of Fig. 1. Fig. 4 is a side elevation of the improved brake mechanism, and Fig. 5 is an end eleva-

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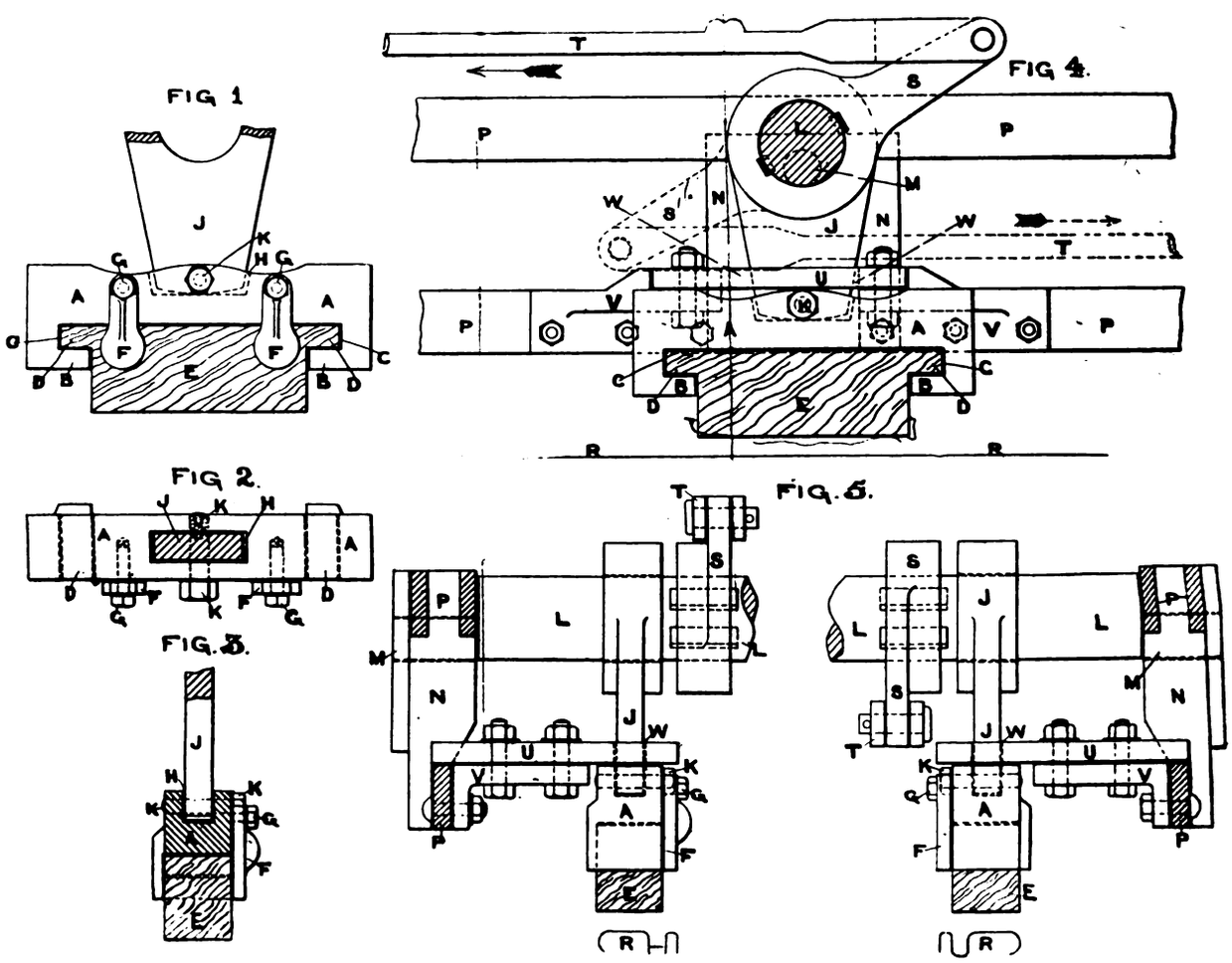
tion of Fig. 4. Mr. Greenwood constructs the improved slipper block A of the ordinary section with a lug or projection B upon its underside. Each lug B has a suitable recess C within which fits a corresponding projection or lip D of the shoe E. The depth of these recesses correspond with the width of the shoe, so that when the latter is placed within the slipper block its sides are flush with the sides of the block. He also attaches to the slipper block suitable hinged or pivotted flaps or stops F, pivotting upon set screws G. When the shoe is placed within the block, these flaps are moved upon their pivots G into a vertical position, the screws are then tightened, making the flaps rigid, so holding the shoe firmly in position within the block. The wood shoe E projects a suitable distance below the slipper block A, and may be easily and quickly removed and replaced by simply slackening the set screws and



moving the flaps sideways, sufficient to allow the shoes to be withdrawn. In mounting the slipper blocks and shoes upon the car he preferably employs one upon each side of the car and centrally situated. The slipper block A has a suitable recess H upon its upper surface, within which fits one end of a plunger arm J, the block being held in suspension upon the arm by means of a bolt or pin K. The block and shoe not being rigid on account of the arms J having slightly rounded ends, accommodates itself to the different gradients. Two of these plunger arms are mounted upon a roller I. passing transversely underneath the car. This roller is eccentrically mounted upon suitable gudgeons or necks M, carried or supported in bearings N, bolted to the top and bottom side rails P of the undercarriage of the tramcar. These plunger arms are loose upon the roller, and placed so as to suspend the slipper block and shoe immediately over each tramline or rail R. Adjoining each plunger arm and keyed upon the roller is a crank arm S. The arms project in diametrically opposite directions from the centre of the roller in order to facilitate the operation of the roller from either end of the car, either separately or simultaneously, as desired. These crank arms are attached to connecting rods T passing to the back and front of the car, and are operated by the driver or conductor from one or both ends of the car in the direction indicated by arrows. In order to steady the plunger arms or prevent them from moving from a position immediately over the tramlines or rails, the inventor preferably employs a plate U upon each side of the car mounted upon an angle iron or plate V bolted to the bottom rails of the car. This plate has a slot W, through which passes the plunger arm. These slots are larger than the plunger arm, sufficient to allow of the free traverse of the arms during the throw of the roller when putting on or taking off the brakes. The plates U also act as buffers for the arms J, or, when convenient, in the place of the plate U and its supports, it is possible to fix a collar—not shown—upon each side of the boss of the plunger arm. so as to prevent any movement of the arms longitudinally upon the roller. In action, the connecting rods T are operated from either end of the car in the direction indicated by the arrows, moving the eccentrically mounted roller upon its gudgeons or necks and lowering the plunger arms in order to bring the slipper blocks into contact with the rails, and so apply a brake to the car. The action of the crank arms and eccentrically mounted roller exert a sort of double leverage, enabling enormous pressure to be applied to the plunger arms and slipper blocks, so producing a most effective brake.

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TYNESIDE NOTES.

(From Our Correspondent.)

NEWCASTLE.

Electrical affairs in Newcastle and the surrounding industrial area are not for the moment excessively brisk. It takes a considerable time for general trade to recover from the effect of two such severe strikes as those which occurred recently among the shipbuilders and engineers, and the pessimists are predicting trouble at the beginning of next year when the new Mines Act comes into operation in Northumberland and Durham. So acute is the apprehension, that it is reported that some of the power supply companies in this area are storing coal, purchased by their larger consumers, for use in the power house should a strike occur.

The general situation is, therefore, not very good, but in spite of this, colliery electrification appears to be in progress. Both Messrs. Callenders and the British Insulated and Helsby Cable Co., are at present erecting pole lines for the transmission of electricity at 6,000 volts to various collieries in the area, and the latter company appears to be making quite a feature of aluminium conductors for overhead transmissions. During the past month, for example, a quantity of about six tons of stranded aluminium cable, consisting of 37 strands of ·107 conductors, has been supplied to a local colliery. An interesting material which the British Insulated Helsby Cable Co., are pushing at present is the Monnot patent copper clad steel wire. This is finding a use in telephone systems and shaft signalling connections for colliery work, and in view of its uses it may be worth while briefly describing the material. It is made by welding a coating of copper to a steel ingot, which is then rolled into a rod and drawn to the proper size of wire. The proportion of copper and steel existing in the original ingot remains practically constant even after drawing. As hard drawn copper wire has its greatest proportion of strength near the surface of the wire a transverse cut or scratch decreases its tensile strength. On the other hand, steel, though possessing great strength, has only a conductivity of 15 per cent of copper. Galvanised steel wire corrodes in a fairly short time. Monnot wire for electrical purposes is, approximately 40 per cent conductivity of pure copper, and for the same size, copper clad wire is lighter than pure copper wire, the former having a length of 7½ per cent. greater than the former, weight for weight.

A rather interesting development in connection with the rolling stock on the electrified portion of the North Eastern Railway's system in and around Newcastle, is the use of a comparatively new fireproof flooring in the passenger cars called "Terrano." This is a secret mixture of a stone-and-wood composition, which is laid in a plastic state and well trowelled. Seven coaches have up to the present been laid with this flooring, and as each floor has an area of 60 sq. yds., laid without joint, the interest of the process is obvious. The material appears to be sufficiently elastic to withstand the heavy vibrations set up in the coaches when travelling. In addition to its fire-resisting properties the material appears to have good insulating properties, as it sets into a very hard and dry condition.

Among recent signs of the resuscitation of Tyneside engineering may be mentioned the fact that Messrs. Clarke Chapman and Co., Ltd., have recently secured some very large and important order for their "Woodeson's Patent" water tube boilers. Among these are an installation for South Africa, a large repeat order for Messrs. Strakers and Love, of County Durham, and an order for the Admiralty, and the order for the new station for the Bury Corporation Electricity Works. The most recent of the series is a repeat order for a large boiler installation for the Yorkshire Electric Power Co.

One of the latest additions to the equipment of the Tyne is a 150 ton electrically-operated Titan crane erected by Sir William Arrol and Co., Ltd., of Glasgow, for the North Eastern Marine Engineering Co., Ltd., of Wallsend. It consists of a square tower, 125 ft. high and 40 ft. square at the base, carrying a ring of live rollers up, in which a horizontal jib, 245 ft. long, is supported. The long arm of the jib has a total radius of 150 ft. This jib has slewing gear to revolve it in either direction, racking gear and separate lifting motions for the main and auxiliary hooks. The separate main lift has a speed of 5 ft. per minute, with a load of 150 tons and 7½ ft. per minute with 100 tons; the auxiliary lift operates on 30 tons at 13½ ft. per minute, and 7½ tons at 50 ft. per minute. With a load of 550 tons the crane is racked at 40 ft. per minute, and slewed one revolution in 10 minutes, while with a 30 ton load it can be racked at 100 ft. per minute, and slewed at one revolution in 5 minutes. The operators cabin, containing the controllers and resistances, is placed on the right hand girder of the jib and has porjecting windows so that a clear view is obtained of the load at all times. It is connected to the machinery house by speaking tubes and to the ground by telephone. All the motions are actuated by motors made by the British Westinghouse Electric and Manufacturing Co., Ltd. For convenience, these are of the same size throughout, being all 50 b.h.p., running at about 380 r.p.m., and worked on direct current of 480 to 500 volts. Two of the motors, arranged to work in series or parallel, operate the main hoisting gear. In the cabin is an ingenious indicator to show the radius at which the "jenny" is working. This indicator has a glass front behind which lamps are placed. The lights of each appear and disappear as the jenny moves down the jib.

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IRON AND STEEL INSTITUTE MEETINGS.

ELECTRICAL SUBJECTS FOR DISCUSSION.

Much that is of interest to the electrical world will come under discussion at the Autumn meeting of the Iron and Steel Institute, which is to be held in London on September 27 to 30 and October 1. The venue of the general meetings will be at the Institution of Civil Engineers, Great George-street, Westminster. Of the eleven papers offered for reading, a good proportion deal with subjects of special interest to the electrical industry. Mr. C. A. Ablett (London), has promised to speak on the determination of the power consumption of reversing rolling mills, Disponent E. J. Ljungberg (Falun, Sweden) will read a paper on "The refining of steel by electricity"; Dr. J. Newton Friend (Darlington) will deal with "Corrosion of iron"; and Mr. R. Price-Williams (London) is to introduce the question of the maintenance and renewal of permanent way. Members attending meetings will have the opportunity on the afternoon of September 28, of visiting the works of Messrs. Siemens Bros. and Co., Ltd., Woolwich, the Royal Arsenal at Woolwich, the works of Messrs. Fraser and Chalmers, Ltd., Erith, and the London County Council's electric generating station at Greenwich. The following day alternative visits will be made to the National Physical Laboratory at Teddington, and the Motor Car Works of Messrs. D. Napier and Son, Ltd., Acton, and in the evening the members and ladies accompanying them will be entertained informally at a dinner given by the Reception Committee at the Trocadero Restaurant, Shaftesbury-avenue. Sir Hugh Bell, Bart., is the President of the Institute, the President-Elect being the Duke of Devonshire.

We understand that the next International Congress of Mining, Metallurgy, Applied Mechanics and Practical Geology, will meet at Düsseldorf during the last week of June next, under the auspices of the Rhenish-Westphalian Mining Industry. An influential Committee of Organisation has been formed to make arrangements for the reading and discussion of papers, visits to places, of technical interest and social entertainments.

CORRESPONDENCE.

STREET LIGHTING ABROAD.

SIR,—In view of the report presented by the deputation of the Streets Committee of the Corporation of London, who recently visited the Continent, were were surprised to find at our visit to Berlin a few days ago that the principal street, such as Unter-den-Linden, Friedrichstrasse, Leipzigerstrasse, Potsdamerstrasse, etc., corresponding to Regent-street, Oxford-street, Piccadilly, Strand, etc., were lighted by Arc lamps (white flame), mostly suspended in the centre of the streets on span wires fixed to the buildings, and with automatic contact lowering gear with arrangements for drawing to the side for trimming.

Only the less important streets were lighted by gas, and judging from the effect, we can only imagine that the Berlin City Fathers, being progressive (as shewn by the beauty of their charming city), are not likely to take the retrograde step of putting in more gas lighting than they can possibly help.

With regard to the recommendations that all lamps (both gas and electric) shall be on lowering gear, we pointed out some months ago that our lowering gear is equally applicable to gas as to electric light by the substitution of a gas connection for the usual electric coupling, and there is no difficulty to us in dealing with this problem either for swan neck poles, centrally hung carriers, or cross street suspension gear.

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CONTRACT.

CITY OF DUBLIN ELECTRICITY SUPPLY.

The Lighting Committee of the Corporation of the City of Dublin are prepared to receive Tenders for the supply of the following:—

750 Alternating Current Meters, Single-phase.

Specification, with Terms and Conditions and Form of Tender, may be inspected at the Office of the City Electrical Engineer, Fleet Street, Dublin, on and after Tuesday, 31st August, and may be obtained from the latter on payment of £1 0s. 0d., which sum will be refunded on the return of the Specification, filled up, with a *bona fide* Tender.

Tenders (sealed and marked "Tender for Electricity Meters") must be addressed to "The Chairman, Lighting Committee, 3, Cork Hill, Dublin," and be delivered not later than 12 o'clock noon on Monday, 13th September.

Each Tender must contain the names of two Sureties who will be prepared to execute a joint and several bond for the due performance of the Contract in a sum of 20 per cent. of the Contract price.

The Committee do not bind themselves to accept the lowest or any Tender.

FRED J. ALLAN, Secretary.

Lighting Committee's Offices,
3, Cork Hill, Dublin.
28th August, 1909.

PATENTS.

PATENTS AND DESIGNS ACT, 1907.

NOTICE IS HEREBY GIVEN that the British Coalite Company, Limited, of 3, London Wall Buildings, London, E.C., Manufacturers and Merchants, seek leave to amend the Specification of Letters Patent No. 25631 of 1896, granted to Thomas Parker, F.R.S.E., M.Inst.C.E., etc., of the Manor House, Tettenhall, near Wolverhampton, in the County of Stafford, Engineer, for "Improvements in the means employed in the Electrolytic Production of the Chlorates of Sodium and Potassium."

Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), issued on the 25th August, 1909.

Any person, or persons, may give notice of Opposition to the Amendment (on Patents Form 18), at the Patent Office, 25, Southampton Buildings, London, W.C., within one calendar month from the date of the said Journal.

W. TEMPLE FRANKS,
Comptroller-General.

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Agents for the Applicants.

THE PROPRIETOR of PATENT No. 19979, of 1904, for "Improvements in Magnetic Wheels for Electro-Magnetic Motors," is desirous of entering into arrangements by way of licence, and otherwise, on reasonable terms for the purpose of exploiting the same, and ensuring its full development and practical working in this country.

All communications should be addressed in the first instance to HASELTINE, LAKE & CO., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

TO MAKERS OF ELECTRICAL HEATING APPLIANCES.—The PROPRIETOR of PATENT No. 14256105 for "Electric Heating Cartridges" is desirous of having the same manufactured under licence or otherwise in this country in accordance with the terms of the Patent Act, 1907.

Communications, in the first instance, to be addressed to H. D. FITZPATRICK, 100, Wellington Street, Glasgow.

TO ELECTRIC LIGHT ENGINEERS.—The OWNERS of the Patent No. 23,501, 1899, relating to "Improvments in Vacuum Tube Lighting," and the Patent No. 12,582, 1902, relating to "An Improved System of Electric Lighting," desire to negotiate with Electric Light Engineers with the view of granting licences under them on reasonable terms.—For information apply to MESSRS. LLOYD WISE AND CO., Chartered Patent Agents and Consulting Engineers, 46, Lincoln's-inn-fields, London, W.C.

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SESSION OF 1909/10 (COMMENCING SEPTEMBER 27th, 1909).

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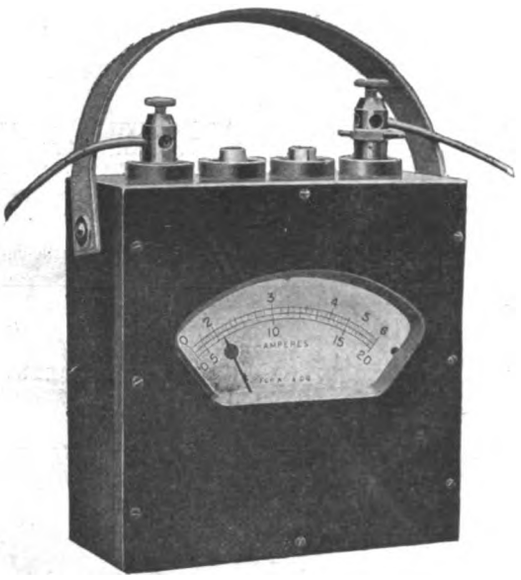

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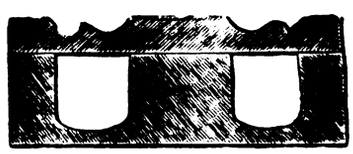

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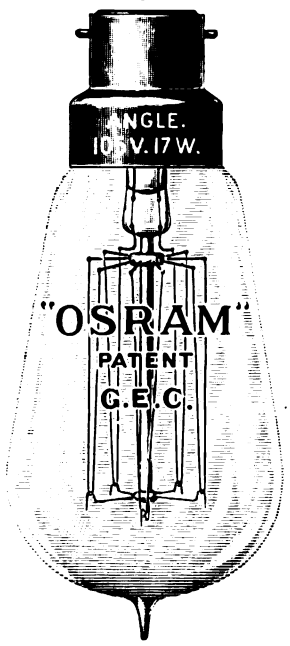

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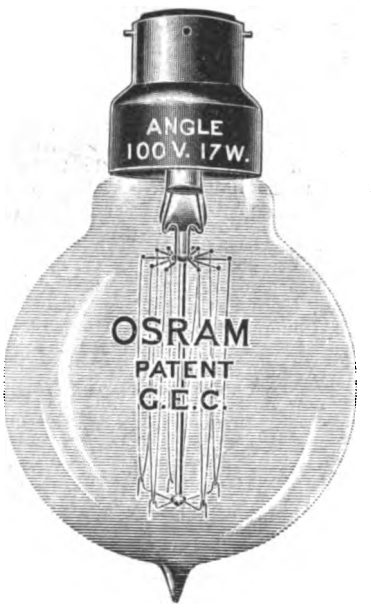

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ELECTRICITY IN THE HOME.

Some highly interesting details concerning the progress of domestics electric lighting in Detroit were given by Mr. F. T. Mather, of the Edison Illuminating Company, in a paper read at the recent Electric Light Convention at Ohio. It seems that Detroit, with a population of about 360,000, has 13,000 homes lighted with electricity. Electricity has no competitor in the high-class residences, little in the moderate-priced homes, and considerable business is secured among the owners of small cottages. Few homes are now built without electric wires. The proportion of old houses wired for electricity is increasing every year. The rapid growth of this class of business dates from 1898, when the present Detroit residence rate was adopted. Its peculiarity lies in the method used in determining the amount to be charged monthly to each consumer at the primary rate, which is 14 cents per kw-hour. The amount so charged is 2 kw-hours per month for each room counted. Unfinished attics, storerooms, laundries, closets, bathrooms, stairways, halls, servants' rooms, kitchens, pantries, porches and vestibules are not counted. Before adopting this method the Detroit company ascertained by observation that the number of lamps likely to be burned at the hour of the district maximum was actually very closely proportional to the number of these living rooms which are taken as the basis of primary charge. The secondary charge for electrical energy used in excess of 2 kw-hours per room counted is 4 cents, and fans, flatirons, disk-stoves and cooking devices are not counted on the demand charge, thus giving the customer the advantage of this low secondary rate for such devices.

The occupants of modest homes are desirous of electricity not only for lighting, but for the saving devices operated with electricity. One concern selling washing machines has placed 450, mostly in houses where the laundry work is done by members of the family. Between 7,000 and 8,000 flatirons are in use on the company's lines. The average monthly revenue from a flatiron is estimated at about 50 cents. In the higher class of houses the vacuum cleaner is coming into general use. The owner of a building is usually quick to appreciate the saving on decorations and furnishings when electric light is used; and, quite unsolicited by the Electric Light companies, some of the Detroit real estate dealers with large rental lists are inserting a clause in their leases providing for the exclusive use of electric lighting in their rented residences. A display room in connection with the company's main office is in charge of competent clerks, who explain to visitors the uses of electricas appliances that may be employed in the home. Sales of thil merchandise amount to about $10,000 a year.

From a central-station standpoint the company considers residence business very desirable. It has been found by studying several groups of residences at different periods that the ratio of connected load to the district demand is more than 4 to 1, and the company finds this ratio increasing as the practice of adding lamps in halls, basements, etc., becomes more common. The annual load factor of residence lighting is approximately 1,000 hours use of the maximum demand of the district. Mr. Mather also referred to a gasless town of 700 people, where there were 189 electric light users who found that form of illumination 50 per cent. cheaper than oil or gasoline.

ELECTRICITY AT CHOPWELL MINES.

A party of about sixty members of the North of England branch of the National Association of Colliery Managers, accepting the invitation of Mr. F. O. Kirkup, visited the Garesfield, Chopwell and Whittonstall Collieries, belonging to the Consett Iron Co., Ltd. Mr. Kirkup, resident manager for the Company, explained that at Chopwell Colliery electrical machinery had been installed to a large degree, and the erection of further plant was under consideration. The Towneley winning was wholly worked by electrical energy from Chopwell. The ventilation underground was by electrically driven fans of the Sirocco type. The electrical energy was generated at present by high pressure reciprocating engines, but these were being augmented by means of an exhaust steam turbine of 1,000 h.p. capacity now in course of construction, and provision was likewise being made for a duplicate set. With a view of meeting the extra expense likely to be incurred by the operation of the Eight Hours Act, a third pit was now being sunk about three-quarters of a mile to the west of the existing pits, and the new pit would be entirely generated by electrical current. The central or main generating station, which came in for a large share of attention, and was described by Mr. Field, the Company's electrician, would be equipped eventually with two direct current 200 kw. reciprocating sets for generating electric current for electric locomotives, two sets 325 kw. capacity generating current at 625 volts, and two 1,000 h.p. exhaust steam turbine sets generating current at 5,000 volts. The 230 coke ovens were loaded by means of an electric loading car. The winnings at Whittonstall are connected with Chopwell by a narrow gauge railway, upon which electric locomotives travel. The line is equipped with double overhead cables, and the locomotives are capable of hauling a load of 25 tons up heavy gradients, each handling 250 tons daily. High tension current at 5,000 volts pressure is sent from the main station.

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Mr. Henri Reeser's "Celloline" is a material that has an even wider range of possibilities than celluloid itself, but above all, it possesses the invaluable property of being non-inflammable. Of course, if placed directly into a sustained flame it will be burned, but the combustion is very slow. As a matter of fact, it smoulders, and unless kept directly in the flame soon extinguishes itself. We have handled this substance in various forms, such as photographic films, transparent and opaque sheets, and various fancy articles. For the electrical engineer this "Celloline" has great interest, because its possibilities are great and manifold. It will give us sheets of any dimensions, both transparent and coloured. It can be moulded, and can be used in the form of a varnish. It, therefore, will take the place of celluloid, giving the requisite safety which this does not possess, and in many instances can be used as a substitute for vulcanite. Certainly such a substance is admirably adapted for the manufacture of storage battery cells, caps for switches, and so on. We have examined copper wire of very small gauge insulated with "Celloline" enamel, which withstood a current of 40,000 voltage, the insulation being less than one-tenth the thickness of ordinary silk covering. We are assured that this non-flammable "Celloline" can be made cheaper than the combustible celluloid. It has greater tensile strength, and, being absolutely safe, can be employed for very many purposes for which the inflammable celluloid is quite unfitted. Apart from the electrical applications above referred to, the non-flammable "Celloline" may be applied to the following among many other purposes:

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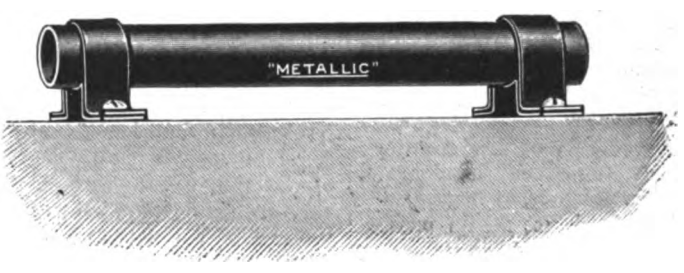

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NOTES ON CONDENSING AND WATER COOLING PLANTS*

By F. LUNN.

The condensing plant has always been an important part of a steam-power installation, and since the introduction of the steam turbine the importance of this portion of the equipment has been greatly increased. In the case of steam turbines, condensing plant is essential: and, in the majority of cases, condensing plants can be used with advantage in connection with reciprocating engines, although it is impracticable to utilize a high vacuum to its full value in this class of prime movers. There are, of course, cases where owing to the small load factor, or the small maximum output of the plant, the saving due to condensing would not pay for the additional complication and capital charge on the plant.

The chief points to be taken into account when considering whether it would be advisable to install a condensing plant, are the load factor, *i.e.*, number of h.p.-hours per annum divided by 8,760 times the maximum h.p., and the cost of obtaining condensing water. The load factor may in some cases be so low that even with an unlimited supply of cold water conveniently situated it would not pay to put in condensing plant, while on the other hand with a load factor in the neighbourhood of 80 or 90%, the saving in fuel by the use of condensing plant would more than pay for the most expensive kind of water-cooling apparatus.

As a general rule, it is not worth while installing condensing plant unless the saving to be effected thereby will amount to more than 10% on the cost of such plant, as about that amount would be required to cover the cost of interest, depreciation, repairs and attention. Assuming a condensing plant would cost £14·50 per kw., and the cost of fuel and water to be 8 cts. per kw.-hour, and assuming that the plant effects a net saving in fuel and water of 16% (it is assumed that the steam consumption is reduced by 20%, and that the steam required by the condensing plant amounts to 4%), then the saving in cost of fuel and water would equal 10% on the cost of the condensing plant (8% for interest and depreciation, and 2% for repairs), when the load factor amounted to 13% (*i.e.*, when 1,140 kw.-hours were generated per kw. of plant per annum).

By installing condensing plant, the maximum output of the engines would be increased by about 20%, and in some cases this might be a valuable consideration, but neglecting the increased output of the engines and assuming the above data to be correct, there would be nothing to be gained by the installation of condensing plant, unless the load factor exceeded 10% where cheap condensing water was at hand, and 13% where cooling towers had to be used.

Types of condensers.—The following types of condensers are in more or less general use: (1) Surface; (2) Evaporative; (3) Parallel Flow Jet; (4) Counter-current Jet Low-Level; (5) Counter-current Jet Barometric; (6) Ejector.

A surface condenser consists of a number of brass tubes fixed in end plates: the tubes being arranged in such a manner that the circulating water passes through them, and condenses the steam which comes in contact with their outside surfaces. The most efficient arrangement is for the circulating water to enter the tubes where the temperature is a minimum, and discharge at the point of maximum temperature. This is known as the counter-current principle, and in some of the recent condensers this principle has been elaborated.

In an evaporative condenser the exhaust steam passes through a series of pipes (preferably of cast iron) so arranged as to afford a large radiating surface. These pipes are situated in the open air, and a stream of water is allowed to trickle over them, the latent heat of the steam being dissipated by the evaporation of this water.

The parallel flow jet condenser is usually of the peg top shape, and receives the steam and water at the top. The air flows through the condenser in the same direction as the water, the one pump dealing with both air and water.

Counter-current jet condensers receive the injection water at the top, while the steam enters near the point at which the injection water discharges. The former passes over and through a series of baffle plates on its way to the discharge pipe, thus effecting a thorough mixing of the steam and water. The air is drawn from a receiver placed near the injection water inlet, and so occupies the least volume.

A low-level counter-current jet condenser obtains its injection water by means of atmospheric pressure, a float regulating the supply. A pump is necessary to effect the discharge, but the same pump will also lift the water to the top of a cooling tower if necessary. The maximum allowable difference between the injection water level and the injection water inlet is 16 ft. to 18 ft.

The barometric or elevated counter-current jet condenser is one in which the condenser is placed at such a height that the water will drain away without the aid of a pump, the end of the discharge pipe being water sealed. The height at which the condenser must be placed is determined by the vacuum desired, and upon the fact that for each pound per sq. in. below atmospheric pressure a height of water equal to 27·68 ins. is required, or for 14·7 lbs. per sq. in. atmospheric pressure a height of 33·9 ft. A circulating pump is required to lift the injection water to such a level that atmospheric injection becomes possible.

An injector condenser consists of a cast-iron chamber fitted with a condensing tube containing one or more jets. The head of water entering at one end of the condenser creates a vacuum in the condenser chamber, into which the exhaust steam, entering at the side, is drawn, the mixture discharging at the opposite end.

The ideal condenser, of course, is the one in which the condensing water attains the same temperature as the steam in the condenser, for the amount of condensing water is then reduced to a minimum, and the temperature of the water in the hotwell is the highest obtainable.

Efficiency of condensers.—The efficiency of a surface condenser is governed by the amount of heat transmitted per unit area of surface in a given time, from the exhaust steam to the water. The result of the heat having to be transmitted through metal surfaces, is that the temperature of the condensing water in an ordinary type surface condenser seldom approaches nearer than 15° F. to that of the exhaust steam, approximately three times the difference obtained in a counter-current jet condenser, in which no metal intervenes between steam and water. When this subject was before the association some years ago, it was stated that the possible theoretical gain from the absence of metal casing between the hot steam and the cold water would not work out at one-tenth of 1%.

Where water is plentiful and siphonic action can be obtained, the difference in the power required by a larger or smaller amount of water is practically negligible, but where the expense of obtaining condensing water necessitates the erection of a cooling tower, to the top of which the water will require to be lifted, the difference is appreciable.

Consider the case of a condenser capable of creating a vacuum of 27 ins. with condensing water at 80° F. The temperature of steam at an absolute pressure equal to 27 in. vacuum is 114° F., and the total heat of dry saturated steam at this temperature is equal to 1,116 b.t.u.

If the difference between the temperature of the exhaust steam and condensing water is 15° F., the discharge temperature will be 99° F. (*i.e.*, 114—15), and each pound of water in passing through the condenser will receive an amount of heat equal to (99—80 =) 19 b.t.u.; therefore the amount of water necessary to condense 1 lb. of steam = (1,116—99)/19 = 53·5 lbs.

On the other hand, where a difference of only 5° F. exists, which gives a discharge temperature of 109° F. (*i.e.*, 114—5), the heat received by each pound of water equals (109—80 =) 29 b.t.u., and the amount required to condense 1 lb. of steam = (1,116—109)/29 = 34·71 lbs., thus showing the amount of water in the former case to be 54% more than the amount required in the latter, and this is the ratio of the powers required by the circulating pumps in the two cases. The higher the vacuum and the inlet temperature of condensing water, and the more

* Paper read before the Incorporated Municipal Electrical Association.

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marked does this difference become. In addition to the extra power required in the first case, the increased capacity of the cooling tower, pump and pipes means a corresponding increase in the capital expenditure.

The effective transmission of heat through the metal surfaces is adversely affected by the oil held in suspension by the exhaust steam being deposited on the surface of the tubes during the process of condensation, and by the amount of air in contact with the tubes.

The evaporative condenser is a type of surface condenser brought into use in central stations some 12 or 15 years ago to meet the difficulty of limited water supply, as the amount of water required is very small. The actual weight of water required to condense 1 lb. of steam is variously stated at from 0·75 to 10 lbs. Air and circulating pumps are necessary, but as the quantity of condensing water is so small the total power required is comparatively small.

This type of condenser is unsuitable for high vacua, as the position of the condenser outside the engine-room necessitates a long line of exhaust pipe, and the number of joints where a leakage may occur is considerable. Corrosion of the pipes may be prevented to a large extent by periodically passing a small quantity of oil over them.

A parallel-flow jet condenser with wet air pump is a most inefficient type of condenser, as the steam comes at once into contact with the coldest water, and the bulk of the condensing takes place immediately, with the result that little further rise of temperature takes place as the water continues its way through the condenser. For a vacuum of 26 ins. the power required by the pumps when dealing with 12,000 lbs. of steam is 50% more than with any other type, and for higher vacua the increase is considerably more. For small powers, and vacua not exceeding 26 ins., the first cost is less than any other type of jet condenser.

The disadvantage of the low-level counter-current jet condenser is the remote possibility of flooding the condenser and exhaust pipe, due to the simultaneous failure of the float actuated throttle valve on the injection pipe, and of the emergency vacuum breaking valve. The author has, however, been in constant touch with a condenser working on these lines for the last two years, and has never known the slightest trouble from this cause.

The amount of condensing water is less than in the surface type, due to the high temperature of the condensing water discharge, for equal vacua, the relative gain being greater the higher the temperature of the condensing water, and the higher the vacuum required. In discharging the water from a low-level jet condenser the pump has to work against a head measured by the vacuum.

During a three hours' full load test on a condenser of this type designed to condense 20,000 lbs. of steam per hour and maintain a vacuum of 26 ins., an average temperature difference of 3·5° F. between the exhaust steam and the discharge water was maintained without difficulty.

The first cost of a plant of this size is from 70 to 80% of the cost of a barometric or surface type, the lower percentage where a cooling tower is required, and the higher percentage where water is obtained from a river or canal at a constant level.

A barometric counter-current jet condenser requires an expensive steel structure, and strong foundations for its support; the exhaust pipe is long, and the expense of erecting the plant is large. Against these disadvantages, however, must be set the advantage of the barometric action, derived from the elevated position of the condenser.

Under no circumstances will the atmospheric pressure cause the water in the discharge pipe to rise so high as to reach the exhaust range. The only way in which water may reach the exhaust range is when more water enters the condenser than the discharge pipe is capable of draining away. This may be brought about by a sudden increase in the speed of the pump when working at a high vacuum. If the area of the discharge pipe and the height at which the exhaust pipe enters the condenser, are correct, the possibility of flooding the exhaust range is very remote.

The plant is rather simpler in operation than the low-level type, and the power required to drive the pumps is practically the same in each case. The first cost of a plant of this type is practically the same as a surface type in the smaller sizes, but in the larger sizes the cost is considerably less. When comparing the horizontal and vertical types of counter-current jet condensers, the extra head of water required in the vertical arrangement must be taken into account.

An ejector condenser gives the best results when provided with an ample supply of cold water with a natural head, as it then becomes an exceedingly simple plant, requiring no moving parts in the form of air or circulating pumps. These conditions are seldom available, and in practically all cases a centrifugal pump must be provided, in order to obtain the necessary head of water.

The author's experience of ejector condensers is that the injection water must be as free from air as possible, and that best results obtain where the water is pumped into a tank, providing 15 ft. to 20 ft. head at the injection inlet. This arrangement ensures a steady flow of water, and also allows any air to escape that may be carried forward by the water from leaky joints or the bearings of the pump.

Where a supply of water is obtained direct from a centrifugal pump, any air introduced in the above manner tends to break the column of water, and it is essential for the best working that the water be supplied in a constant unbroken column. The temperature of the water for an ejector condenser must be kept below 75° F., as at temperatures above this the water and power become disproportionately high.

As this type of plant works without an air pump, it is not as suitable for high vacua as the surface and counter-current jet type, but it may be used with advantage in stations with a low load factor, as the cost is considerably less than any other type.

Wet Air Pumps.—Formerly the most common type of wet air pump was the vertical single-acting bucket-pump, with foot, bucket and discharge valves. A more recent type is the Edwards pump, its special feature being the elimination of the bucket valves. The pump cylinder is so formed that when the pump bucket or piston reaches the bottom of its stroke, the inlet port of the cylinder is wide open, and the entry of the water and air is assisted by the splash produced by the bucket striking the water, the splash being directed in a proper manner. This splash device is the essence of the Edwards patent.

The former type is the most difficult to overhaul, the most costly to maintain, and the most liable to break down, all due to the large number of valves the pump contains. A higher vacuum can be obtained with the Edwards pump than with the older type mentioned, as the single-acting bucket pump requires a difference of pressure between the air pump and the condenser to cause the suction valve to operate. In an Edwards pump of a given piston displacement, the discharge capacity is less than that for a pump with bucket valves, because the inlet ports, being formed in the cylinder barrel, prevent the full length of the stroke being effective.

Dry Air Pump.—The two principal types of dry air pumps are the Edwards and the balanced slide valve types. In order to use the Edwards type as a dry air pump, a small supply of cool water is necessary to seal the bucket, but this water has the effect of keeping down the temperature of the air passing through the pump.

The balanced slide valve type is one in which the air admission to the cylinder is controlled by means of a slide valve, allowing a momentary connection between the two ends of the pump, as it reaches the end of each stroke. This action of coupling the two ends of the pump, has the effect of reducing the pressure of the air in the clearance spaces, and thus increasing the capacity of the pumps. This is shown by the larger area obtained on indicator diagrams.

Where it is desirable to have a specially high vacuum, two pump cylinders are sometimes used, arranged in series, as the effect of clearance is then still further reduced. Slide valve friction is the weakness of pumps of this pattern, and the pump cylinder requires water jacketing. It is necessary also to take special precautions against water entering the pump cylinder.

Where a more complete vacuum than about 93% is desired, this type of plant will give the best results, but

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for lower vacua the Edwards type is the cheapest, both in first cost and power required.

The maximum speed in air pump working is usually fixed at 400 ft. per minute, but the author considers this too high in the majority of cases. In an 18 × 18 in. air pump designed to run at 350 ft. per minute, it was found that better results were obtained when this was reduced to 300 ft., and still further improvement at 250 ft. per minute.

The size of an air pump depends upon the conditions of working; for example, with jet condensers the quantity of air is greater than with the surface type, due to the air entering the condenser along with the condensing water. Water taken from a fast-running stream or from under a cooling tower, contains a larger amount of air in suspension than water from an undisturbed source. This, of course, must be taken into consideration. If the exhaust range is long and the engines scattered, here again must the air pumps be of larger capacity than when the condenser is coupled direct to a single engine or turbine.

The power required to drive an air pump depends upon the degree of vacuum obtained, for the work at the beginning of the evacuation is 0, and at the end, if a perfect vacuum were attained, is 0; in between these extremes there is a certain condenser pressure when the work becomes a maximum, and in the case of a dry air pump this is found to be 0·37 atmosphere, or 18·9 ins.

Circulating Pumps.—Both the reciprocating and centrifugal types are used, but the field of the latter has become more extended of recent years, due to the constant steady flow obtained and to the higher efficiencies now obtainable, together with the lower cost and simpler construction.

Steam and Electrically-Driven Pumps.—In providing motive power for the operation of air and circulating pumps in a central station, it is necessary to consider the question of continuity of operation, in addition to the efficiencies of the two methods of driving, as a failure of the vacuum may have serious consequences.

The author contends that the possibilities of a failure occurring in the vacuum are less with steam than with electric driving. With the latter method the number of stages of transition from the steam to the applied power at the pumps, in each of which an interruption is possible, is greater than with the former method.

Steam-driven pumps require from 50 to 100% more steam than electrically-driven pumps, but this may be counter-balanced to a great extent by the large percentage of the total heat of the steam it is possible to return to the boiler by employing a feed-water heater, even after allowing for the reduced efficiency of the economiser.

Steam-driven pumps ought not to exhaust into the main condenser, for while a possible 10% reduction in the steam consumption of the pumps is effected, the reduction of the available capacity of the condenser caused by this arrangement is a more serious item. A preferable arrangement is to pass the exhaust steam through a feed-water heater as already explained.

A careful consideration of existing conditions and requirements is necessary before the most advantageous type of condensing plant can be decided upon. It is necessary, for instance, to know whether the initial cost of plant or low running costs is the most important, for a small difference of temperature between the condensing water leaving the condenser and the exhaust steam entering, means a large condenser and a small quantity of condensing water, and *vice versa* a large temperature difference gives a small condenser and larger quantity of water.

Another point to be borne in mind is that where the load factor is low it is advisable to keep down the capital cost of the plant, even if the power taken by the plant is increased somewhat, and that where the load factor is high the running costs are of the first importance, and more can be expended on the plant in order to reduce the running costs.

The advent of the low-pressure exhaust-steam turbine has increased the importance of the condensing plant, for with its aid it is possible in many cases to effect considerable economy, besides increasing the capacity of practically any steam plant already in operation. There is as much available energy below the atmosphere pressure line as there is above, and the exhaust-steam turbine is capable of utilising this lower pressure far more effectively than a reciprocating engine.

The increased output obtainable by the installation of a plant of this type, together with condensing plant where not already installed, is from 25 to 100% of the present output. A 500 kw. exhaust-steam turbine with steam pressure of 15 lbs. per sq. in. absolute, and 28 ins. vacuum at turbine, wil require 33 lbs. of steam per kw. at full load, and 40 lbs. at half load. In calculating the power available for a plant of this kind, an allowance must be made for the loss between engine exhaust and turbine admission.

Water-Cooling Plants.—Formerly the usual method of cooling water was by means of a pond, the hot water being delivered by open troughs to the part of the pond most remote from the suction pipe. The actual drop in temperature effected in these troughs is much less than is generally supposed. In an actual case it was found that in a trough 2 ft. 6 ins. wide, 7 ft. deep, and falling 1½ ins. in a length of 80 ft., the temperature was only reduced 2° F., and this with the temperature of the water at 146° F.

The duty required of any water-cooling plant working in conjunction with a condensing plant is to remove a specified number of units of heat in a given time from the discharged condensing water. Higher efficiency of heat transmission is obtained from the water to the air, the nearer the final temperature of the air approaches that of the water. This efficiency is dependent upon the construction, the difference of temperature between air and water, the humidity, and upon the draft. The three principal types of cooling plants are (1) the natural draft open type, (2) the natural draft chimney type, and (3) the fan-draft chimney type.

For central station work the second type is the most common owing to the necessity of economy in ground space, and in order that the vapour issuing from the plant may be carried away at a height at which it will not become a nuisance to any inhabited buildings in the vicinity of the tower. The area of ground required is approximately 1 sq. ft. for 20 lbs. of steam condensed (allowing 30 lbs. of water per lb. of steam), and the height varies from 40 ft. to 80 ft.

Where these objections do not exist, the open type may be installed at a less cost, the maintenance will be less, and as the height of the plant is usually about 20 ft., the operating costs will be the lowest. An approximate figure for area of ground and steam condensed is 1 sq. ft. per 12 lbs. of steam.

The fan draft tower is only used in special cases as the upkeep, attendance, and power required by the fan make the operating costs very high. A tower of smaller proportions is required with this arrangement than with the natural draft chimney type, the height varying from 40 ft. to 50 ft., and 1 sq. ft. of ground is sufficient for 40 lbs. to 50 lbs. of steam.

Depreciation will vary according to the method of construction and the care taken in erection. It is now possible to obtain water-cooling plants in which the wooden laths simply lock each other in position, and the rate of depreciation will be much less with this arrangement than where nails are used. The amount of water lost is usually found to be 75% of the water required for boiler feed, but owing to varying climatic conditions this quantity is not constant.

Where it is necessary to install plant of this nature, it is essential that the temperature of the water discharge from the condenser be as high as possible, conducive with economy in the condensing plant, as the conditions are then more favourable for the dispersion of the heat contained in the water. From this it will be plainly evident that surface condensers should only be used for high vacua when other considerations, such as boiler-feed water, outweigh the factors of heat dispersion.

For a high vacuum of say 28 ins., and water leaving the condenser about 95° F., the quantity of water required at 75° F. would be only 75% of the quantity necessary when cooled to 80° F., and as the cost of cooling plant would be practically the same in each case, the lower temperature is the more economical, as the saving in power would be considerable.

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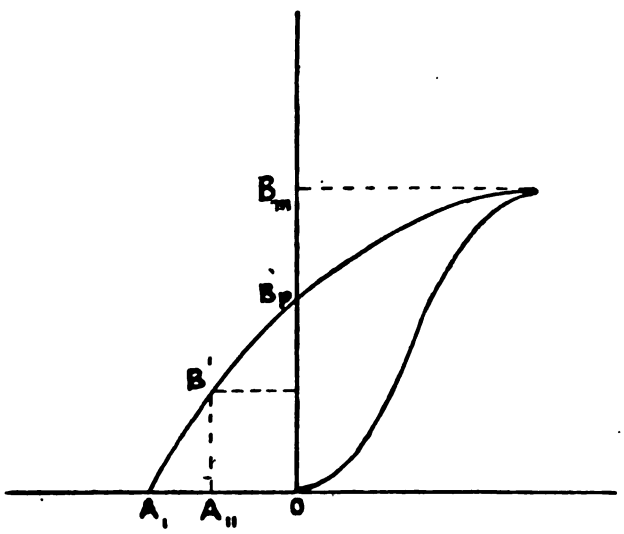
TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

"If thou hast knowledge, let others light their candle at it."

Question No. 1,196.—The magnets of some meters of the mercury motor type have become demagnetised to an extent which makes satisfactory adjustment of the meters impossible. Describe the process necessary for remagnetising them, and any other treatment necessary to ensure their future reliability.

Answer to Question No. 1196 (*awarded 7s. 6d.*).—In the first place it may be stated that magnets which have deteriorated in strength to the extent stated, must have been carelessly prepared or else be of very inferior material. Probably the latter cause is the chief source of the trouble, and in that case entire replacement of the magnets will be the only permanently satisfactory remedy. It is, of course, possible that fairly good material has been used, but that the magnets have been incorrectly proportioned and aged, hence the following notes dealing with the requisties of a good permanent magnet iron, the proportions to be given to such magnets and the methods of ageing them will enable a decision as to the advisability of using new magnets or of re-magnetising and ageing the present magnets.

The shape to which a magnet is forged is determined in some cases by the shape of the instrument into which it is to be fitted, and in other cases by the question of magnetic leakage (particularly if the air gap be relatively long.) In determining the ratio of length to area of a permanent magnet it must be remembered that the power of overcoming magnetic resistance in the circuit (*i.e.*, the M.M.F.) must be proportioned to the coercive force of the material used. The M.M.F. of a magnet is expressed per cm. of its length, and it is clear that the area of the



iron will bear to the length of iron necessary to provide the total M.M.F. a ratio proportional to that of the gap area to the gap length. For permanence, Hookham has found that $\frac{A}{L}$ should $= 70\ \frac{a}{e}$ where a, A are the iron and gap areas and b, L the iron and gap lengths. If a = A the iron path must = 70 × gap length, but if a = 2A b = 140 L, showing the increase of M.M.F. necessary if the gap flux be concentrated by tapering the pole tips (assuming B in iron constant). This empirical formula gives a factor of safety of about 3, *i.e.*, the demagnetising force is about ⅓ the magnetising force.

Referring to the illustration, the curve shown is part of the familiar hysteresis curve of iron. After magnetising the iron up to an induction density B_m, the residual induction on removing the magnetising force is represented by OB_p. Let it be supposed that this represents the residual induction in a closed magnetic circuit, *e. g.*, a ring or rectangle, then OA_1 represents the retentivity of the iron or steel of which the circuit is composed. If now a sawcut be made through the hitherto closed iron circuit, the M.M.F. available for the metal portion of the circuit will decrease, and if the gap be large and the metal very permeable, practically the whole of the M.M.F. OA_1 will be expended in the gap. In any case the M.M.F. available in the iron will be much reduced and may be A_1A_{11} (Fig.1), the iron flux density then falling to B. Given the magnetisation curve of the steel to be employed it is possible to predict fairly accurately the size of magnet for a given gap flux.. The induction in the steel should not exceed 2,000-3,000 lines per sq. cm. if permanence is to be ensured, and, having assumed this density, the M.M.F. A_1A_{11} required in the iron is at once read off from the magnetisation curve. The remaining M.M.F. O'A" is then available for the air gap, and since the gap M.M.F. = 0·8 B_g per cm. of gap, the B_g obtainable for a given length of gap and length of magnet is calculable and hence the gap area required for a given total flux. Otherwise, if H represents the M.M.F. required by a given gap, the necessary length of magnet $= \frac{H}{OA_{11}}$ (since OA_{11} is the available gap M.M.F. per cm. of magnet).

The area and length of magnet should be increased by 10% of the values so estimated to allow for leakage, pole piece reluctance and loss of induction density during ageing. The total gap flux ∝ volume of metal in the magnet: the gap density required usually lies between 800 and 2,000 C.G.S. lines per CM^2. To keep constant B_g in a longer gap, the length of magnet must be increased since the gap M.M.F. increases in direct proportion to its length. Increasing the iron section to reduce its flux density and so leave a larger surplus M.M.F. for the gap, does not give such good permanence as if extra length of iron be provided to allow for the longer gap. The gap length and gap density per cm. of magnet iron are confined within well-marked limits if permanence be desired. In general, the greater $\frac{A_1A_{11}}{O\ A_{11}}$, *i. e.*, the greater the proportion of the M.M.F. expended in the iron the more permanent the magnet whence the rule that the polar area at the gap shuold be as large and the gap length as small as possible.

The choice of magnet material and the method of its magnetisation are relatively simple matters and are dealt with below: practically the whole difficulty of the manufacture lies in the "ageing" of the magnet, as the processes are termed whereby magnetic permanence is secured in the metal. The importance of securing such permanence needs little explanation since the whole subsequent permanence of calibration, and hence reliablity and commercial value of the instrument depend directly upon it. The object of magnet design is to secure the highest possible flux density that is consistent with permanence, since this gives the maximum instrument sensibility for a given weight of material or, otherwise, enables the lightest and cheapest instrument for given characteristics.

Materials Used.—There are many steels available for the manufacture of instrument magnets, and for each there is a definite hardening process recommended by its makers. If by a reliable maker, this process should be rigidly adhered to, since the slightest variations in treatment produce great differences in the characteristics of the metal. Most of the hardening processes are trade secrets, the makers supplying the metal forged to desired shape and hardened ready for use. Considerable skill is necessary to achieve results of any value and to avoid cracking the iron excessively: even the best instrument magnets frequently exhibit numerous cracks as the result of the stresses set up during hardening. Such cracks are not detrimental if not too deep or too numerous. Pierce, of America, has found C.I. to be suitable for permanent magnets in instruments, and Campbell, of England, has confirmed these results. Common grey C.I. is used and hardened by sudden cooling in water from about 1,000° C. The metal is very brittle at high temperatures, and hence needs careful handling. The remanence of the metal is about 30% less than that of the best magnet steel, its coercivity about 20% less, while it is, of course, much cheaper. The "ageing" effects of vibration temperature and time are no more serious on such C.I. than on the best magnet steel.

Magnetisation of the shaped and hardened iron is best effected by placing its poles on those of an electro-magnet, possibly slightly lubricated to facilitate subsequent re-

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moval. Magnetisation by permanent magnets is obsolete, being costly, producing only low flux density and being liable to create "consequent" poles. In the case of damping magnets and similar shapes with very short gaps, the leakage across the latter is so great that the desired magnetisation cannot be obtained by the above method. It is financially impossible to wind the iron with an exciting coil, unwinding the latter after magnetisation is complete, though if a large number of cases had to be dealt with it might pay to use a heavy current hinged coil of comparatively few turns such as is used in cetrain iron tests. The usual procedure is, however, to rotate a copper disc rapidly between the poles of the iron to be magnetised. The eddy currents induced in this disc by the leakage flux will oppose the latter (Lenz's Law) and, the energy "generated" in the disc being at once used in the desired place and manner, the efficiency of this simple device is very high. Such a disc is occasionally used to "age" magnets by partially demagnetising them.

Ageing.—The steel or iron having been magnetised, it must be "aged" before use. The probable ultimate loss of retained magnetism is greatly accelerated, the metal being so brought to a more truly permanent state before being used in the instrument. The magnet is steam or water heated to from 60°–100° C. for 6 to 48 hours, being meanwhile, or subsequently, as the case may be, subjected to mechanical vibration. Ageing naturally somewhat reduces the induction density in the iron, but this has already been allowed for in the preliminary calculations. Some makers go so far as to demagnetise the metal to the extent of 10% during ageing, in order to ensure that permanence is attained, and in view of the vital importance of the latter such a course, though unnecessarily drastic in the case of the best materials, is on the whole quite justifiable.

"L. C."

Question No. 1,197.—If the maximum speed of an electrically-driven winding engine is given, show how the rate of acceleration and retardation may be arrived at in order to obtain the most efficient conditions of winding. How does this rate of acceleration compare with that of a steam-driven winding engine, and what is the maximum practicable rate?

Answer to Question No. 1,197 (*awarded* 10s.).—The factors influencing the acceleration to be allowed in any winding equipemnt include—the strength of rope used, the weight of flywheel, the h. p. of motor, the extent to which the demand on the mains may fluctuate and the overall speed of winding desired. As a general rule it is desirable that the excess energy taken during acceleration over that required during the constant speed period of winding be supplied wholly by the flywheel, leaving the motor load and hence the demand on the supply mains as nearly constant as possible. The maximum acceleration employed should not be greater than will make the load on the cage rope double the weight of the load, *i. e.*, on starting $I\frac{a}{r^2}$ should not be greater than W where W = weight of load: I = inertia fall the moving parts of the winding apparatus: r = radius of winding drum and a = acceleration. It is the increased stress so produced on the rope at starting that greatly limits the acceleration permissible with steam engine drive, since the starting torque is very uneven in such cases, and the strain on the rope correspondingly accentuated. Only one cylinder of a steam engine is operative at the moment of starting, and the torque is therefore very uneven for a time: the heavy moving parts essential to reduce this unevenness to practicable limits are of little value till they have acquired a fair velocity—till then their inertia has no effect. The size of rope used is ultimately limited by its weight and the space taken up on the winding drum (tapered ropes offer some advantages in this respect, but are, on the whole, inadvisable), and in consequence of the higher factor of safety required with steam driving in order to allow for the more severe strains on the rope, the acceleration possible with steam driving is considerably less than may safely be employed with electric operation. With electric winding a rope factor of safety of 6 is permissible, while with steam operation this should not be less than 9 or 10: the ratio of the permissible accelerations is therefore about 1·5 to 2 : 1.

Not only is the starting torque more uniform when using electric motors, but also it may rise to considerably higher values since the use of quite a reasonable flywheel may make the total energy available during acceleration =2 to 3 times that which would be available from the normal output of the motor alone. The desirable acceleration and retardation are the highest obtainable with safety and with reasonable demands on the supply mains: the overall speed of winding is greater the higher the acceleration and retardation employed, and this is of the greatest importance, especially where short shifts and high output have to be combined, as, notably, in this country. The safety considerations referred to, mainly concern the rope stresses, though very high winding speeds are used for coal, a lower speed must be provided for raising and lowering men: in England a moderate speed, the same for men and coal, is usual. Bearing in mind the rule already given regarding the maximum acceleration permissible on account of rope stresses, the acceleration should be as high as is consistent with reasonable load demands on the supply, and reasonable speed variations of the flywheel. The latter variation is generally between 10 and 15% of the normal speed. The general method of approaching the present problem, whether from the point of view of the size of flywheel required to allow of a given acceleration, or the maximum acceleration permissible with a given flywheel is set out below. The chief principle to be conformed to is that the normal h.p. of the winding motor acting during the retarding and "decking" periods of a complete winding cycle shall store sufficient energy in the flywheel to permit of the acceleration decided upon without extra demand from the mains. Thus to raise a nett load of W tons, D feet in T seconds (including "decking"), the work done $= \frac{W \times 2240 \times D}{T}$ ft. lbs. per second, and if the retarding + decking period = t secs., the flywheel must store $\left(\frac{2240\ WD.\ t}{T}\right)$ ft. lbs. in this time.

Assuming maximum and minimum flywheel speeds of N and n r.p.m. respectively, and a simple disc flywheel of weight w lbs. and diameter d ft., then

$d = \frac{17000}{N\pi}$ ft. (1) (assuming maximum peripheral velocity of 285 ft. her sec.), and the energy output from the wheel falling in speed from N to n r.p.m.

$$= \frac{wd^2}{8g} \cdot \frac{\pi^2}{900} \cdot (N^2 - n^2) \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

whence the weight of wheel required, the diameter being determined from equation (1) is

$$= 0{\cdot}000802 \times \frac{WDtN^2}{T\ (N^2 - n^2)} \text{ tons} \quad \ldots\ldots\ldots\ldots (3)$$

As already explained, $W = I\frac{a}{r^2}$ gives the maximum a desirable and if the maximum winding velocity be v ft. per sec., the accelerating period $= \frac{v}{a}$ sec., during which time the accelerating energy available is

$$= \left(\frac{2240\ WD}{T}\right)\left(\frac{v}{a} + t\right) \text{ ft. lbs.} \quad \ldots\ldots\ldots\ldots (4)$$

and, the rope tension being denoted by R lbs., the work done during acceleration is

$$= \left(Rr + I\frac{a}{r}\right)\frac{v^2}{2ar} \text{ ft. lbs.} \quad \ldots\ldots\ldots\ldots (5)$$

If the available energy (equ. (4)) is greater than the required energy (equ. (5)) all is well: otherwise, we must be content with a lower acceleration a *or* provide a stronger motor, *or* use a heavier flywheel, or slow down the present one to a lower minimum speed (either of the latter alternatives necessitate a longer retarding and decking period, *i. e.*, a longer winding cycle). It is assumed that the demand on the supply mains and the maximum speed of winding remain constant.

The rate of retardation may be considerably greater than the rate of acceleration, a ratio of from 2 to 3 : 1 not being uncommon. With a maximum winding speed of about 20 ft. per sec., the acceleration may be 1-1½ ft. per sec.², and the deceleration 3 to 4 ft. per sec.², while

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for maximum speeds of 40-50 ft. per sec. (at present the highest attempted), the acceleration and deceleration are 1½ to 2 times as high. The distribution of the total period of a winding cycle over its various operations in four typical cases is shown in Table 1, whence it appears that acceleration usually occupies 25-30% of the actual winding period and deceleration 10-15% thereof (case (1) being accepted as unusual). The effect of the acceleration employed, and consequent frequency of winding possible, on the energy consumption of the prime mover per wind is not great in the case of electric drive so long as this frequency is fairly high. Thus for 30 winds per hour the energy consumption per wind is not much higher than for 60 winds per hour, but Becker has shown that below 20 winds per hour the consumption per wind rises rapidly. In general, however, it is desirable to maintain as high a frequency of winding as possible to minimise the relative importance of all losses, and to obtain a high load factor—particularly necessary with electric drive on account of the high capital cost of the equipment.

TABLE I.

Case	Time in Seconds Occupied by									
	Accelerating.		Full Speed Running		Decelerating.		Decking.		Complete Wind A.	Complete Cycle.
		Per Cent of A.		Per Cent. of A.		Per Cent of A		Per Cent of A		
1	16	26·3	27	44·3	18	29·5	17	27·9	61	78
2	12	30·0	23	57·5	5	12·5	15	37·5	40	55
3	19	29·7	40·5	60·9	6·4	9·6	23·3	35·1	66·7	90
4	10	20·0	35	70·0	5	10·0	20	40·0	50	70
Mean Percentages		26·5		58·2		15·4		35·1		

"R."

Answer to Question No. 1,197 (*awarded 5s.*).—The first operation is to find the time allowable for the complete cycle comprising the periods of acceleration, full speed run, retardation, and decking, and this is ascertained as follows :—

$$\frac{\text{Tons to be wound per day}}{\text{Working hours per day} \times \text{tons raised per winding}} = \text{No. of windings per hour.}$$

$$\frac{60 \text{ minutes}}{\text{No. of windings per hour.}} = \text{Time in minutes per complete cycle.}$$

It will be necessary to make some allowance for winding officials and for other extra duties, and the number of windings of *coal* per hour will be some what less than as arrived at above, but this allowance can only be arrived at by knowing the special conditions obtaining at the particular pit; for instance, there may be a shift of men to ride at some time during the day, and examination and greasing of the ropes and guides, lowering of timber or winding stone or dirt may have to be done during working hours, and some deduction must be made from the actual working time for these and similar necessary operations.

The time required for decking will depend upon the number of decks in the cages, and the number of boxes in each and whether one or more decks are loaded and unloaded simultaneously, and these are points which the querist can best settle from experience of the actual conditions.

Deducting the decking time from that of the complete cycle, the difference is the winding period

$$\text{Winding period} = \begin{cases} \text{Time for acceleration from rest.} \\ \text{Full speed running time.} \\ \text{Time for retardation from full speed to stop.} \end{cases}$$

Now the acceleration period and the inertia of the moving parts determine the torque required from the motor, since it is during the acceleration period that the greatest torque is required. The inertia of the moving masses also mainly determine the time required for retardation.

The next point to be settled then is the output of the motor (*i. e.*, its maximum torque), or, if this is already fixed, to find the time required for acceleration so as to keep the output within the power of the motor.

The load during the acceleration period may be divided into :—

(1) Power required to lift the unbalanced weight.
(2) ,, ,, ,, accelerate the moving masses.
(3) ,, ,, ,, overcome friction.

With regard to (1), it will be understood that if there are two cages they will balance each other, and if there is only one cage there should be a balance weight also running in the shaft, so that, as the loaded cage is starting from the shaft bottom, the unbalanced deadweight will consist of the coal in the loaded cage plus the rope by which this cage is raised (the empty cage being at the shaft top there is practically no rope to be accounted for on this side), unless there is a rope joining the bottoms of the cages round a pulley at the shaft bottom, which is unusual in this country.

In calculating (2) it is most convenient to reduce the weights of the moving shafts, drums, motor armature, and gear wheels to their effective weight at the drum periphery.

The kinetic energy for acceleration is obtained from the simple formula $\frac{V^2}{2_g}$ where V = running speed in feet per second.

Now the power required for acceleration is a maximum at starting and falls as the speed increases, so that, for this purpose, the power developed by the motor should be averaged over the whole of the acceleration period.

It would appear from the question that the power of the motor is settled upon, and the querist wishes to ascertain the length of time that he should allow the motor for bringing up the moving parts to the running speed. He will therefore know the average h.p. which the motor can develop during the acceleration period, without undue heating over the day's work, and calling this average horse-power B, and the total weight to be accelerated W

$$\text{Acceleration period in seconds} = \frac{W\ V^2 \times 60 \text{ seconds.}}{B \times 33{,}000 \times 32}$$

The same procedure will give the period of retardation except that, when the loaded cage is reaching bank, its rope will be short and that of the descending cage will be long, but a little actual practice will soon show at what point of the wind, as shown by the indicator, the current may be switched off so that the cage will just stop at the flat sheets. It can, however, be calculated as above fairly accurately unless, as is sometimes the case, the electric brake is applied automatically when the main current is switched off, and in this case, the retardation period depends very largely on the adjustment of the electric brake.

In working out these calculations it is more usual to ascertain, first of all, the actual time that can be allowed for a wind in order to raise a given amount of coal per day and then to fix the winding speed to suit this. A curve of the horse-power is then worked out for a complete wind at full speed and the average horse-power obtained from this curve by integration. The average horse-power at full speed being then known, the acceleration period can then be fixed so that the motor can run the moving parts up to speed a given number of times per hour without undue heating.

The average h.p. B for acceleration will then be

$$(2)\ B = \frac{W\ V^2 \times 60}{\text{acceleration period in sec.}} \times 33{,}000 \times 32 \times 2$$

and the average h.p. for lifting the unbalanced weight during acceleration

$$(1)\ \frac{\text{Unbalanced load} \times V \times 60}{33{,}000 \times 2}$$

The total average will be the sum of (1) and (2) and the maximum twice the total average.

The difference in the weights of the two ropes must be allowed for when calculating the power required at any part of the wind at full speed, and to all of these calculations tions must be added the friction of bearings, etc., to arrive at the brake horse-power of the motor.

Generally speaking, the electric winder is quicker than the steam winder, since there is less weight to get into motion and the torque is steady and constant, whereas the steam winder, having two cranks set at right angles so that it may start in any position, does not get full speed

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so that it may start in any position, does not get full pressure on both pistons at once throughout its stroke. Again, the simple steam winder has generally a late cut off (some have full steam throughout nearly the whole of the stroke) also so that it may start at any point, and a fairly heavy drum is required. The consumption of steam with this type is enormous, and compound engines with lower steam consumption are becoming more common, but these again have additional pistons and piston rods, etc., to get into motion and the complication of by-pass valves, admitting live steam to the low pressure cylinders, to start the dead weight, further tends to lengthen the starting time.

The limit to the speed at which the load may be accelerated is governed by the breaking strain of the winding rope, torsion stress of the shafts and teeth of the gear wheels, if any, and these should always be worked with a good factor of safety.

It is also dangerous to raise men too quickly from the shaft bottom, since to do so may cause dislocation of the hips, and if the speed at the end of the wind is very excessive and the engines have to be pulled up quickly, the men are liable to lose their balance and even knocked against the top of the cage.—WIGWAM.

COMPANIES' MEETINGS AND REPORTS.

ENTERPRISE IN SOUTH AMERICA.

A bulletin of the Compañia Alemana Transatlantica de Electricidad bears striking testimony to the development of the concern. It was founded in Berlin in January, 1898, and in April, 1899, the station at Reconquista and Paraguay was inaugurated. It consisted of two engines of 1,000 h.p. each and a battery of 8 boilers; in the streets there were 270,000 metres of cable laid, covering a distance of 70,000 metres. At the end of April, 1899, the Company supplied current to 8,450 incandescent 16 c.p. lamps or their equivalent. The capacity of the power houses in h.p. increased from 7,000 in 1900, to 51,960 in 1908. The coal consumption last year totalled 132,253 tons against 4,683; the number of 16 c.p. lamps connected, 729,128 against 51,025; and h.p. connected equivalent to 16 c.p. lamps, 524,509 against 15,783. In 1908 the tramcars numbered 1,464 as compared with 145, while there were 2,132 employees, being an increase of 847.

MELBOURNE ELECTRIC SUPPLY.

The Melbourne Electric Supply Co., Ltd., announces issue of £150,000 six per cent. Cumulative Preference Stock, in lieu of the Preference Shares of the Electric Lighting and Traction Co., of Australia, Ltd., 20,000 seven per cent. First Cumulative Preference Shares of £5 each, and a further issue of £100,000 five per cent. First Mortgage Debenture.

ISLE OF WIGHT CENTRAL RAILWAY.

The meeting of the Isle of Wight Central Railway was held at the offices of the company, 11, Ironmonger-lane, E.C., Mr. P. Mortimer (the Chairman of the company) presiding. The Chairman said that the half year had been fairly satisfactory, considering the very wet weather they had in June, when the holiday traffic began in the island. The receipts were £89 less than in the corresponding half year, and the expenses were £11 up. The result was £100 to their disadvantage on their own line, and they took £166 less for working the Freshwater line. They also brought in a smaller amount by £374, so that as the result of the half year they had £637 less to deal with. The present half year was quite hopeful so far, the traffics showing an increase of £266. They had a record Bank Holiday, when they took £1,280. The reduction of fares which they made in July promised to be quite successful. They had had two proposals to electrify the line, but so far no definite offer, and he did not attach much importance to the negotiations. It would take half-a-million to buy up the line. They would give full consideration to any scheme which came before them.

UNITED ELECTRIC CAR CO., LTD.

The directors of the United Electric Car Company, Ltd., recommend a dividend for the year ended June of 2½ per cent. on the Ordinary shares.

SOUTH METROPOLITAN ELECTRIC LIGHT AND POWER CO.—The above Company announce that Warrants for Interim Dividends, payable the 31st inst. on the Company's 7% Cumulative First Preference Shares and 6% Cumulative Second Preference Shares, for the half-year ended June 30, 1909, have been posted.

PERSONAL.

Mr. James H. Shepherd, who has been manager of the Dundee, Broughty Ferry, and District Tramways since they were opened about four years ago, is leaving to take over the appointment of manager of the Dumfermline and District Tramways. Mr. Shepherd, who is a trained electrical engineer, belongs to a family well-known and respected in the Butterburn district of the city.

We learn that the Governors of Faraday House, Southampton Row, London, W.C., have appointed Dr. Alexander Russell, M.A. (Cantab.), D.Sc. (Glasgow), M.I.E.E., Principal of the Institution, in succession to the late Mr. Hugh Erat Harrison. When Faraday House was started in 1890 Dr. Russell was offered, and accepted, the posts of Lecturer on Applied Mathematics and Head of the Physical Laboratory Department. Since his appointment he has written more than fifty papers on subjects connected with electrical engineering. He has also prepared an advance treatise an Alternating Currents, and contributed to the electrical Press. To electrical engineers, Dr. Russell's name is, perhaps, best known in connection with the grading of electric cables, a subject to which he has devoted a great deal of thought. He was the first to explain what was meant by the capacity of polycore cables, and in conjunction with Mr. G. F. C. Searle, F.R.S., devised an accurate definition of the capacity between two cores. In 1901 he devised "Russell's" test for measuring the insulation resistance of a network of mains. He has this year, in conjunction with Mr. Arthur Wright, been engaged with considerable success in perfecting methods for solving algebraical equations and doing other mathematical operations by electricity.

Mr. Robert Rankin, B.Sc., A.G.T.C., late assistant to Professor Maclean, Glasgow Technical College, has been appointed electrical engineer to the Electric Co. of Manchester.

THE MONTEREY FLOODS.

The British Empire Trust Co. is advised by cable from Monterey that the damage done to the Company's property by the recent serious floods is not very serious. The San Lusito suburb across the river was cut off for 40 hours. The river covers several blocks of property on the other side of the bridges. The electric light lines in San Lusito have gone; also several poles on the city side. The damage to the plant is slight. The light service is continued with only few interruptions during the day. The railway plant is reported to be "all right," but the service has been interrupted since the morning of the 28th. The water mains over the bridges have been washed away. No water has been had since Tuesday morning.

CONTRACTS OPEN.

HOME.

LEEDS.—Corporation.—One, two, or three years' supply of paper insulated cables (£8,000 to £10,000 per annum). (Spec., £1 1s., Manager, 1, Whitehall-road.) September 7.

LEYLON (Essex).—Urban Council.—Public lighting lanterns with clock switches for incandescent electric lamps, for the Leyton Urban District Council. Specification, with schedule and form of tender attached, can be obtained by deposit of £1 1s. from Mr. F. Harman Lewis, electrical engineer to the Council, Electric Light and Power Works, Cathall-road, Leytonstone, London, E. Duplicate copies of specification can be obtained by the deposit of 10s. 6d. for each copy. Sealed tenders, on the form attached to the specification, and enclosed in specially endorsed envelopes supplied with the form, must be delivered at the meeting of the Council to be held at the Town Hall, Leyton, on September 7, at 7 p.m. Deposits are returnable one month after the receipt of *bona-fide* tenders and return of specifications in respect of which deposits have been made. Sureties will be required.

LONDON, E. (Poplar).—Guardians.—Annual supply of electrical supplies. (Part., Clerk, 45, Upper North-street, Poplar, E.). September 8.

LONDON, S.W.—London County Council.—Tenders are invited for roadwork and platelaying for reconstruction of tramway in Highgate-hill. Length equivalent to about 1·4 mile of single track. The track rails, fastenings, the slot rails and conductor rails, and special work for the junctions, cross-overs, etc., will be provided by the Council, remaining metal work and other materials is included in the contract. Spec., Chief Engineer, County Hall, Spring-gardens, S.W. Dep., £5. September 7.—Also for the following:—(1) Manufacture, delivery, and erection in certain of the Council sub-stations of two 500 kw. and one 150 kw. motor generators; (2) manufacture, delivery and erection of high and low tension switchgear for Woolwich and other sub-stations; (3) manufacture, delivery and erection at the Greenwich electricity generating station of steam, exhaust, feed and drain pipes, valves, water tanks, etc. Persons desiring to submit tenders may inspect drawings and obtain specifications, bills of quantities, form of tender, and other particulars at the County Hall, Spring-gardens, S.W., upon payment to the Cashier of the Council of £2 for each section. This amount will.

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after the Council or its Committee shall have come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a *bona-fide* tender and not have withdrawn the same, but in no case will the fee be returned unless a *bona-fide* tender is submitted. Full particulars of the work may be obtained on application at the County Hall before payment of fee for specification, etc. Rate of wages, etc., clause to be observed. Each tender is to be delivered at the County Hall in a sealed cover, addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked "Tender for Motor Generators," "Tender for High and Low Tension Switchgear," "Tender for Pipes, Valves, Water Tanks, etc.," as the case may be. September 21 (by 11 p.m.).

OVERSEAS.

AUSTRIA-HUNGARY.—At the Town Hall, Magyarkanizca. To instal electricity. September 18.—At the Town Hall, Agram. To instal a central electric station. At an early date.

BELGRADE.—Post and Telegraph Department. Telephone construction material. September 13.

BRAZIL.—At the Municipal Offices, Corumba-Matto Grosso—Instal the electric light, October 5.

BRUSSELS.—At the offices of the Société Nationale des Chemins de Fer Vicinaux.—To supply the aerial electric equipment of the Anderlues-Lobbe section of the Carnières-Thuin Light Railway. September 20.

FRANKFORT-A-M.—Two electrically worked movable cranes of 20 tons each and 12·260m. span; one ditto five tons and 13·840m. span; two ditto hand or electrically worked, two-three tons and 7·195m. span each. Spec., 2s. 6d. (P.O.O.) Eisenbahndirection Hohenzollernplatz 35.

GERMANY.—At the District Offices, Merschweller.—To instal electricity. At an early date.

NEW SOUTH WALES.—At Petersham telephone exchange.—Supply, delivery, and erection of a branching metallic multiple magneto switchboard. November 10.

NORTH SYDNEY TELEPHONE EXCHANGE.—For the supply, delivery and erection of a common battery switchboard at the Exchange, and also for the supply and delivery of apparatus for use on subscribers' premises, in accordance with specification No. 266. Specifications, general conditions, plans, etc., may be seen at the General Post Offices, Sydney, Melbourne, Brisbane and Adelaide. The work must be tendered for in accordance with schedule, New South Wales, E.E. 144/08, and the shortest time in which the apparatus would be delivered, and the country of manufacture, must be stated. Tenders must be endorsed "Tenders for Switchboard and Apparatus, North Sydney," and addressed to the Deputy Postmaster-General, Sydney, by 2.30 p.m., January 12, 1910. A deposit, or receipt for deposit, must be enclosed with each tender, of 5 % on the amount thereof up to £1,000, and 2½% on the amount over that sum. Tender forms, specification, etc., may be obtained, and preliminary deposits paid, at the Commonwealth Offices in London, 72, Victoria-street, S.W.

RESULTS OF TENDERS—Home.

AXBRIDGE.—The Joint House Committee and Electric Lighting Committee have accepted a tender of £23 15s. for repairs to the engines connected with the lighting plant.

BELFAST.—Messrs. Hadfield, of Birmingham, have secured the contract for tramway crossings.

SALFORD.—The Guardians of the Salford Union have accepted the tender by the Hart Accumulator Co., Ltd., for the renewal and maintenance of the storage battery of 110 cells installed at Culcheth Cottage Homes.

Overseas.

CHINA.—An American telephone system is to be installed in Pekin. The contract has been secured by the Western Electric Co. of Chicago in competition with British, French, German, and other firms. Under the contract the equipment is to be completed early in February next.

BUSINESS NOTES.

LIGHTING AND GENERAL—Home.

ACTON.—The Urban Council propose applying to the Local Government Board for sanction to borrow £2,200 for the purpose of furnishing electric light fittings at the new public offices.

ALDERSHOT.—The Electrical Engineer has been requested to prepare estimates for an extension of the electric light mains down York-road.

AMBLE.—The opinion of the ratepayers as to the advisability of adopting a scheme of electric lighting will be taken by ballot.

BELFAST.—The Police Sub-Committee has had under consideration the question of lighting several of the principal parts of the city by electricity. It was decided to recommend the principal committee to adopt this class of lighting for High-street and Castle-place, provided satisfactory terms can be arranged with the Tramways and Electricity Committee for the erection of lamps and the supply of current. To the Tramway and Electricity Committee, the Tramways Manager (Mr. Nance) submitted a report on the suggested abolition of tramway centre poles, in the interest of improved street traffic regulations. This report was referred to the Electrical Engineer for his remarks. A sub-committee was appointed to make inquiry (1) as to the gain or loss from the tramways on such outlying sections as that from Knock-road to terminus; and (2) as to the probable gain or loss, without reference to the settlement of Mr. Harrison's action against the Corporation, on the working of the proposed tramway to Holywood.

BRIGHOUSE.—At the Council meeting, Alderman Healy (chairman of the Gas and Electricity Committee) announced that they hoped to be able to supply electricity, which would be received in bulk from the Yorkshire Power Co., on September 1. For lighting purposes the voltage would be 230 and for power 460 volts. The price would be as at present, 5d. per unit for lighting and from 4d. to 2d. for power. They hoped if there was a largely-increased consumption to be able to reduce these prices at an early date.

DARLINGTON.—To the Board of Guardians, a Committee suggested that the lighting of the Workhouse Hospital should be improved by the introduction of incandescent burners. Councillor Crooks moved that the whole question of lighting the Workhouse by electricity should be considered, and he moved that the matter be referred back. He thought that if the institution were to lead the way it would develop the use of electric lighting at Eastbourne. The Clerk said that if it was only to introduce electric light into the Hospital it would be a small matter, but if it were to be carried out throughout the Workhouse it would be an expensive matter, especially in view of the fact that in many of the rooms very little artificial light was used. The amendment was lost, and the matter then dropped.

DUBLIN.—For purposes of the electric lighting undertaking the Corporation has taken up a loan of £18,650 from the Royal Liver Friendly Society of Liverpool.

DUNDEE.—The Public Health Committee have agreed to instal a system of electric lighting into King's Cross Hospital at a cost of between £250 and £260.

KETTERING.—An application by the Urban Council for sanction to borrow £2,000 for the purposes of the electricity undertaking has been the subject of a Local Government Board inquiry.

MAESTEG.—The Board of Guardians have under consideration the question of electrically lighting the cottage homes at a cost not exceeding £70.

MIDDLETON.—The Heywood and Middleton Water Board has resloved to instal the electric light in the Middleton offices.

NOTTINGHAM.—The Electricity Committee of the City Council report that the rate of wages paid in the Electricity Department is a little less than 5½d. per hour, and to increase it to 5½d. would cost £96 4s. more. The additional cost at 6d. would be £355 17s. 6d. One day's rest in seven would cause very little, if any, additional expense.

PORTSMOUTH.—The Corporation electrical undertaking continues to make most encouraging progress. Although the demand upon the resources of the generating station for the purposes of public lighting has greatly increased, there has been nothing more remarkable in connection with the growth of the business of the undertaking than the ever-growing popularity of the light among private consumers. At the present time there are 4,380 private consumers using 16 c.p. lamps or their equivalent, numbering something like 117,000, connected with the mains, and the total number of units sold by meter approximates two and three-quarter million, as compared with 135,556 units sold during the first year of the undertaking; and the total number of units sold for all purposes, including public lighting and by contract, now aggregate 3,476,000. Since the opening of the generating station in Gunwharf-road in June, 1894, the undertaking has provided £12,000 out of surplus profits for the relief of the local rates.

RENFREW.—The Clyde Valley Electric Power Co., are to lay electric cables from Rutherglen to Renfrew, *via* Cathcart, Newlands, Pollokshaws, Crookston, and Cardonald.

STOURBRIDGE.—Electric light is to be placed within the reach of consumers resident in High-street, Coventry-street, Market-street, and New-road. The laying of the connections takes place this month and the time taken for this work should be about six weeks. The work is being done by the Midland Corporation Electric Supply Company. The Urban Council obtained the Electric Lighting Order several years ago, but did not put it into use, having meanwhile found a speculation in the gas undertaking, and the order was leased to the company.

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WORKINGTON.—It is reported that negotiations are in progress between the Electrical Co., Ltd., London, and West Cumberland Distribution Power Co. with the object of acquiring all the rights of the latter and erecting large electrical works, the site of which is that of the old North-Western works, on the north side of Workington. Mr. G. R. Beith is acting in the matter for the electrical company and Mr. J. Paterson, Workington, for the distribution company.

Overseas.

BRITISH COLUMBIA.—A new long distance line between Victoria and Cumberland has been opened by the British Columbia Telephone Co. Nanaimo was the farthest point north reached by the telephone system formerly. The new line adds another 70 miles of wire, and gives communication with Parksville, Little Qualicum, and Union Bay. At the present time the company is installing a branch exchange in Cumberland and in Courtenay. From this point it is proposed to extend the line up the Courtenay Valley and down to Comox Bay.

BUENOS AIRES.—The local authority is reported to be considering a scheme for municipalising the telephone service. *The Review of the River Plate*, commenting on the proposal, says: "We do not expect anything to come of it, and it will be best for the public if nothing does. The Buenos Aires municipality has not shown itself an expert in any of the public services to-day under its direction." The Public Works Committee of the Chamber of Deputies has reported favourably on the project of the Western Railway for the construction of a "Tube" from the Once to the Port of Buenos Aires.

CALCUTTA.—The Calcutta Electric Supply Corporation, Ltd., announce that the number of units delivered to consumers during the five weeks ended July 30, 1909, were 904,731, compared with 724,011 units in the corresponding five weeks of 1908.

CALIFORNIA.—Modern electrical pumps are to replace the old Cornish plunger pump, which has been working in the Empire mine for the last 40 years. As the mines of the district grow deeper, the Cornish pump will, it is stated, be eliminated, and replaced by the electric centrifugal pump.

CONSTANTINOPLE.—The Turkish Ministry of Public Works has appointed a Commission to make investigations with a view to the establishment of electric lighting and power works in Constantinople. The Ministry of War and the Municipality of Constantinople are also represented on this Commission. After estimates have been prepared an invitation will be publicly made to those interested to make offers for the concession, which will be granted to the firm giving the best advantages.

COSTA RICA.—A report states that the Costa Rica Electric Light and Traction Co. have acquired rights for a 5,000 h.p. water-driven power station at El Brazil, and have commenced work.

INDIA.—At an estimated cost of Rs. 45,000, the Oudh and Rohilkund State Railway are, it is reported, arranging to fit 16 more upper class carriages, four-wheelers, with this pattern of electric lights and twin fans; namely, 4 first-class, 8 composite first and second-class, and 4 second-class carriages. The North-Western State Railway also are fitting Stone's electric lights and fans to 14 more composite first and second-class carriages at a cost of about Rs. 41,000 as part of a larger scheme for so equipping all passenger vehicles. At the end of last year the North-Western Railway had only 43 vehicles fitted for electric lighting, while 2,204 vehicles were fitted for gas lighting. The Oudh and Rohilkund State Railway had 13 vehicles fitted for electric lighting, and 730 vehicles for gas lighting, while 144 vehicles were not fitted on either system.

NEW YORK.—There is to be an improvement effected in the fire-alarm system in the city. For a great many years, according to the *Times Engineering Supplement*, New York City has had an inefficient fire-alarm system, and it is still centred in a building which is not fireproof. The Board of Estimate and Apportionment recently appropriated £20,000 for the preparation of plans for an entirely new and modern system, and probably £400,000 will be allowed for its installation. The central fire-alarm telegraph station will be located in a strictly fireproof building in some isolated place, possibly Central Park, and the telegraph and telephone wires will be laid in underground ducts or subways, and thoroughly protected at all points from disturbance by or damage from high voltage circuits. The alarm boxes themselves, which are now of such a type and so located that simultaneous alarms would conflict, will be of a non-interfering type and systematically disposed, so that there can be no confusion. When this new system is in operation there will be no need further for placing reliance on the public telephone service, as it was found expedient to do last winter, when an emergency duplicate telephone switchboard was installed in one of the central exchanges so that, should the fire headquarters be destroyed, communication could still be obtained with the engine houses.

ONTARIO.—The work of reconstructing the telephone system of the Temis Kanung and Northern Ontario Railway between North Bay and New Liskeard is now in progress. The new system will be equipped with all the most modern improvements, and will be designed to provide a convenient and efficient service to the mines and the settlers of the district. In the new depot at Cobalt an up-to-date switchboard will be installed to give a connection with the mines. The line will also be extended along the Kerr Lake branch to Kerr Lake Station, where a switchboard will be located.

RUSSIA.—It is reported that the Slatons Works in the Ural District, which are the property of the Russian Crown, have obtained the right to use the process of a German company for electric steel plant, the furnace in question being on the induction principle. The electric plant will be supplied by the Siemens-Halske Co. The Slatons Works propose to further handle the produce of their electric steel works.

SANTA FE.—Authority has been given the Mayor to invite tenders for the necessary plant for increasing the output of the electric light station.

SOUTH AMERICA.—It has been decided to establish wireless telegraphy stations at Mogotes, Punta Delgada, Leones Island, Penguin, Monte Entrance, Cape Virgen, Rio Grande, Observatory at Año Nuevo, San Pio Cape, and Port Halventon, and a land line from that place to Ushuaia. Each of the towers will be 40 m. high, and on top will have lamps of 300 c.p.

TRACTION—Home.

ABERDEEN.—The question of the arbiter's award between the Suburban Tramways Co. and the Aberdeen Corporation has been discussed by the Electricity Committee. The position taken up by the Suburban Tramways Co. was that the reference to the arbiter was to fix the charge for the current at so much per Board of Trade unit supplied, whereas the arbiter fixed the price upon the maximum demand system, making a standing charge per annum of £900, and in addition to that a charge of ½d. per unit supplied. This award the company holds to be *ultra vires* on the part of the arbiter, and they decline to abide by it. The position taken up by the Town Council is that, while they do not admit that the award is outside the reference, the Suburban Tramways Co.'s agent acquiesced in the finding of the arbiter, and was now barred from taking exception to it. A sub-committee was appointed to investigate the facts with reference to the award before the committee should decide whether it should maintain its validity or otherwise. A report was submitted showing the flat rates for electricity which would produce a revenue similar to that now obtained for the past year. It was resolved to postpone the question until *next meeting*. The Suburban Tramways Committee, it is *understood, deny having* acquiesced in the finding of the arbiter, and state that they protested against it whenever they were made acquainted with its terms.

DUNFERMLINE.—The construction of the Dunfermline and District Tramways is being pushed forward rapidly, and the towns to be tapped in the meantime from Dunfermline include Lochgelly, Cowdenbeath, and Kelty, while in the near future it is expected that the line will run from Dunfermline to the naval base, and that there will be forty or fifty miles of tramways.

EDINBURGH.—The Bill promoted by the Colinton Tramways Co. has been before the Examiner at the House of Commons. By the Bill power is taken to construct tramways in Colinton (Edinburgh) to be worked by electric traction. The capital of the company is to be £50,000, in £1 shares, and borrowing powers are taken up to one-third of the share capital actually issued. The general orders were found to have been complied with and the Bill was allowed to proceed.

HALESOWEN.—The Board of Trade have recently confirmed the Halesowen Light Railways (Transfer, etc.,) Order, 1909, transferring to a Company the powers conferred upon the Rural Council of Halesowen by the Halesowen Light Railway Order, 1901, and by the Halesowen Light Railways (Extensions) Order, 1902, and amending those Orders.

PRESTON (Lancashire).—The income in respect of the Corporation tramways for the year ended March 31 last was practically the same as in 1908, £38,863 against £38,762. The expenditure, as Councillor Crompton (chairman) explained to the Tramways Committee, amounted to £23,495, against £22,961, an increase of £534 over last year, which was accounted for by £200 extra being paid in wages for motor men and conductors, and £300 for new cables put overhead to replace the underground cables, so that the expenditure also was practically the same as last year. To the reserve they placed £3,760, against £3,194, which was £565 more. The miles run totalled 924,609, against 906,360, an increase of 18,249, and the car earnings per mile were, therefore, slightly less—9·94d. against 10·13d. Since the trams commenced running they had run 4,042,913 miles, and the passengers carried numbered 37,587,311, equal to the inhabitants of Preston three times over. The receipts during that time had been £171,746, and out of this they had paid £55,127 in interest, and to sinking fund, and £58,319 in wages. The units generated for the year were 1,652,207, and the cost was 363d. per unit. There were

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thirteen other municipal tramways owning their own generating station, and the average cost to these was 494d., so that Preston stood in the happy position of being 25% less than this average. They had accumulated £16,862 to the reserve fund, but that did not include all that they had made or ought to have had. They had been paying an assessment of £1,000 a year more than they ought to have been paying, representing £4,000. They had repaid £4,343 of the old tramways debt, which was part of the legacy of £22,032 left them from the old trams, and they had paid out of revenue for top covers £1,750. They had also spent £400 on the alteration to Fishergate paving, and £400 to Corporation-street paving, they had put in a new loop at the Workhouse at a cost of £220, and altogether they had expended £11,242, which might have been added to the reserve fund, and would have made the fund, in his opinion, very handsome indeed. Taken on the whole, they might conclude that the trams were worked not only satisfactorily, but so far had been a very marked success.

SOUTHAMPTON.—The abstract of the Tramways accounts for the year ended March 31 last shows that the traffic receipts amounted to £54,176, being an increase of £1,482 compared with the previous year. The total income was £56,204 against £54,628. Working expenses, including repairs, came to £37,062, being an advance of £1,704; power for traction and lighting cost £11,193 against £11,081; and repairs and maintenance and other expenses, £18,857 against £18,180. The gross profit for the year was £19,142, a decrease of £128. After allowing for loan and interest charges, the balance carried to appropriation account is £12,767, as compared with £13,089 in the preceding year. The passengers carried numbered 10,418,959 against 10,121,887. The capital expenditure defrayed out of revenue last year amounted to £4,732, and the total capital expenditure undertaking now stands at £202,483.

YORK.—Arrangements have been made by the Corporation with Messrs. Dick, Kerr, and Co., the contractors for the system of electric tramways, in York, to make a start with the new track at Fulford and work towards the city. Dringhouses will also be invaded by an army of workmen, almost at the same time, who will join forces with those working from the opposite direction somewhere about the centre of the line of route. It is desired by the City authorities to keep the old system of horse tramways running as long as possible, which is one reason why a commencement is being made at the extreme ends of the track, although it must necessarily follow that there will be a shortening of the existing route as the new track is being laid. Six months have been stipulated as the period for the completion of the contract.

TRACTION—Overseas.

BUENOS AYRES.—Official returns of the Tramway Companies show that in June there were 630 kilometres of electric tramway, and only 1 kilometre of horse tramway in the city. For the first six months of this year there were 135,918,298 passengers carried on the electric tramway, as compared with 123,646,681 for the corresponding period of 1908. The output (kilowatts) of the German Electric Light Co. for the half-year comprised the following, the figures in parentheses giving the totals for the corresponding period of 1908: Light, 14,401,767 (11,588,099); power, 5,731,920 (4,838,666); traction, 24,304,990 (22,611,604). The Rosario Tramways, with 160 kilometres of line, carried 9,201,428 passengers during the half-year, as against 6,974,192 in the corresponding period of last year.

BUENOS AYRES.—To the Municipality the Administrator-General of the Anglo-Argentine Tramway Co. has presented the outline of a scheme for the construction of underground tramways in Buenos Ayres. As a guarantee of the fulfilment of the obligations the company undertakes to enter into, the sum of $100,000 has been deposited in the Banco de la Nacion. The network of underground tramways which it is proposed to construct will extend over, or rather under, the whole of the city, and will connect Palermo, Retiro, Plaza de Mayo, Once de Setiembre, Parque Lezama, and Constitucion with each other. The Administrator-General of the Anglo-Argentine Tramway Co. undertakes to present the plans of this important work within six months and to complete the construction within three years of signing the contract. The cost of the undertaking is estimated at $50,000,000 paper.

FRANCE.—The first section to be completed of the great network of electric railways, which are to serve the whole region of the Pyrenees in the South of France, is the line from Villefranche to Bourg-Madame. This undertaking, says a correspondent to the *Times Engineering Supplement*, will continue the railway from Perpignan to Prades and Villefranche into the Upper Valley of the Tet, and will link together the two lines which join France and Spain—namely, the line following the coast from Perpignan to Barcelona and the railway between Ax and Ripoll, the construction of which is being actively prosecuted. This latter line will unite Toulouse and Barcelona through the valleys of the Ariége and the Sègre. The new railway starts from Villefranche at an altitude of 1,407·5 ft. above datum and climbs by a very pictureque ascent to the summit of the Col de la Perche, at a height of 5,220 ft. The gradients throughout average 6 per cent. The line then descends by the Valley of the Sègre and reaches Bourg-Madame at an altitude of 3,750 ft.; the total distance traversed being a little over 34 miles. The railway is of the narrow gauge and the width of the formation is 13·8 ft. There are three composite trains daily in each direction, with a fixed speed of 12·4 miles per hour. These trains will consist of motor coaches and trailers, and each of them will accommodate about 300 passengers and carry 80 tons of goods. Among the chief structural features of the undertaking are the viaduct of Fontpédrouse and the rigid suspension bridge over the Cassagne. Electric traction is provided for by means of motor coaches, each one fitted with four motors of 50 h.p., two on each bogie. The motors are dealt with as multiple units on the Sprague system, and continuous current is employed for the supply at a tension of 800 to 850 volts, as is used on the Paris Metropolitan Railway and on the line from Paris to Juvisy. The central generating station is situated at La Cassagne, about the middle of the line. The hydraulic power for the central generating station is derived from the river Tet, each of the turbines being supplied by a pressure main 3,346 ft. The railway, inclusive of the accessory works and the construction of the above reservoir, has cost £800,000.

ITALY.—The Ministry of Public Works have issued a favourable report in connection with the concession for the construction and working of an electric tramway from Trani to Corato. The plans were submitted by Signor Giuseppe Traversi last April. A favourable report has also been issued relative to a concession for the construction and working of an electric tramway from Badia to Ripoli and Grassina, in the province of Florence.

NETHERLANDS.—According to the published terms of an agreement, dated 19th August, entered into between the Minister van Waterstaat and the Nederlandsche Buurtspoorweg-Maatschappij, of Utrecht, whereby the latter are granted a concession to construct and work an electric railway from Utrecht to Zeist *via* Bilt. The work of construction must be completed within two years from the date of the concession.

NORTH COBALT.—The grading for the electric railway from Cobalt to Haileybury is nearing completion. The only delay now is that the Haileybury end, where, in deference to the representations of many citizens, the proposed line has been slightly altered.

OTTAWA.—Notice has been given of the intention to apply to Parliament for a charter for the Rainy River Radial Railway Co., with power to build from the international boundary to Fort Francis to the Lake of the Woods at the mouth of Big Grassie River, with branches to Long Sault Rapids, and with power for telephone, express, light, heat, and power business.

PARLIAMENTARY.

MINING RATES REVISION.

Mr. Gladstone (Home Secretary), in reply to Mr. John Wilson (Lab., Mid-Durham), said: I have had under my consideration the report of the Chief Inspector and District Inspector on the West Stanley disaster, and other reports which have reached me from time to time in regard to the use of electricity in mines and the working of the special rules. Since the previous inquiry five years ago much further experience on the subject has been obtained, new points have arisen, and the special rules, the working of which has been carefully watched by my Department, have shown themselves in need of amendment on a number of points. I propose, therefore, to appoint a small expert Committee to revise the rules in the light of the experience which has now been gained of their working.

Mr. Gladstone added that a thorough enquiry would be made into the use of electricity in mines, and its relation to explosives.

WIRELESS TELEGRAPHY.

Mr. Seddon (Lancashire, S.W., Newton, Lab.) asked the President of the Board of Trade whether, in view of the national concern for news of the steamship *Waratah*, he could promise an inquiry into the various systems of wireless telegraphy with a view to making an installation compulsory on all vessels carrying passengers, and at British and Colonial ports.

Mr. Churchill said: The question of the installation of wireless telegraphy apparatus on passenger ships has been, and will continue to be, very carefully watched by the Board of Trade, but I do not think any useful purpose would be served by a special inquiry at the present moment.

ADMIRALTY AND SUBMARINE CONSTRUCTION.

Dr. Macnamara, replying to Mr. Middlemore, said that Messrs. Vickers Sons & Maxim, Ltd., had not a monopoly in submarine construction. The Admiralty did consider designs and suggestions put forward by other firms.

COST OF A "WIRELESS" STATION.

The Postmaster-General stated, in reply to Mr. Will Crooks, that the capital cost of the Post Office wireless telegraph station at Bolt Head has been about £2,000, and its annual cost, including allowances for interest and depreciation, is estimated at about £750. The work of the station hitherto has been chiefly experimental, and in connection with the arrangements for giving effect to the International Radio-telegraphic Convention. A considerable number of ships report their position to Bolt Head in passing, but happily no messages have had to be received from ships in distress.

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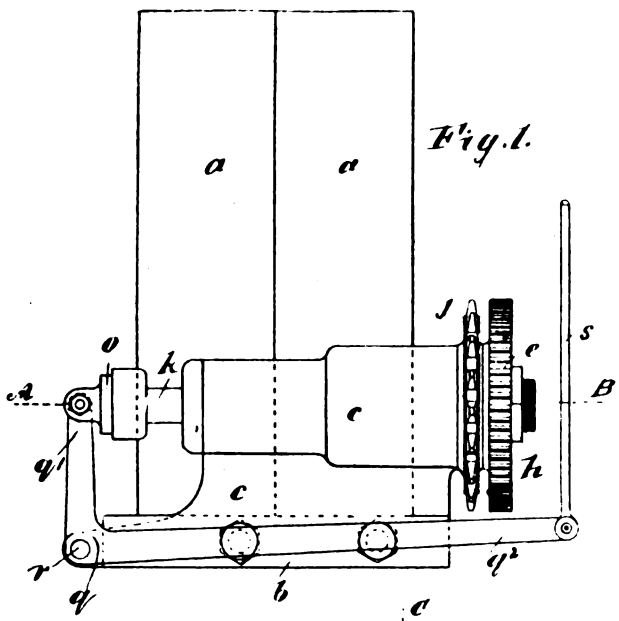
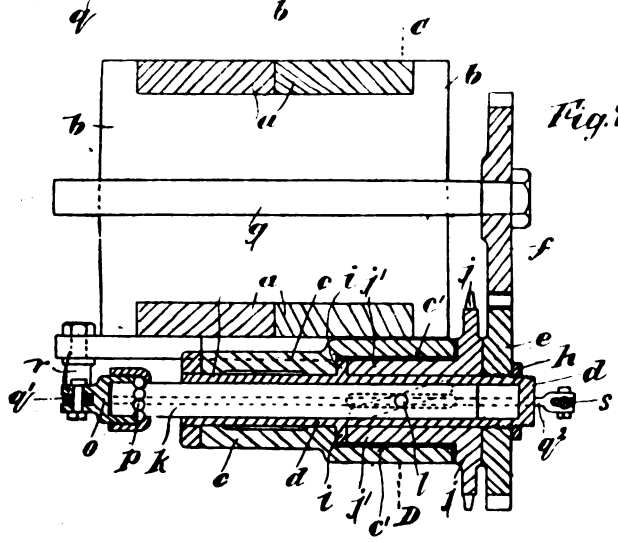
PATENTS.

Magneto-Ignition Devices.

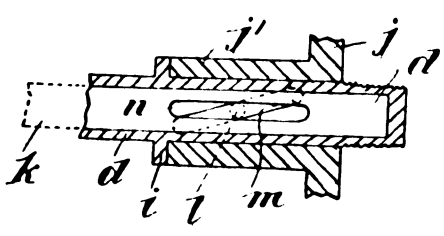
24403.—1908. W. MULHOLLAND, Belfast. The improvements consist in providing means for mechanically advancing and retarding the ignition whilst retaining the maximum spark in all positions whether fully advanced or fully retarded, thus rendering magneto-ignition equal in flexibility or adaptability to accumulator or battery ignition. Fig. 1 is a side view, and Fig. 2 a sectional plan on line A, B, Fig. 1. Fig. 3 is a sectional end view taken on the line C, D, Fig. 2,



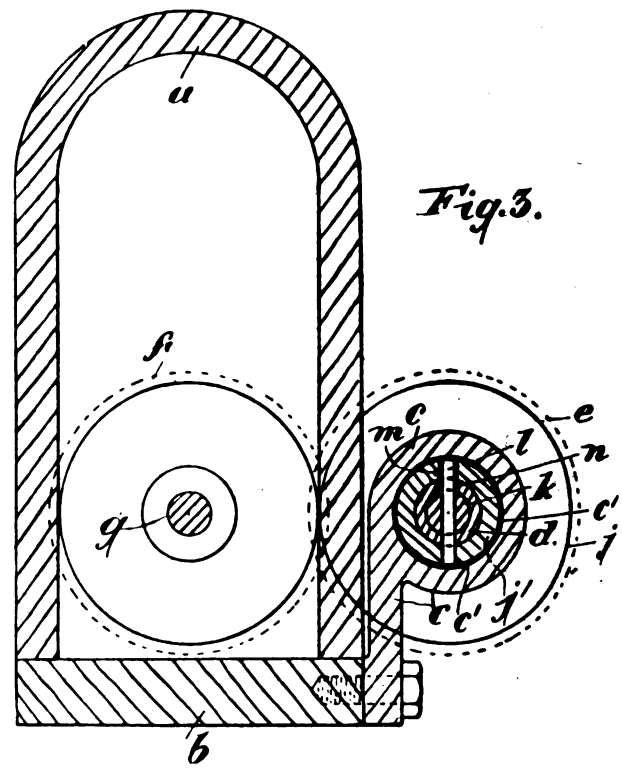


and Fig. 4 is a detail view. The magnets *a* are mounted on a base *b* as usual, and fitted to the base is a hollow bracket *c*, which has a hollow countershaft *d* slightly tapered and screwed at one end for the reception of a toothed wheel *e* which gears with a corresponding wheel *f* fitted on the armature spindle *g*. This wheel *e* may be secured on the end of the countershaft *d* by means of a jam nut *h*. The hollow countershaft *d* is provided with a collar *i* about midway of its length, and fitted loosely on

Fig. 4.



the exterior of the hollow countershaft is a driving pinion *j* actuated from the usual half speed shaft. The driving pinion *j* is made with a boss j^1 which extends along the exterior of the hollow countershaft, so that its end bears against the collar. Fitted in the hollow countershaft *d*, and extending a short distance beyond one end, is another shaft *k* which is capable of being moved backwards and forwards longitudinally, and is provided with a pin *l* which projects at right angles. The boss j^1 of the driving pinion *j* is made with a short volute or helical slot *m*, and the hollow countershaft *d* is also made with a slot *n* parallel to its axis so that the pin *l* fitted on the shaft *k* projects through the longitudinal slot *n* in the hollow countershaft into the slot *m* in the boss of the driving pinion. The projecting end of the shaft *k* has fitted to it an end piece *o* to which one arm of a bell crank lever *q* is secured. In order to allow of freedom of movement, this end piece may be provided with a ball bearing *p*. The bell crank lever *q* is fulcrumed at *r* to the base *b* carrying the magnets *a*. When the advancing and retarding lever *s* is raised or depressed the shaft *k* is actuated either in one direction or the other, and in this longitudinal movement the projecting pin moves freely along the slot in the hollow countershaft, but as the pin also projects into the slot *m* in the sleeve of the driving pinion, and as this latter is capable of a certain amount



of rotary movement on the hollow countershaft, its movement can be either advanced or retarded in accordance with the direction of movement of the longitudinally moving shaft *k*. As the driving pinion is directly connected to the armature of the magneto, it will be obvious that when the movement of the pinion is advanced or retarded the armature is similarly advanced or retarded. By advancing or retarding the movement of the driving pinion and the armature of the magneto in the manner described through the medium of the lever, bell crank lever, and longitudinally moving shaft, the ignition can be either advanced or retarded mechanically as may be desired, whilst the maximum spark is retained. The improvements are specially applicable to magnetos such as are used on motor cycles where space is limited lengthwise, and as the mechanism is all enclosed the apparatus is practically rendered dust-proof.

Time Relay for Electric Currents.

8570.—1909. D. TIMAR & R. ZIEGLER, Berlin. Safety fuses are allowable in low tension installations, but in high tension installations it is better to use special cutting-out switches, which only come into action when a definite excess of the current beyond the normal is reached. In this case their current circuit is interrupted in a time which is so much shorter the greater the unexpected increase of strength or excess of current is beyond the fixed upper limit permissible in the normal working, so that the product of the strength of the current multiplied by the time remains nearly constant. Fig. 1 shows a time relay of this description in vertical section, and Fig. 2 is a diagram of the main switch and the relay current circuit and the relay current circuit connected to it. The contact vessel 1 is rigidly connected with the armature 2 and with the two contact pieces 3 and 4. With an excess current the armature 2 is drawn down by the action of the solenoid 5 excited by the current, and is dipped into the mercury 6 in the fixed vessel 7. If the contact pieces 3 and 4 are insulated, it is indifferent whether the vessels 1 and 7 are made of insulating material or not. The mercury now flows slowly in through the opening 8 in the bottom of the vessel 1 and closes, after the predetermined time, the contacts 3 and 4, so that the releasing circuit 12 is likewise closed. The stronger the excess current

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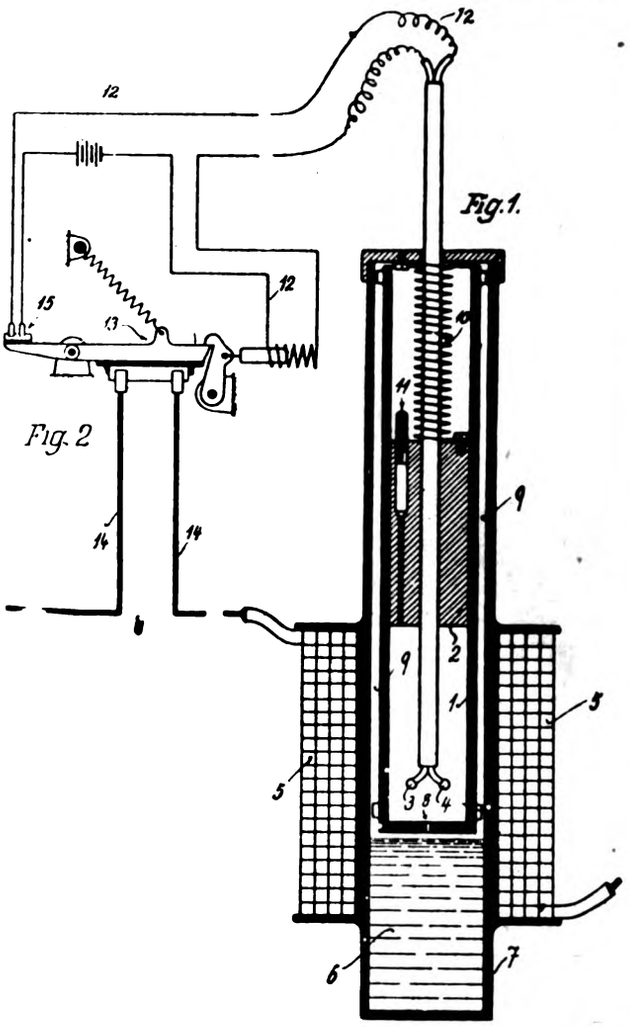
so much deeper is the contact vessel immersed in the mercury, and so much higher rises the mercury in the narrow space 9 between the two vessels, and so much more does the difference of pressure increase and the consequent inflow of the mercury. By this very simple arrangement the dependence of the releasing time upon the varying strength of the excess current is secured. The air pressed by the entering mercury can escape through a narrow channel in the iron core 2, which is furnished with a regulating screw 11. The adjustment of current and time is in this case very easy to effect. For this purpose there come into consideration the tension of the spring 10, the position of the iron core in the solenoid, the distance of the contact pieces from the inflow opening 8 for mercury, the arrangement and the sizes of the various parts all of which can obviously be made regulatable by known devices. The air screw 11 can also be used as a regulating means. On stopping the excess current the armature is raised by the spring 10 and the mercury flows slowly back. When a special source of current is used for the releasing circuit injurious sparking occurs at the backward flow of the mercury from the contact pieces. In order to avoid this, the releasing switch may be so arranged that immediately the main switch 13, Fig. 2, interrupts the main conductor 14, a contact 15 belonging to the releasing circuit is broken. This contact can, in consequence of its position, be made large enough to resist sparking for a considerable period. In this way the releasing circuit becomes free of current before the opening of the mercury contact, and the contact pieces and the mercury remain protected from injury.



Electric Motor Generator Sets for Supplying Arc Lamps to be Used as Searchlights.

15130.—1908. ALLGEMEINE ELEKTRICITATS GESELLSCHAFT, Berlin. The invention consists in so connecting the field windings that instead of the motor and generator each having series windings as hitherto, the second winding of the motor is excited from the armature of the generator and connected in series therewith. The second winding of the generator is connected in parallel with its armature.

Machine for Winding Coils of Wire for Electrical Purposes.

15053.—1908. A. E. WILDERSPIN & E. S. HOUGH, London. The wire is maintained in winding at right angles to the reel on which it is wound, so that the wire travels in that position to and fro, corresponding to the speed of winding. The machine is operated by positive gear, and change wheels are introduced for the purpose of varying the speed according to the number of turns of wire per inch length coil to be wound. Guiding nuts are also provided and mounted on spindles, whereby the wire to be wound is guided in a position always at right angles to the reel in its movement to and fro in winding.

Magnetic Separators.

15646.—1908. E. OSTERLE, Indiana, U.S.A. The electromagnet comprises an upper pot magnet consisting of an outer bell-shaped member and an inner core with a magnetising coil placed between the core and the outer member. The outer member is cylindrical for the greater part of its length, but at the lower portion it is of increased diameter to form the poles, and this larger portion does not form a complete circle, but is cut away so that two pole pieces are formed. A lower member is also provided, shaped somewhat similarly to the upper member, but quite short, its function being to partially complete the magnetic circuit, and not to hold the magnetising coil.

Electric Furnaces for Treating Ores.

15645.—1908. E. OSTERLE, Indiana, U.S.A. The furnace has an annular chamber provided with water-jacketed walls. In this chamber the finely divided ore is placed, and heated gas entering through inlets in the upper part of the chamber is caused to pass through the ore and to issue from under a circular lip formed by the under edge of the chamber wall, thus finally acting on the ore just as it enters the pool of molten lead at the bottom of the furnace.

Supports for Contact Ploughs.

16305.—1908. J. G. BRILL Co., Philadelphia. A support is provided for contact ploughs or electric current collectors for electric railways that will properly support the plough in any desired position without interfering with the brake or motor mechanism.

Arc Control Mechanism for Searchlights.

16722.—1908. BRITISH THOMSON-WOUSTON CO., LTD. Arc control mechanism for projectors is usually provided with an automatic feeding device which keeps an even gap between the electrodes to compensate for the loss of carbon while burning. According to the patentees, this mechanism is unable to move the electrodes through varying small amounts in order to increase or decrease the gap to compensate for arc changes. In large projectors, especially when thick carbons are used, the arc current and volts vary with the crater formation and carbon texture, causing either a sudden decrease or increase in the arc drop. In order to maintain even illumination it is, therefore, desirable automatically to increase or decrease the arc length. The inventors provide an automatic device of this nature. A driving mechanism moves one or both electrodes, and is controlled by a pilot device which determines both the direction and extent of movement required to keep the arc length constant. This pilot device may take the form of an electro-magnet, and is made responsive to potential between the electrodes by being connected in parallel with them, and controls the driving mechanism in any suitable way.

Shade Carrier for Lamps.

19705.—1908. J. NELSON & DRAKE & GORHAM, LTD., Westminster. The object is to support and clip electric lamp shades so that they can be readily removed for cleaning and at the same time be secure against accidental displacement. Two or more bayonet slots are cut in the barrel of the lamp. holder similar to those already cut for the support of the lamp. A tube with pins fitting the slots is passed outside the barrel of the lamp holder, and the end of the tube is turned up to retain a spiral spring. The shade is slipped over the barrel of the lamp holder in the usual way, the spiral spring is placed on the outside of the separate tube, and the two are slipped over the barrel from the inside of the tube and pressed up until the pins engage with the slots.

Induction Coils and Transformers.

19886.—1908. H. F. BIGGE, Hemel Hempstead. The improvement in induction coils and transformers having a hollow chamber within the insulated soft iron core section of the primary winding consists in the arrangement of the insulated sections of the core in the space between radiating projections of insulating material and also in the method of insulating the core scetions from each other and from the disc.

Converting Petrol Omnibus Chassis into Electric Vehicles.

20210.—1908. This is a method of converting into electric or petrol-electric vehicles existing omnibus chassis in which the final drive is by means of sprockets and chains from a differential gear fixed at right angles to the frame. The invention consists in the application of an electric motor fixed across the frame of the chassis at the rear of the main axle and with its shaft parallel to the side frames. The differential shaft carrying the chain wheels on its extremity with its bevel gear is reversed in its position

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on the chassis shaft so that the cardan shaft is carried towards the back of the vehicle instead of towards the front. The electric motor then drives the small bevel wheel of the differential direct by means of a horizontal cardan shaft, parallel to the side frame of the vehicle. In vehicles originally driven by a petrol engine the engine and gear box are removed and the battery is slung under the frame in the ordinary way. In this way the electric motor is fixed in a very convenient position on the chassis, enabling the battery to be suspended from the frame as near to the back wheels as possible, part of the weight of the battery being balanced by the electric motor on the opposite side of the axle, thus keeping the weight on the steering wheels down to a minimum.

Electrodes for Accumulators.

21004.—1908. Nya Ackumulator Akt. Junger, Smaland, Sweden. This electrode for accumulators using an alkaline electrolyte consists of porous graphite made from carbon by heating it. Into the pores of this an electro-active substance insoluble, or nearly insoluble, in the electrolyte is deposited. The thin plate of porous graphite is saturated with a solution of chloride of nickel crystals in alcohol. The alcohol is driven off by heat, and the operation is repeated until a sufficient quantity of chloride of nickel has been introduced into the pores.

Incandescent Electric Lamps.

3897.—1909. E. Böhm, London. The top of the bulb of this lamp is opal, the sides crystal, and the bottom opal. The light is thus reflected from the top to the bottom and from the bottom back to the top. At the same time the light from the sides of the filament is thrown out at the crystal sides horizontally and in other directions from the top and bottom of the globe. The top opal is very deep in shade and the bottom very transparent; this gives a softer and more diffused light from the points of the bends of the metal filaments.

Trolley-Frogs.

7795.—1909. F. J. Venning, Pittsburgh. A wearing plate that can be easily and quickly attached to the frog is provided to increase its life and an attachment that will receive the wear and tear of the trolley wheel.

Transformers for Operating Vapour Electric Apparatus.

7630.—1909. F. Conrad, Swissvale Station, U. S. A. These transformers comprise primary windings, secondary windings and windings common to both circuits so arranged on the core that the portion of the primary winding not common to the secondary circuit, has magnetic leakage paths which influence the magnetic leakage paths of the other portions of the transformer windings.

Life Guards for Electric Cars.

3280.—1909. H. W. Johnson & W. Steele-Brown, London. This improved guard not only has its back end curved upwards to prevent fallen objects getting over the rear, but is also curved in above to prevent injury to the fallen person by being thrown upwards. The guard has special actuating mechanism whereby the required scoop-like action is given. An electro magnet holds the guard in position.

INSTITUTION OF MINING ELECTRICAL ENGINEERS.

At a Council meeting of the Institution of Mining Electrical Engineers, held at the Royal Victoria Hotel, Sheffield, the following Branch Presidents and representatives were present:—Messrs. R. Hood Haggie (South of England), Sidney F. Walker (South Wales), H. W. Clothier, A. M. C. Field, H. J. Fisher (North of England), Arthur Hall (Warwickshire and Staffordshire), J. A. Bosher (North Wales), J. Kirkby and F. Cusworth (Derbyshire and Notts.), P. D. Coates and J. H. C. Brooking) Lancs.), R. J. Frost (Rotherham), and others, the President of the Institution (Mr William Maurice) being in the chair. A report was presented by the Hon. Secretary (Mr. J. G. Williams, 3, Moresby Park, Whitehaven), showing that the membership had now reached 300, with a prospective immediate increase to 400 by the addition of candidates who had not yet been formally elected.

The Draft Memorandum and Articles of Association were submitted and provisionally approved.

It was resolved to create a Diploma Class of Membership, to which candidates could only obtain admission by examination, after having had an approved term of practical experience in charge of electrical plant in mines. It was further arranged that entrance fees should be payable by members of all classes who join after the incorporation of the Institution.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last price. £
Alliance Electrical Co., 5 p.c. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
—— Ord., 1,125,000	1 ..	¼-½
Aron Electr'ty Meter, 6 p.c. Cum. Pref. Sh's, 1-125,000	1 ..	¾-1
—— Ordinary, Nos. 1-125,000	1 ..	¾-1
British Aluminium Co., Ordinary, 1-40,000	5 ..	4-4¼
—— 7 p.c. Cum. Pref., 1-40,000	5 ..	11¼-11½
—— "A" 6 p.c. Cum. Pref., 1-20,000	5 ..	3¼-3½
—— 4 p.c. Funding Certificates, 1-20,000	5 ..	2¼-3¼
—— 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	73-78
—— 5½ p.c. Loch Leven Deb. (Reg.), Red., 1-3,000	100 ..	95-98
British Insulated and Helsby Cables, Ord. 1-100,000	5 ..	7¼-7½
—— 6 p.c. Cum. Pref., 1-100,000	5 ..	6¼-6½
—— 4½ p.c. Mortgage Debentures	100 ..	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	89-94
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 275,001-475,000	3 ..	3/16-7/16
—— p.c. Mortgage Debenture Stock	100 ..	38-42
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	0-¼
—— Non. Cum., 6 p.c., Pref.	2 ..	0-¼
—— 4 p.c. 1st Debenture Stock	100 ..	41-46 xd
—— 4½ p.c. 2nd Debenture Stock	100 ..	27-31
Callender's Cable, Debentures	100 ..	104½-106½
—— Ordinary	5 ..	10¼-10½
—— 5 p.c. Pref.	5 ..	5¼-5½
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	¼-½
Crompton and Co., Nos. 1-85,000	3 ..	¼-1¼
—— 5 p.c. 1st Mort. Reg. Debs., Nos. 1-900 of £100, and 901-11,100 of £50, Red.	— ..	90-93
Dick, Kerr, and Co., Ordinary, 1,260,000	1 ..	1¼-1 5/16
—— 6 p.c. Cum. Pref., 1-305,000	1 ..	1¼-1½
—— 4½ p.c. Debenture Stock.	100 ..	100-103
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¼-½
—— "A" Shares, 01-017,139	5 ..	1-1½
—— 4 p.c. Deb. Stock, Red.	100 ..	84-87
—— 5 p.c. Debentures	100 ..	68-73
Electric Construction, Nos. 1 to 112,100	2 ..	7/16-½
—— 7 p.c. Cumulative Pref.	2 ..	1 3/16-1 7/16
—— 4 p.c. Perp. 1st Mort. Deb.	100 ..	65-69
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	71-77
General Electric Company (1900) 5 p.c. Cum. Pref.	10 ..	7¼-8¼
—— 4 p.c. 1st [illegible] Deb. Stock	100 ..	85-88
W. T. Henley's Telegraph Works, Ordinary	5 ..	12¼-13¼
—— 4½ p.c. Preference	5 ..	5-5½
—— 4½ p.c. Debentures	100 ..	105½-107½
India Rubber, Gutta Percha, and Telegraph Works	10 ..	14¼-15¼
—— 4 p.c. Debentures	100 ..	100-102
National Electric Construction Co., 1-170,000	1 ..	¼-½
Telegraph Construction and Maintenance	12 ..	34½-36
—— 4 p.c. Bonds	100 ..	100-102
White, J. G., and Co., 6 p.c. Cum. Pref., 1-15,000	10 ..	9½-10½

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4¼-5¼
Bournemouth and Poole, Ordinary	10 ..	9¼-9½
—— 4½ p.c. Cum. Pref., 7,501-15,000	10 ..	9¼-10
—— 6 p.c. Cum. Second Pref., 15,001-22,500	10 ..	10-10½
—— 4½ p.c. Debenture Stock, Red.	100 ..	99-103 xd
Bromley (Kent) Electric Light and Power Co.	5 ..	4¼-4½
—— 4½ p.c. 1st Debenture Stock, Red.	100 ..	93-96
Brompton and Kensington, Ordinary	5 ..	7¼-8
—— 7 p.c. Preference	5 ..	7¼
Calcutta Electric Supply Corp., Ord., Nos. 1-100,000	5 ..	6-6¼
Cambridge Electric Supply Company, £10 Ord.	8 ..	12¼-13¼
Canadian General Electric Co., Common Shares	$100 ..	122-127
—— 7 p.c. Cum. Pref. Stock	$100 ..	118½-123½
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100 ..	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5 ..	4-4¼
—— 4½ p.c. Cum. Pref., 1-80,000	5 ..	4¼-4½
—— 4 p.c. Debenture Stock, Red.	100 ..	96-99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5 ..	3¼-4¼
Chelsea Electricity Supply	5 ..	3¼-4¼
—— 4½ p.c. Debentures	100 ..	100-103 xd
City of London, Ordinary	10 ..	10¼-10½
—— 6 p.c. Cumulative Pref.	10 ..	11¼-12¼
—— 5 p.c. Debenture Stock	100 ..	121-124
—— 4½ p.c. 2nd Deb. Stk., Red.	100 ..	100-103
Cordoba Light and Power Co., 1st Mt. Stl. 5 p.c. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	2¾-3¼
—— 5 p.c. Preference, 1-50,000	5 ..	3-3¼
County of London Elec. Supply, Ordinary	10 ..	7¼-8¼
—— 6 p.c. Cum. Pref.	10 ..	10¼-11
—— 4½ p.c. Debentures Prov. Certs. Al pd., Rd.	100 ..	104-107
—— 4½ p.c. 2nd Debentures Prov. Certs.	100 ..	100-103
Edmundson's Electricity Corporation, Ord., 1-80,000	5 ..	¼-5/16
—— 6 p.c. Cum. Pref.	5 ..	¼-½
—— 4½ p.c. First Mort. Deb.	100 ..	58-61
Electrical Development Co. of Ontario, 5 p.c. 1st Mort. 30-year Gold Bonds, 10,751-15,750	— ..	86-88
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100 ..	91-94
Folkestone Electric Supply, Ord., Nos. 1-10,000	5 ..	4¼-5¼
—— 5 p.c. Cum. Pref., Nos. 1-10,000	5 ..	5-5¼
—— 4½ p.c. First Deb. Stock, Red.	100 ..	97-100
Hove Electric Lighting, Ord., 1-13,000	5 ..	7¼-7½
Indian Electric Supply and Traction Co., 6 p.c. Construction Deb. Stock, Red.	5 ..	1¼-2
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100 ..	74-79
Kalgoorlie Electric Power and Lighting, 6 p.c. Cum. Pref., 1-150,000	1 ..	½-27/32
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	6¼-6½
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100 ..	95-98

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Name.	Amount paid. £	Last price. £
London Electric Ordinary	3 ..	1¼-2⅛
—— 6 p.c. Pref.	5 ..	5-5⅛
—— 4 p.c. 1st Mortgage Debenture Stock, Red.	100 ..	93-97
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100 ..	76-80
Metropolitan Ordinary, 100,001-300,000	5 ..	4⅛-4⅛
—— 4½ p.c. First Mortgage Debenture Stock	100 ..	105-108
—— 4½ p.c. Cum. Pref.	5 ..	4⅛-5
—— 3½ p.c. Mortgage Debenture, Red.	100 ..	83½-84
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,000 ($500) M 1-4,400 ($1,000)	— ..	83-85 p.c. 75
($500), 4,001-14,000 ($1,000)	— ..	88-⅛89⅛
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	94-97
Newcastle-upon-Tyne Electric Supply, Ord., 1-87,500	5 ..	4⅛-4⅛
—— do. 87,501-137,500 (issued at £1 prem.). All paid (Prov. Certs.)	5 ..	4⅛-5⅛
—— do., 5 p.c. Pref., 1-87,500 (Prov. Certs.)	2 ..	4⅛-5
—— 5 p.c. Pref., 87,501-137,500 (Prov. Certs.)	4 ..	4⅛-5⅛
Notting Hill Electric Lighting	10 ..	11-12
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6-6⅛
—— 4 p.c. Debenture Stock	100 ..	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1 ..	1 5/16-1 7/16
—— 6 p.c. Non-Cum. Pref., 1-100,000	1 ..	11/32-1 3/32
—— 5 p.c. Debenture Stock, Red.	100 ..	102-103
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5 ..	5⅛-5⅛
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5 ..	5⅛-6
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100 ..	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	.. —	105-106
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	9/16-13/16
South London, Ordinary	4 ..	2⅛-3
South Metropolitan Electric Light and Power, Ord.	1 ..	5/16-9/16
—— 7 p.c. Cum. Pref.	1 ..	1⅛-1⅛
—— 4½ p.c. 1st Mort. Deb.	100 ..	102-105
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	8⅛-9
—— 7 p.c. Pref.	5 ..	7-7⅛
—— 3½ p.c. Deb.	100 ..	84-88
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	⅛-1
—— 5 p.c. Cumulative Preference, 50,001-80,000	5 ..	1⅛-2
—— 4½ p.c. First Mort. Debenture Stock, Red.	100 ..	77-81
Westminster, Ordinary	5 ..	8⅛-9 xd
—— 4½ p.c. Cum. Pref., 110,101-138,251	5 ..	5-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 10 p.c. Non-Cum. 2nd Pref., 260,008-280,007	5 ..	4⅛-4⅛
—— Permanent 6 p.c. Debenture Stock, 1888	100 ..	91-92
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	102-105
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	⅛-⅜
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1 ..	9/16-11/16
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100 ..	88-91
Blackpool and Fleetwood Tramroad	10 ..	13⅛-13⅝
Bombay Elec. Supply and Trams. Co., 6 p.c. Cum. Pref.	10 ..	9⅛-9⅞
—— 4½ p.c. Deb. Stock, Red.	100 ..	93½-95½
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	6⅞-7
—— 5 p.c. Cum. Pref., Nos. 1-75,000	5 ..	5-5⅛
—— 4½ p.c. Deb. Stk., Red., Prov. Certs., all pd.	100 ..	100-103
British Columbia Electric Railway Co., Ord. Def.	100 ..	148-152
—— Ord. Pref.	100 ..	123-127
—— 5 p.c. Cum. Perpetual Pref. Stock	100 ..	109-112
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	102-104
—— 4½ p.c. Vancouver Power Deb.	100 ..	102-105
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10 ..	9/16-13/16
—— 6 p.c. Cm. Pf., 30,001-60,000	10 ..	
—— 5 p.c. Perpetual Debenture Stock	100 ..	85-88
—— 4½ p.c. 2nd Deb. Stock	100 ..	63-67
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	81-86
Buenos Ayres Gd. Nat. Trams. Co., 5½ p.c. Pref. Deb. Bonds, Red., 1-1,500	100 ..	102-107
—— 6 p.c. Deb. Bonds, Red., 1-2,275	100 ..	103-106
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	97-99
Calcutta Tramways, Ord., No. 1-137,610	5 ..	4 9/16-4 13/16
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5 ..	4⅛-5
—— 4½ p.c. 1st Deb. Stock, Red.	100 ..	99½
Cape Electric Tramways, Nos. 1-491,222	1 ..	⅛-⅜
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5 ..	4⅛-5⅛
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	97-101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5 ..	5 11/16-5 13/16
—— 4 p.c. Deb. Stock, Red. (1985)	100 ..	98-101 xd
Colombo Electric Tramways and Lighting, 5 p.c. 1st Mortgage Debenture Stock, Red.	100 ..	98-101
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 p.c. Cum. Pref.	10 ..	12⅛-13⅜
—— 4 p.c. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12⅛-13⅛
—— 6 p.c. Pref., Nos. within 1-60,000	10 ..	12⅛-13⅛
—— 3½ p.c. Mort. Debs., 1-3,000 Red.	100 ..	90-95
Hastings & Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	76-81
Havana Electric Railway Consolidated Mort. 5 p.c. 50-year Coupon Bonds of 1952, 1-6,957	$1,000 ..	91-94
Imperial Tramways, Ordinary	all ..	18-19
—— 6 p.c. Cum. Pref.	all ..	14-14⅛
—— 4½ p.c. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 p.c. Cum. Pref., Nos. 30,001-60,000	5 ..	⅛-1⅛ xd
—— 4 p.c. 1st Mt. Db. Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/32-3/32
—— 5 p.c. " A " Deb. Stock	100 ..	91-94
—— 6 p.c. " B " Deb. Stock	100 ..	66-68⅛
Kidderminster & District Lighting & Traction, Pref.	5	9 15/16-10 3/16
Lancashire United Tramways, Limited, 5 p.c Prior Lien Deb Stock, Red	100 ..	88⅛-90⅛
—— £296,500 2nd Mort Deb Stock	— ..	—
—— £83,330 Deferred Deb Stock (all fully paid)	— ..	—
Lisbon Elec Trams, Limited, Ord, Nos 1-594,188	1 ..	29/32-1 1/32
—— 6 p.c. Cum Pref, Nos. 1-425,553	1 ..	15/16-1 3/16
—— 5 p.c. Mort. Deb., 1-5,000, Red.	100 ..	98-102
London United Trys (1901) 5 p.c. Cum. Pref.	10 ..	2⅛-2⅜
—— 4 p.c. 1st Mt. Db. Stock, Red.	100 ..	67-70
Madras Elec. Trams. (1904) 5 p.c. Deb. Stk., Red	100 ..	93-93
Manila Elec. R.R. & Ltg. Corp., 5 p.c. 1st Lien & Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000 .	95-97
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5 ..	4⅛-5
—— 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	86-91
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	1/32-5/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1 ..	11/16-13/16
—— 4½ p.c. Deb. Stock, Red.	100 ..	95-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 p.c. Gold Bonds	.. —	96-97⅛
Milwaukee Electric Rail and Light, 5 p.c. 30-yr. Con. Mort. Bonds (1926) 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ p.c. Sterling Deb., 601-2,000 (1922)	100 ..	102-104
New General Traction, 6 p.c. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	⅛-⅜
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100 ..	100½-103½
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	⅛-⅜
—— 5 p.c. Cum. Pref., 300,001-545,000	1 ..	⅛-⅜
—— 4½ p.c. Debenture Stock	100 ..	86-89
Provincial Tramways Co., Ordinary, 1-24,912	10 ..	4-4⅛
—— 6 p.c. Cum. Pref., 1-10,000	10 ..	9⅛-10⅛
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5 ..	5⅛-5⅜
—— 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	99-101
San Paulo Tramway, Light, and Power Co.	$100 ..	146-1 8⅛
—— 5 p.c. 1st Mort Deb., Red. (1929) 1-12,000	$500 ..	101-103
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	⅜-⅝
—— 4 p.c. Deb. Stock, Red. (1940)	100 ..	70-74
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red., 1-1,600	100 ..	81-85
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5 ..	⅛-⅜
—— 6 p.c. Cum. Pref., 1-46,261	5 ..	1⅜-2⅛
—— 4½ p.c. 1st Deb. Stock, Red.	100 ..	81-85

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100 ..	62-64
—— 4 p.c. Pref.	100 ..	8 -86
—— " " deferred	100 ..	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	101-103
City and South London, Consolidated Ordinary	100 ..	31-32
—— 4 p.c. Debenture Stock	100 ..	100-102
—— 5 p.c. Pref. Stock '91	100 ..	108-110
—— " " " '96	100 ..	10 -107
—— " " " '01	100 ..	100-103
—— " " " '03	100 ..	93-96
Liverpool Overhead, 5 p.c. Pref.	10 ..	4⅛-5
—— Ordinary, 1-50,000	10 ..	⅞-1⅜
—— 4 p.c. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 p.c. 4½ p.c. Bds.	— ..	89

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price £
Amazon Telegraph Co., 1-25,000	10 ..	2⅛-3⅛
—— 5 p.c. Debs., Red., within 1-1,069	100 ..	93-96
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000 ..	96-144⅛
Anglo-American Telegraph Co., Ordinary	100 ..	60½-62½
—— 6 p.c. Preferred Ordinary	100 ..	103½-104⅛
—— Deferred Ordinary	100 ..	20⅛-21⅛
Anglo-Portuguese Telephone Co., 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	103⅛-105⅛
Chili Telephone Co., 1-44,000	5 ..	8-8⅜
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100 ..	90-92
Cuba Submarine Telegraph Co., Ordinary, 1 16,000	10 ..	8⅛-9
—— 10 p.c. Preference, 1-6,000	10 ..	17-18
Direct Spanish Telegraph Co., Ordinary	5 ..	3-3⅛
—— 10 p.c. Cum. Preference	5 ..	8⅞-8⅞
—— 4½ p.c. Debs., 1-600	50 ..	99-101
Direct United States Cable Co.	20 ..	12⅞-13⅛
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100 ..	99-101
Eastern and South African, 4 p.c. Mort. Debs., within 1-3,000 (1909)	100 ..	100-100⅛
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	25 ..	103⅛-105⅛
Eastern Extension, Australasia and China, 1-300,000	10 ..	11⅛-11⅛
—— 4 p.c. Mort. Deb. Stock, Perp.	100 ..	102-104
Eastern Telegraph Co., Ordinary Stock	100 ..	129-132
—— 3½ p.c. Preference Stock	100 ..	84⅛-85⅞
—— 4 p.c. Mortgage Debenture Stock	100 ..	104⅛-106⅛
Great Northern Telegraph Co. (of Copenhagen)	10 ..	26
Halifax and Bermudas Cable Co., 4½ p.c. 1st Mort. Debs., within 1-1,200, Red.	100 ..	99-101
Indo-European Telegraph Co.	25 ..	51⅛
Marconi's Wireless Telegraph Co., Nos. 256,128-384,190.	1 ..	11/16-13/16
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	13/16-15/16
—— 5 p.c. Preference, 1-86,492	1 ..	⅛-⅜
National Telephone, Preferred	100 ..	106⅞
—— Deferred Stock	100 ..	123⅛
—— 6 p.c. Cum. First Pref.	10 ..	10⅛-10⅜
—— 6 p.c. Cum. Second Pref.	10 ..	10⅛-10⅛
—— 5 p.c. Non. Cum. Third Pref.	5 ..	5 7/16-5 11/16
—— 3½ p.c. Deb. Stock, Red.	100 ..	98-100
—— 4 p.c. Deb. Stock, Red.	100 ..	100-102
Oriental Telephone and Electric Company	1 ..	15/16-1 7/16
—— 6 p.c. Cum. Pref.	1 ..	1 1/16-1 3/16
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100 ..	99½-101⅛
United River Plate Tele. Co., Ordinary, 1-100,000	— ..	7⅛
—— 5 p.c. Cum. Pref., 1-40,000	5 ..	5⅛-5⅛
—— 4½ p.c. Debenture Stock, Red.	100 ..	103⅛-105⅛
Telephone Co. of Egypt, 4½ p.c. Deb. Stock, Red.	100 ..	100-102
West African Telegraph Co.	10 ..	12⅞-13⅛
West Coast of America, 1-30,000 and 53,001-53,008	2½ ..	1⅛-1⅛
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	99-101
West India and Panama Telegraph Co., Ordinary	10 ..	⅛
—— 6 p.c. Cum. 1st Preference	10 ..	8-8⅛
—— 6 p.c. Cum. 2nd Preference	10 ..	8 9
—— 5 p.c. Debs., Red., 1-800	100 ..	101-103
Western Telegraph Co., 1-207,930	10 ..	13 7 16 9 32
—— 4 p.c. Debenture Stock, Red.	100 ..	103⅛

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.							
	Ending	1909.	1908.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	Cost per car mile.
		£	£	£	£				£						
Aberdeen Corporation	Aug. 25	1,567	1,720	— 153	— 657	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5·93
Ayr Corporation	„ 21	506	487	+ 18	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	„ 7	2,770	2,650	+ 120	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	„ 1	1,073	1,108	— 35	— 492	13·52	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	July 31	6,446	6,326	+ 120	—	56·702	—	—	—	—	—	—	—	—	—
Blackburn Corporation	Aug. 25	1,009	1,065	— 55	— 920	24·5	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	„ 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,329	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	„ 1	2,210	2,500	— 290	— 990	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·56
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Aug. 21	5,250	4,983	+ 267	+ 1,938	98	98	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	„ 22	1,282	1,172	+ 110	+ 806	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	„ 27	5,742	4,916	+ 826	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	„ 28	1,270	1,157	+ 113	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	„ 29	282	283	— 1	—	10	10	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Aug. 21	4,473	6,528	— 2,055	— 14,059	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	„ 7	3,695	3,515	+ 180	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	„ 29	2,888	2,845	+ 43	+ 1,302	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 19	— 811	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Aug. 26	504	479	+ 25	—	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	„ 20	1,693	—	+ 254	+ 798	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	„ 13	305	282	+ 23	— 202	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	July 31	258	336	— 78	— 478	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Aug. 27	181	147	— 34	—	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	„ 27	6,848	6,435	+ 413	+ 1,394	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	„ 25	1,217	—	— 18	— 558	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	„ 28	987	808	+ 179	+ 3,091	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	July 17	15,961	17,286	— 325	— 2,745	185½	179	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Aug. 25	293	283	+ 10	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	„ 7	4,430	4,480	— 50	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	„ 21	1,741	1,645	+ 96	+ 771	28½	28½	„ 31	84,704	16,200,020	1,960,320	1·29	10·37	2,421	5·10
Hull Corporation	„ 28	2,571	2,357	+ 214	+ 1,433	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	July 31	487	498	— 11	+ 687	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Aug. 25	147	144	+ 3	— 200	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	„ 25	300	295	+ 5	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	„ 25	1,313	1,583	— 270	— 529	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	„ 21	7,178	6,672	+ 506	+ 2,024	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	„ 21	2,288	2,183	+ 105	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	July 21	11,088	11,403	— 315	— 3,0·7	104	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Aug. 1	1,452	1,481	— 29	— 72	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	„ 14	37,585	34,790	+ 2,795	+ 24,437	124	121½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	„ 17	216	258	— 42	— 743	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Aug. 28	206	190	+ 16	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	July 31	14,874	16,424	— 1,550	— 2477	181	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Aug. 28	8,569	8,353	+ 216	—	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	„ 22	13,951	13,839	+ 112	+ 1,658	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	„ 28	146	136	+ 10	— 92	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	July 31	3,860	3,850	+ 10	— 1,416	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	„ 31	672	713	— 41	— 382	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Aug. 26	631	651	— 20	— 89	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Aug. 2	4,554	5,379	— 825	— 3,017	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	July 18	5,718	5,528	+ 190	— 1,112	68½	66½	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·74
Southampton Corporation	„ 28	1,123	1,267	— 144	— 586	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·1
Southend-on-Sea Corporation	„ 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·73
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,084	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Aug. 18	170	157	+ 13	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	„ 26	630	647	— 17	—	8·41	—	Dec 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	„ 21	992	1,012	— 20	+ 523	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	„ 12	2,449	2,175	+ 274	+ 2,636	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·5
Wolverhampton Corporation	„ 25	762	792	— 30	— 906	20½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·5

a Train miles. *b* Half-year's figures.

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THE
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NOTES.

ELECTRICAL STANDARDISING.

To Dr. H. L. Bronson, Assistant Professor of Physics, and Mr. A. N. Shaw, Demonstrator of Physics, the McGill University, Montreal, thanks are due for their admirable paper and demonstrations on "Clark & Weston Standard Cells," submitted to the British Association. It is clear from their observations that these cells when manufactured with great care are wonderfully accurate, quite sufficiently so for all practical work. The special point as regards the Weston & Clark cells is the preparation of the mercurous sulphate, because if impure a divergence from the normal as high as 500 microvolts may be recorded. It was found that the presence of small quantities of basic oxide, oil or organic impurities did not seriously influence the electromotive force." A pleasant feature of these very useful researches is that much of the work was, on the invitation of Dr. H. T. Barnes, carried out in the laboratories of the Bureau of Standards, Washington.

WEATHER FORECASTING.

The Blue Book, containing the fourth annual report of the Meteorological Committee, just published, affords interesting evidence of the many-sided usefulness of wireless telegraphy. Messages sent by this system are now largely availed of by our official weather prophets, and it is clear that when practically every ship carries a wireless installation and more shore stations are in operation, the daily weather charts will be far more complete, accurate, and with a deeper peep into the future, which will be useful to both those who go down to the sea in ships and those who stay on land pessimistically busy with crops. As it is, since the beginning of the year wireless messages have been received from Atlantic liners, 1,219 being so dealt with during the first three months. Unfortunately, the majority of these messages are not transmitted direct to land stations, but are collected by the fast liners, and re-transmitted, a system causing delay and occasional blocks, so that much data that would be useful if received direct is wasted. Accuracy of transmission appears to be all that could be desired, but this is not always the case as regards observations, for many ships carry aneroid barometers only, with the result that it is often difficult to bring their pressure observations into correspondence with those on other ships and on shore stations. These flies in the ointment may soon be removed. Clearly this Blue Book adds yet another argument in favour of multiplying wireless equipments both on board ship and on shore.

FOUNDRY ELECTRIFICATION.

An optimistic note marked the observations of Mr. Ambrose Firth when presiding last week at the annual meeting of the Brightside Foundry and Engineering Co., Ltd., at the Wicker Works. The point that particularly concerns us is this, that the Directors, while deploring recent bad trade, look forward to an early revival and busy times. Indeed, not content with their existing field of exploitation, they have gained a footing in the markets of India, Nigeria and South Africa, developing largely the hydraulic engineering branch. Now, imbued with the necessity of conquering new markets, and preparing for the good times ahead, these keen business men took advantage of the temporary slump to put their house in order. And the first thing they did to effect economies and provide for bigger output, was to clear away every steam engine and boiler. The whole foundry is now worked by electricity, and is in better care to cope with a rush of orders. Such enterprise deserves to be noted, if only *pour encourager les aoutres*.

ELECTRICAL EXHIBITIONS.

Accrington has been indulging in an electric exhibition of its own, installed in the Town Hall and organised by the Electricity Committee with a view to instruct the community, and, incidentally, to encourage the demand for current. These exhibitions are unquestionably of great service to central stations, for they demonstrate the wonderful adaptability of electric lighting, and open up a wider horizon for the citizens, who can see for themselves what a useful servant in the household is the electric current. Accringtonians will be more alive to the multiplicity of ways they can turn the current to account, from toasting their bacon or their toes, the warming of the master's shaving water or the mistress's curling tongs, to the energising of organs and pianos into discoursing sweet music. Already the town's minor industries are largely worked by electric power, and it is hoped to induce the bigger works to fall into line. Demonstrations such as these are generally worth hours of argument, for the eye, though probably a less accurate guide than the eye, has a more direct and enacting appeal to brain.

PETROL-ELECTRIC MOTORS.

Mr. J. B. Entz has been discoursing before the Franklin Institute on his system of petrol-electric transmission for motor cars, which has now been put to the practical test of three years' fairly wide use in America. It deserves to have even greater popularity, for it is essentially a simplifying system. Without actual mechanical connection, the engine drives direct to the generator field, being in line with the motor and main driving shaft. In his paper Mr. Entz showed in his car, when going at full speed, the generator acts in a way as an induction-motor clutch, the 5% slip between the field and armature being sufficient to transmit the requisite torque to the motor shaft, to which the generator armature is connected by clutch. At full speed the generator armature provides the whole torque, the motor being electrically idle. But at reduced speeds, though the engine runs at full speed, the extra slip between the generator field and its armature generates a correspondingly large current, utilised in the motor to develop an auxiliary torque to that transmitted directly by the generator field to armature. By this method a smooth running, sufficiently elastic, and non-mechanical drive is attained at an increase in weight of less than 10% over the usual mechanical system. At the same time, greater efficiency, with reduced wear and tear, is secured. Those who have had experience of the Entz system on the Columbia cars corroborate these claims.

FLY-WHEEL SPEEDS.

With winding engine and rolling mill plants, in order to get the fly-wheel to give up its energy at the periods of maximum load, the speed of both fly-wheel and motor has to fall. When the motor is a compound wound direct current machine this is easily and automatically arranged by connecting the series turns, so as to strengthen the magnetism due to the shunt turns. It is thus effected without loss of energy. With a three-phase equipment, however, the matter is not so simple, because the speed can only be reduced by inserting a resistance in the rotor circuit, and this, of course, means loss of energy; and if

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it is done automatically an extra piece of apparatus has to be provided for the purpose. In order to keep down the loss in the resistance, the "slip" is kept as small as possible, and this means a heavier fly-wheel than in the direct current set, where a good big drop can be automatically provided for without any loss of energy. It might at first sight appear as if the direct current motor set would make the best arrangement, but the problem is not so easily settled, for there are several other points favourable to a three-phase motor, such as its simplicity, freedom from sparking troubles, and if a three-phase supply is laid on from an outside power company, it has thereby to be transformed. These winding and rolling mill plants run into big powers, and call for the employment of a professional electrical engineer to advise, especially when it is remembered that improvements are coming out every month.

ALUMINIUM CONDUCTORS.

It will be useful to give a rule whereby a decision can be arrived at when confronted with the choice between aluminium and copper as a conductor. It is well known that copper is the better conductor for the same size of wire, while aluminium is the better for the same weight, as the difference between the specific gravities of the two metals is so great that an aluminium conductor may exceed a copper conductor sufficiently in cross section to give it the same conductivity and yet be still much lighter than its copper equivalent. It is remarkable, too, that when a copper and an aluminium wire have equal conductivity for electricity they have practically the same tensile strength. In other words, the conductivity of aluminium bears the same ratio to that of copper as its tensile strength bears to that of copper. Hence, the question of strength may be disregarded in making our rule. This is that the cost for mere wiring will be the same whether copper or aluminium is used, when the price of the former is to that of the latter as 13 to 25. Obviously if the quotient of aluminium price by copper price is less than $\frac{25}{13}$, the aluminium has the advantage, and *vice versa*.

BISMUTH FOR MICROPHONES.

For wireless telephony, and also for increasing the volume of sound in ordinary telephony, microphones are necessary for high voltages, but for all ordinary carbon microphones the voltage must be kept low, for, if it becomes considerable, arcing takes place, whereby the carbon particles are caked together and sounds are produced in the apparatus itself which greatly hinder or altogether prevent the transmission of the sounds. Herr Munchenhagen, of Tempelhoy, proposes to remove the difficulty by taking advantage of a fact already well known and one already useful in the construction of measuring instruments, viz., that the resistance of a bismuth coil changes in a magnetic field, increasing when the strength of the field increases and *vice versa*. If, then, the coils on the poles of the permanent magnet are made of bismuth instead of copper, the change will enable the telephone to be used as a microphone. When the instrument is spoken into the field strength of the permanent magnet will vary with the vibrations of the iron diaphragm, and hence alter the resistance of the bismuth coil. In this way we shall get current changes like those in the ordinary carbon microphone, and the above-mentioned disadvantage will be got rid of, the limit to the voltage being the conductivity of the bismuth wire.

ELECTRICITY IN MINES ENQUIRY.

As our readers know, one result of the West Stanley Colliery Explosion is that the Home Secretary has promised to appoint a Select Committee to consider the rules relating to the use of electricity in mines. The present rules are now about six years old, and they were drawn up after a most exhaustive enquiry, and everybody was apparently satisfied with them. The prominence given by Prof. Redmayne, Chief Inspector of Mines, and Mr. R. D. Bain, Inspector of Mines in Durham, in their report on the West Stanley explosion to the dangers arising from the use of electricity in mines has, however, caused the Home Secretary to appoint this new Committee of Enquiry. In their report the above-mentioned experts said that on the assumption that the explosion did originate in the Busty seam, they were of opinion that electricity was a more likely first cause than any of the alternatives discussed. The urgency for such a Committee of Enquiry is shown when we consider that the Durham Miners' Association at their last meeting actually considered a resolution that all electric machinery and cables should be removed from mines, as they were a source of great danger.

RULES IN NEW SOUTH WALES.

About two years ago electricity was blamed for certain accidents in New South Wales collieries, but it was never definitely traced home to electric power. A Committee of Enquiry was, however, appointed, and it was brought out in evidence that motors of certain American-made coal-cutters were not as well protected as they should have been. The insulation of the trailing cables in general use was also found to be faulty. The workmen evidently did not like electric power, and their Trades Union tried to do away with it, but the upshot of the enquiry was to vindicate the use of electric power in collieries. Stringent regulations were passed regarding entirely enclosing motors and the regular inspecting and testing of trailing cables. The remainder of the rules were pretty much the same as adopted in this country.

SAFETY IN HIGH PRESSURE.

There is no doubt that colliery installations should be carried out in the most thorough way, without any of the cutting of prices that spoils so many installations above ground. It is probable that a three-phase installation may cost more than one on the direct currency system, and yet it is so infinitely better as regards the safety of the motor that it would be best to pay extra. As a matter of fact, where the distances are considerable the three-phase system would probably come out cheapest in the end, because it can be so easily extended. Many of the low pressure direct current systems now being put down will be unequal to the conditions in a few years' time when the mines are extended. The very fact that low pressures are *supposed* to be safe, makes them more dangerous, because the precautions taken against accident are not so complete, and the workmen are less careful. This fact has been recognised in some of the more recent installations laid down in collieries south of Sydney which have three-phase high voltage in use. The mines round Maitland, on the other hand, are worked with direct current at 250 volts. The writer has seen bare wires in the collieries at that pressure, and connections to coal-cutters made by simply hooking the branch wires over them.

"POULSEN" WIRELESS TELEGRAPHY.

Messrs. Norton, Rose, and Co., make the following announcement:—

We have been requested by Mr. Viggo Gandil, the representative of "Poulsen's" wireless telegraphy in Great Britain, to communicate the following information:—

An influential British company is now in course of formation to work the "Poulsen" wireless telegraph and telephone patents throughout the British Empire and along the principal ocean routes.

The chief advantages of this Danish invention are:—

1. Great selectivity so that outside disturbances occur much more rarely than where other systems are used and are reduced to a *minimum*.
2. Great speed of signalling.
3. Slight expenditure (and hence economy as regards power and space—important in the case of ship installations).
4. The realisation of practical wireless telephony.

As an instance of the economy, it may be mentioned that the station at Lyngby (Copenhagen) has received signals from one of the Scandinavian-American liners, using only 6 kw. (electrical h.p.), over a distance of 1,600 miles, and as regards speed 300 words per minute have been received over a distance, of 180 miles using 2·6 kw.

The intention is that the comapny shall first of all establish a station in Canada (for which the Dominion Government has granted the vendors a licence), to work together with a station in Ireland, which is nearly completed, and later on stations are to be erected along the main routes of the ocean-going steamers.

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ELECTROLYSIS OF WINNIPEG WATER MAINS.

By LOUIS A. HERDT, M.A., E.E.*

The Winnipeg Electric Railway Co., in operating their street railway system, use the rails as a return for the current operating the cars. In order to make the rails a continuous conductor and thus secure a good return path for the current, the rails are bonded at the rail joints with copper bonds; besides this the rails are connected to the station negative busbars by return copper feeders, bonded to the track at different points of the system. This is the usual method of street railway return construction, but electric railway companies using this system, that is, using the

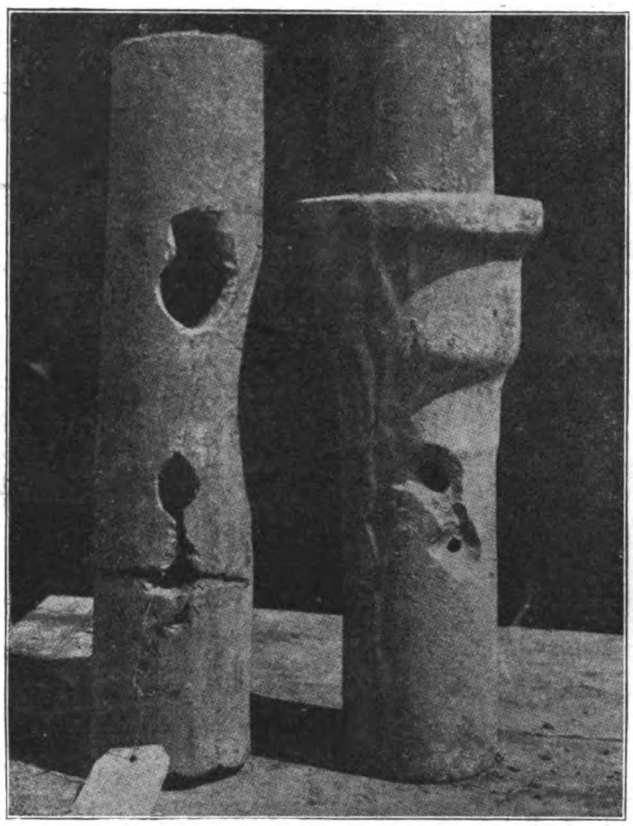

Fig 1.—Pitting of Mains.

rails as the return circuit for the returning currents, are a serious menace to piping and cable systems in proximity to the tracks, if the methods of constructing the above described rail returns are such that the railway companies are unable to control their own currents, but use the piping and lead-covered cables as part of their return circuit. The company have two plants in the City of Winnipeg—one, the old steam plant at the foot of Main-street, corner of Assiniboine-avenue; the other, the sub-station on Mill-street. The first plant is kept as a steam reserve; the second plant, which furnishes the whole of the electric current for the street railway system, receives its electrical energy from the hydro-electric plant at the Pinawa Channel of the Winnipeg River. The average current for the railway service fed out from this plant approximates 6,000 amperes, but reaches as high as 9,000 amperes at times of heavy load in the winter months. The electrolysis survey which was carried out, involved not only mere readings of potential difference between the rails, the piping system and telephone cables, but it embraced an examination of the feeding circuits, the general condition of the road-bed, and the size and efficiency of the return. A complete and thorough examination of the points where the city electrician had reported damage to the pipes was also made. Pieces of water pipe and lead-covered cables taken from various districts by Mr. Cambridge, were examined, and showed without doubt that holes and breaks in them, as will be seen in the accompanying illustrations, had been caused by electrolytic action.

The damage reported in some districts is caused by the very bad condition of the bonding. At several places the bonds are uncovered, and many broken bonds were noticed. Current is leaving the tracks in Sherbrooke-street, South Portage and Notre Dame, west of Sherbrooke (rails are positive to pipes), entering the pipes, flowing down these until close to Main-street is reached (along Main-street from River to C.P.R. subway, pipes are positive to rails), the current leaves the pipes to rails, telephone cables on other pipes causing the damage reported—it accounts also for the trouble reported in the T. Eaton Co.'s store. In connection with the district around the car barns on Main-street, close to the river, the rails on Main-street are bonded to the water pipes. The heavy water mains on this street carry a large part of the railway current till it reaches Water-street, Notre Dame-avenue, and Portage-avenue East; the stray currents are here given back to the telephone cables which are bonded to the negative bus-bars of the sub-station on Mill-street, and also to the intricate network of mains and service pipes lying in this district. This accounts for the trouble reported in the McIntyre Block. In this connection, the writer desires to state that on May 26, in company with the City Electrician, this building was visited. In the basement a recording amperemeter was connected between the water main and the telephone cable. Charts of current readings were kept. At the time of the visit 50 amperes were recorded and the water pipe was positive to the telephone cables. With the statement reported by the City Electrician that such a condition involves danger of fire, the writer does not agree, although the conditions there are remarkable enough that conditions might be assumed under which fire could be possible. The remedial scheme referred to above, that of bonding the tracks with water and gas pipes, although it may afford local protection and was considered a good practice some time ago, will greatly increase the amount of stray currents, and should not be encouraged.

The tracks are bonded at the corner of Main-street and Portage-avenue to the return feeders of a total sectional area equal to 6,848,000 circular mills. The drop of potential between this point and the negative bus-bars, if these carried the whole railway current, would reach 12 volts at times. The distance is approximately 1,200 ft., that is,

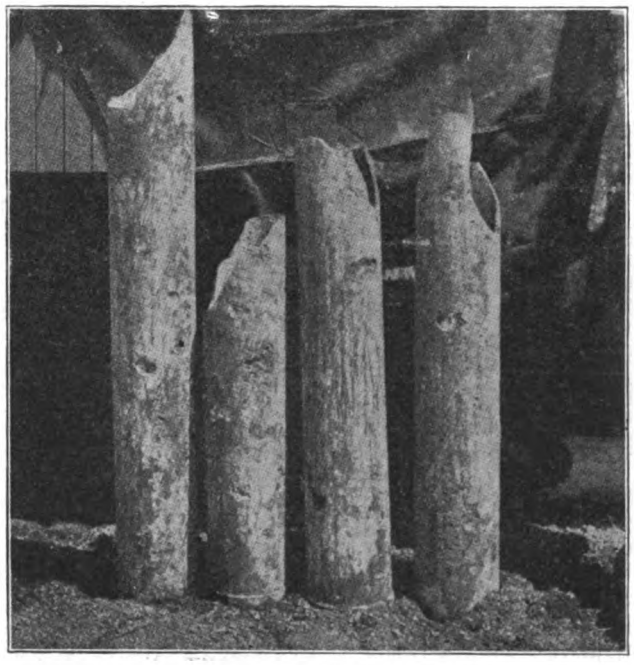

Fig. 2.—Corrosion at Lead Cable Covers.

the drop of potential from these tracks to the station is one volt per 100 ft. This is altogether excessive, a voltage drop of one-half volt per 300 ft. is usually considered large enough. The above condition is responsible for the trouble reported in one district. Return feeders, besides the one stated above, are also used; they are bonded to the tracks at different points of the system, but they are of comparatively small section and little current can be carried by them. To sum up, it will suffice to say:

1. With the exception of Main-street from the Assiniboine River to the C.P.R. subway, Portage-avenue from Main-street to Hargrave-street, Notre Dame-avenue from Main-street to Charlotte, Corydon-avenue from Pembian-street to Lilac-street, Lilac-street from Corydon-avenue to

* Abstract of Report to Winnipeg City Council.

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Woodlaw-avenue, and the tracks which are being now bonded with electrically brazed bonds (*i.e.*, Dufferin-avenue and Logan-avenue), the track returns of the Winnipeg-street Railway Co. are in very bad shape.

2. The load on the Mill-street sub-station and its location are such that it is not possible to return through the rails and return feeders only the large volume of current required for the street railway service.

Electrolytic troubles and damage to the piping system and cables result from these two conditions, and is spread out over the whole of the centre of the city, although it has appeared only, so far, in certain districts. The cure for the electrolytic trouble should come from the Electric Railway Co., as the city cannot do anything to protect its piping system from stray currents. Remedial means are mainly those which I have already stated in my preliminary report dated April 1, 1909, namely: (1) Installation of sub-stations at different points of the system—this with a view of diminishing the amount of current to be returned through the rails in the centre of the city; (2) proper re-bonding of all tracks that show defect; (3) special bonding and cross-bonding work at intersections; (4) a system of inspection of track returns by the railway company.

A sub-station system of power distribution will do away with the electrolytic trouble. At present the whole current for the railway service being fed from one station, gives rise to a concentration of current in the tracks situated in the heart of the city. The current density in the rail returns must be kept low. The soil in this city shows a very low resistance, and only very small difference of potential in rail returns can be allowed. This must be assisted by a re-bonding of the tracks which show defects, that is, which indicates excessive drop. All bonds showing a reading of more than 4·5, that is, whose resistance is greater than 4·5 ft. of rail, should receive attention and be made good. Track intersections should also receive careful attention, ground plates at sides of bridges to carry return currents from one side of river bank to the other must be done away with and insulated feeders placed instead. I am pleased to state that the Winnipeg Electric Railway Co. is carrying its work along these lines. Following recommendations made by William B. Boyd, chief engineer, Toronto Railway Co. and Toronto Power Co., Toronto, and approved by the writer, the Winnipeg Railway Co. have placed orders for electrical machinery, which will be installed in three new sub-stations, located as follows: One sub-station near the car barns at Fort Rouge, another on the line running to the Country Club, approximately 17,000 ft. from the Mill-street sub-station, and the third in the north end of the city near the car barns. This will reduce very largely the amount of current returning through the rails on Main-street. These rails are now very much overloaded with current.

In connection with the re-bonding of the tracks, the railway company have now in the city, and in operation, a bonding car for electrically brazing copper bonds on the rail joints. This type of bond, carefully installed, will secure an effective system of rail return. It can be easily applied on old work with very little disturbance of pavements. Tests made on Logan-avenue, where this type of bond is in place, show very low readings of voltage drop. The work being carried out now by the railway company on Dufferin-avenue shows construction work of a very substantial nature, and plans for special work at intersections submitted by the railway company to the City Electrician and approved by the writer, will give intersections with very small drop of potential. Besides the above, the railway company have advised me through Mr. Boyd, that it is the intention of the company to carry out certain work of reconstruction of their tracks.

The Winnipeg Railway Co. must be instructed to proceed with this re-bonding work and with the installation of the sub-stations without delay. The re-bonding of the tracks must proceed at maximum speed, night and day, until the whole system is in proper condition. After this is done, all bonding of the rails to the telephone cables and pipes should be removed, as well as the ground plates at bridges. The amount of copper in the feeder returns from Main-street, corner of Portage-avenue, to the sub-station, must be increased to at least 10,000,000 c.m., and the railway company should be instructed to place these wires in the ground in approved conduit.

The writer also desires to recommend that, following the termination of the work above outlined, that is, sometime in the fall, a survey be made to see results accomplished. The third recommendation made, namely, that the railway company should maintain its plant in a high state of efficiency through a rigid inspection of the track returns, is of the greatest importance to the city and should be enforced. The track returns should be under test at all times, in order to remedy at once any faulty bonds as they appear. Accurate records of the drop of potential at different points of the railway system should be kept by the railway company and be open to inspection of the City Electrician. If the above recommendations are carried out with a desire to obtain best results, troubles due to electrolysis will be practically eliminated.

EXTENDED USES OF ELECTRICITY ON BOARD SHIP.*

By MR. JOHN McLAREN, Member of Council, INST.MAR. E., M.I.MECH.E.

The application of electricity on board ship for driving auxiliary machinery has made rapid headway of late years. The time has now arrived for engineers to consider the most economical means of applying electric power for ship works, as at present there is great scope for such.

My proposal is to drive all the auxiliary machinery by the use of electric motors, which will include all cargo winches and hoists, capstans and ventilating machinery, etc., and also to use electricity for the heating of cabins and passages and for cooking. In the engine department to drive all pumping, refrigerating, lifting machinery and fans by the use of electric motors, and, of course, to use electricity for lighting the ship throughout.

Since my last paper, which was read before the Institute of Marine Engineers, I have had several communications from superintendents and shipowners on the subject; some were good enough to place their ships at my disposal for the purpose of studying the efficiency of the steam auxiliary plant at present in use. It was rather difficult to get at exact figures, but I came to the conclusion that the efficiency of the steam plant was about 25%. Owing to the great length of present-day ships and the great increase of auxiliary machinery, the steam has greater distances to travel, with very great loss by radiation. The back pressure of the exhaust steam travelling away to the engine-room to get to the winch condenser is very considerable. Several ships had no winch condenser; the exhaust from the winches went up the waste steam-pipe up alongside the funnel; the water that gathered at the bottom of the waste steam-pipe was carried away by a small drain-pipe to a tank, which was pumped out by a donkey feed-pump. This would, of course, reduce the efficiency very considerably. I suppose that there was not more than 10% to 20% of the water returned to the boiler.

A suction gas installation is one of the cheapest and most efficient forms of power known at the present day, which is suitable for commercial purposes. I am also convinced that it is admirably suitable for auxiliary purposes on board ship used in conjunction with electricity. I will not say that it would be cheaper on the first cost, horse power for horse power, but for equal powers the working of the plant would show a very considerable reduction in working costs, and in a very short time it would more than pay for any increased capital outlay.

In the system which I propose all these losses, or at least the greater part of them, would be obviated. A moderate estimate of the efficiency of a plant, such as I propose to describe, is 80%; this figure compared with the efficiency figure for the steam plant, which is, as I mentioned before, a maximum of 25%, gives a difference in favour of the suction electrical plant of no less than 55%. You will see at once that in a large ship the monetary saving would be very considerable, and it is this side of the question which, of course, appeals to shipowners and is causing them to be keenly alive to anything bearing on

* Abstract of Paper read on Saturday, Sept. 4, in the Congress Hall Imperial Exhibition, Shepherd's Bush.

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the question. In my last paper I was asked what objection I had to the continuous current motor which is at present largely used for ship's work; my answer to this is, that it is my object to eliminate all rubbed surfaces such as brush and commutators from the exposed motors, which are well known to be a source of trouble and expense. This can be only got over by the use of alternating current for driving the motors, as the induction motor has no commutator proper, and possesses many advantages over the continuous current motor, chiefly in simplicity and freedom from breakdown. I do not wish to unduly depreciate our old friend the continuous current motor, which we must admit has done good service in the past, but owing to the progress made in alternating current motors it has been surpassed by the alternating motor for a great many purposes.

The size of plant required for driving the auxiliaries on board ship of course depends upon the size of the ship and the number of machines required, but for the purpose of this paper I suggest a 300 h.p. unit.

The approximate weight of the producer plant for 300 h.p. would be 19 tons, and the space occupied about 14 ft. × 10 ft. 6 in. × 16 ft.

GAS ENGINE.—The type of gas engine I would suggest as being the most suitable one for our purpose would be a vertical multiple cylinder, single-acting type, operating on the Otto or four-cycle principle. The speed of the engine should be about 200 r.p.m. to suit the alternator. A good governor should be fitted. The modern gas engine governor is very effective, which is one of the advantages of the gas engine. There are makers in the market now who will guarantee their machines to act at 2% from full load to no load; 5% is quite a common thing. The whole system can be started up in 30 min. from cold, and from 15 min. when standing by, which means under banked fires. A silencer would be fitted to the exhaust pipe.

THE ALTERNATOR.—In my last paper on this subject I suggested that a voltage of 2,000 volts might with advantage be used on large ships and transformed at the point of use to 250 volts for operating the machinery. This to reduce the cost of the transmission cables. This voltage was objected to in the discussion on account of possible danger; although, as I then stated, the system could be made absolutely fool proof. However, in a moderate sized vessel I now suggest that alternating currents should be generated at 250 volts and carried direct to the machinery. Such generator should be built upon the fly-wheel of the gas engine and generate three-phase currents at 250 volts at a periodicity of, say, 50 cycles. At this point it would not be out of place to give an explanation of what is meant by the term "alternating current" and "periodicity," or as it is more usually called, the "frequency."

A current of electricity which passes through a complete cycle of changes of both magnitude and direction at regular intervals of time is called an alternating current. The time taken for a complete cycle of changes is called the "period," and the number of cycles or complete changes per second is called the "frequency." Alternating current is spoken of as "single-phase," "two-phase," or "three-phase." Single-phase is just a series of waves along a single circuit, first one way and then another. Two-phase is the description given to a generator in which the armature is wound in two sets of windings to produce two separate currents in two separate circuits, in one of which the wave will be at its maximum when the other is at zero. In a three-phase generator the armature has three distinct windings which generate three separate currents, the waves of which succeed each other at regular intervals. By connecting the inner ends of these circuits together only three cables are needed to convey this current, but for our purpose I propose to bring out a fourth wire from this point, called the neutral wire, the purpose of which I will explain later on.

The armature of our generator should be of the stationary type with a revolving field magnet built up on the rim of the gas engine fly-wheel. A small direct current dynamo, called the "Exciter" from the fact that it supplies a small current for exciting the coils of the alternator field, should be coupled direct to the armature shaft. The exciting current is carried to the revolving field of the alternator by means of two small slip rings with metal brushes. It is worthy of note that this is the only electrical rubbing device on the alternator, and it is of such a simple nature that it could give hardly any trouble. The armature would be wound to give three-phase currents and would be star connected.

In selecting the type of alternator, care should be taken to see that the wave form of the currents is sinusoidal; this would eliminate those heavy potential stresses which are often a source of danger to the windings and power circuits of alternators which have a peaked wave form. This danger is a very serious one in those machines generating high pressures.

The generator should have a liberal factor of safety to enable it to deal with large overloads should the necessity arise without danger of breakdown.

DISTRIBUTING.—After generating our power we shall require a suitable switchboard to control and distribute the current. This should be placed in some convenient position in the gas-engine room and would be divided into two distinct sections, one for the power circuits and one for the lighting circuits. The power section would be divided into panels for each power circuit, and from each panel would be led a three-core cable, suitably insulated and armoured, to supply current to each distributing centre. From this point smaller mains would be taken off to each alternating current motor in the group controlled from this centre.

SMALL MOTORS.—For the smaller motors I propose to use the induction type of motor commonly known as the "Squirrel Cage" motor. This type of motor would have no commutator or collecting device of any kind, and would be switched straight on to the mains when starting. The armature, or "rotor," of this type of motor consists simply of a laminated iron core with a number of straight copper bars lying in slots; these bars are insulated along their length, but are connected together at each end by means of a copper ring, thus giving the rotor the appearance of a squirrel cage. The field, or stator, is wound with three sets of coils with three separate currents flowing, the waves of which occur in succession as I previously mentioned. Each current produces its own "lines of force," which rise and fall round the conductor just as the current does; thus the magnetism is strongest round one set of coils, then the next and so on in regular sequence. This produces what is known as a revolving field. These regular rising and falling lines of force cut the conductors on the rotor and induce a current to flow in them; these induced currents produce magnetism in the rotor, which, acting in the same manner as the direct current field and armature force the rotor round with a powerful torque or twisting effort.

HEAVY MOTORS.—For the more powerful motors, owing to the heavy rush of current required for starting purposes, it might perhaps be necessary to use a slightly different type of rotor wound somewhat similar to the stator winding, so that resistances could be inserted for starting purposes. The methods that are usually employed in use with polyphase alternating current power transmission, in which (with current generated with constant periodicity) and showing that it is necessary to employ induction motors fitted with slip-rings, or auto-transformers, either for getting speed regulation, or for reducing the voltage at starting, etc.

It will thus be seen that although there is no doubt that even motors so fitted are vastly superior to motors as now used with commutators, as in the continuous current method, which also necessitates the use of regulating resistances for speed, and also thus introduces a source of loss of energy, although the series or shunt wound direct current motor has all those valuable characteristics that are necessary for crane work, etc., such as high and efficient starting torque, but these are got only by the sacrifice of simplicity, robustness, and mechanically sound design.

There is no question about the fact that if it were possible to use the simple squirrel cage induction motor, with polyphase alternating current, that we should have a most ideal condition of affairs, as this motor, consisting as it does of only two parts, the stator and the rotor, with no moving contracts whatever, is the most simple motor yet made. The main reason as to why this most interesting motor has not been much more used, not only on shipboard, but also on land, is because of its natural and inherent faults, which, if they can by some means be overcome, means that the field for this interesting and valuable

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motor is vastly extended, and its use on shipboard for driving machinery for all purposes will inevitably follow.

It is the motor that has not only the acme of simplicity, but also is combined with great mechanical strength of structure; the absence of commutators is an immense advantage, and what is not an inconsiderable item when thinking out an electrical power transmission system on a ship, is the fact that in this design of motor there is no sparking limit to allow for, as in continuous current motors, therefore it can stand the roughest of use, and it has the greatest of output per unit of weight as compared with a direct current machine, and without sacrifice of efficiency. A squirrel-cage polyphase induction motor will run on a given load, quite cool, when compared with direct current motors of the same weight. This is partly due to the large section which can be given to the conductors, and also to the laminated character of the iron, which facilitates ventilation. It is not too much to say that whilst continuous current motors and dynamos will always be a class of electrical machinery that require more or less skilled attention, the polyphase motors and generators are self-oiling, self-aligning, without commutators, etc., can practically be termed (especially the motor) a piece of mechanical machinery, requiring no skilled and very little unskilled attention; consequently, the maintenance is reduced to the minimum, and, further, in the squirrel-cage motor the main working current passes only through stationary windings, while in direct current machines the main working current has of necessity to pass through rubbing contacts such as commutators, which always has been, and always will be, a continuous source of trouble.

A further (and which may prove eventually) very valuable feature in connection with the squirrel-cage induction motor is the fact, that should the rotor by any outside means be driven above the synchronous speed of its revolving magnetic field, the rotor bar winding cut lines of magnetic force, and the machine immediately becomes an as-synchronous polyhpase generator, and will return current to the supply mains. It will thus be seen that should such a motor be driving, say, a crane, the fact that on lowering a heavy load into the ship will not only steady the lowering of the load, but that a valuable portion of the energy that is represented by the falling weight could thus be returned to the mains, and possibly utilised for supplying other motors on the ship doing other work; and in a vessel that may be eventually fitted with this class of motor, some surprising results will no doubt be noted, as where a lot of cranes and other machinery may be at work, such as in docks, etc., the work of the main engine and generator will not be so much as that represented by the actual work done in the aggregate of dock machines at work, so that in that case there will be a not uninteresting reduction in the working costs per ton lifted.

The use of this motor is to be made if possible, though it has some defects which, up to quite recently, have debarred its general use on board ship. For driving cranes, winches, hydraulic pumps working against head, refrigerating machinery, and in many other cases on shipboard, great turning effect or starting torque is absolutely necessary; the squirrel-cage induction motor has little starting torque when supplied in the ordinary way, *i.e.*, with current that is at a constant periodicity and voltage. This is because the time limit in the rotor and the stator is not in satisfactory relation. The heavy current in the motor when standing, with the current turned on in the stator, does not allow the magnetic field in the rotor to rise and die down with the same rapidity as that in the stator, consequently there is not such a powerful couple between the stator and the rotor as when the rotor is running at, say, top speed, when the periodicity in the rotor is reduced to almost zero, the slip being about 2 to 4% then, but at starting the slip is of course 100%. Therefore before the simple squirrel-cage motor is used with real satisfaction for general purposes on ships, it is evident that some means must be produced so that the periodicity of the supply current to the motor at starting can be reduced, and gradually brought up to that required, to run it at the full speed, so allowing the motor to do the full work.

It is also of immense importance to have very reliable means of speed variation for such motors as will be used on cargo boats, etc., and means must be procured that the speed of the motor can be varied with economy.

The only way to vary the speed of the simple induction squirrel-cage motor is by varying the periodicity of the supply current to same, and up to now there have been no efficient means available for so doing, and the general application of this motor is thus limited to driving machines, that either require very little starting torque, and where no speed variation is required.

There is a system of speed variation applied to induction motors without the use of slip-rings or auto-transformers, been put on the market by one of our members, Mr. Durtnall, which, in my opinion, will be the way to employ the above very simple and most desirable motor for auxiliary driving on ships. Mr. Durtnall's system will meet all the requirements, and by means of the generation of variable periodicity current, will overcome the defect of bad starting against load, and also will secure the variation of speed that will be required, in the simplest and most efficient of ways.

He has so designed the generator in this system that polyphase alternating current is generated with various periodicities, and by making connection at various positions on the generator simple squirrel-cage induction motors can, for the above reasons, be adopted (with all their enormous qualifications) for real power transmission, *i.e.*, not a speed regulator only, such as when using regulating resistances, in which case it is true that a variable speed can be obtained, say, with slip-ring motors, but the power is not anywhere near the same ratio at the lower speeds; for instance, a standard slip-ring motor designed for 40 b.h.p. at, say, 800 r.p.m. will, owing to the great losses that take place in the resistance, etc., inserted in the secondary or rotor circuit, only give off approximately, say, 10 b.h.p. at 400 r.p.m., although the machine may be drawing, say, anything from 14 to 20 e.h.p. from the generating plant. It is true that it may be argued that the machine the motor may be driving would naturally, being run at half-speed, require less power, but to get this less power and speed, it is quite evident to you that very large losses must take place electrically.

Now in this, the Paragon system, no resistances are required, because the starting of the motors is done on low periodicity current and at such a voltage that the energy is consequently much lower, and every watt generated by the generator is utilised (leaving line losses out of the question) in power transmission; the over-all efficiency is therefore higher and, for reasons that I have pointed out previously, the recuperation energy that can be secured by the application of squirrel-cage motors makes it quite possible that the total horse-power of the main generating plant to meet a given amount of work can be less, quite apart from the fact that, owing to the higher efficiency that can be obtained by use of this system, the prime-mover power can be less in any case, thus reducing the capital outlay, because it is well known that these squirrel cage-motors are the cheapest motor for a given output, and also a reduction of the dead-weight, because it is also well known that this motor is the lightest per h.p. produced, with a given temperature rise, and these two facts alone must tell in the favour of this well thought-out system.

The system is best explained by reference to an actual case which Mr. Durtnall has now in hand—the design of the plant for operating the machinery for a large dredger now being built, in which it is proposed to use as the prime-mover a 200 b.h.p. Diesel engine, running at 300 r.p.m., this to run at constant speed irrespective of the speed or direction of rotation of the squirrel-cage induction motors, which are to be direct coupled to the bucket chain, main winch, rotary pumps, ladder winch, revolving screen, and belt conveyer. These will be driven by three-phase current, at variable speed as desired, through special controllers situated at the motor, by which means reversing of the machine at any speed can take place. The voltage is to be 350 (between phases); the periodicity will be generated at 10, 20, 30, 40, 50 and 60 periods per sec., or with 1,200, 2,400, 3,600, 4,800, 6,000 and 7,200 alternations per min., which means that (with, say, 3% slip) the 8-pole motors that are to be used in this connection will run at either of the following speeds when connected with the above periodicity current through the controller—146, 290, 437, 582, 730, and with a top speed of 874 r.p.m.

The generator in this instance will consist of six small machines, mechanically coupled together in line and on

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one base-plate. These will be driven at constant speed by the Diesel engine at 300 r.p.m.; they will consist of 4-pole machines, constructed as follows: the first machine will be a synchronous 3-phase alternating current generator; this will give the 10-period current, the field of which will be separately excited (either from the continuous current lighting circuit, or from a small exciter that can be driven by, and mounted on, the end of the prime-mover crank-shaft); the other machines will be 5-transformer generators.

The primary of the first transformer will be excited by means of the 10-period current, and this primary being mounted on the same shaft as the 10-period generator, and being of the same polarity, means that the periodicity of the current in the secondary or the transformer (which is a stator) is double that of the 3-phase generator, namely, 20. For this reason the revolving magnetic flux in the primary revolves once, ahead of one mechanical turn of the prime-mover shaft, tappings from the stator secondary winding are taken off to provide the 20-period current. In the next transformer the opposite is provided, that is, the 20-period current is taken to the primary stator, and it is so connected that the magnetic flux revolves in the opposite direction in the air-gap, that its mechanically driven secondary turns in; the consequence is that as the polarity of the machine is the same as the 20-period transformer, that the periodicity in the revolving secondary is raised to 30 periods for this reason, that for one mechanical turn of the secondary the magnetic flux in the stator primary turns twice in the opposite direction (which makes the relative speed of the magnetic poles or flux, equal to a 12-pole machine driven at 300 r.p.m.). Tappings are taken by means of slip-rings from the windings of the revolving secondary to provide the thus 30-period current; this 30-period current also forms the exciting current for the mechanical driven primary of the third transformer, in which the magnetic flux revolves three times, ahead, of one mechanical turn of same. The result is that the periodicity in the stator secondary is raised to 40 periods, with tappings taken off, etc. This forms the exciting current for the stator primary of the fourth transformer, and is sent in such a direction that the magnetic flux in same revolves in the counter-direction to that of its mechanically driven secondary, the periodicity in which is raised to 50 periods because the magnetic flux revolves four times against one mechanical turn of the prime-mover shaft. Slip-rings are now provided to take off the consequent 50-period current. This current also forms the exciting current for the mechanically driven primary of the final transformer, and is so connected that the magnetic flux revolves in the same direction as the mechanical rotation; the consequence is that the periodicity in the stator secondary of this transformer-generator is raised to 60 per sec., because the magnetic flux revolves, ahead, of the mechanically driven primary five times per mechanical turn; so tappings are taken off the secondary winding to provide the 60-period current.

The whole combination is an efficient machine as a generator of variable periodicity polyphase alternating current for power transmission. Each machine is mechanically driven, supplies its part of the total work done. It is self-regulating, according to the number of motors that may be at any time coupled to it, or at any periodicity connection. It is interesting to note what will take place in the event of stopping a motor that, we will say, is running at the top speed, and to note the effect on the plant as regards momentary reduction of prime-mover power. Assume such a motor is connected with the 60-period current, and that the machine and heavy moving masses are running at high speed. We want to stop, so we turn the controller to the 50-period position; the consequence is the machine does not drop in speed so quick as the change of connections are made, so that momentarily the squirrel-cage rotor is running above the synchronous speed of the then 50-period magnetic flux in its stator (the motor running at, say, 874 r.p.m., while the flux revolves in the stator at only 750 r.p.m.); the consequence is that the heavy moving mass of not only the rotor of the motor, but also the machine that it may be driving, is very quickly brought down in speed by this means, and what is also of the greatest interest is the fact that this moving mass provides momentarily the total power, and eases the prime-mover of same, which power may be used for the driving of other machines working off the same generator. This process is carried down to the 10-period point, so that the return of mechanical energy is a very considerable item in very large work and should meet with considerable success.

The distribution of the electrical energy is to be carried out by means of bare copper bars, led to a trunk set of mains running the distance each side of the engine-room where the motors will work, where tappings are to be taken off by means of suitable cables to the controller, or periodicity selector, as it can also be termed. The reversing of any motor can be very easily carried out at the controller, and either of the above speeds can thus be efficiently obtained in either direction of speed rotation.

LIGHTING.—For lighting the ship the lighting section of the switchboard would be divided into three panels, one for each phase. Advantage can be taken of the star-connected generator, previously mentioned, for reducing the voltage for lighting purposes. The voltage across any of the three phases would be 250 volts, but if the neutral point of the star connection is brought out as a fourth wire, the voltage between this wire and any of the other wires is much lower than that between any of the phase wires themselves. We can thus take advantage of this to reduce our voltage for lighting without the use of transformers. And I propose to balance the lighting of the ship between this fourth wire and each of the phase wires.

Many advantages may be claimed for the gas and electricity system, numerous and far reaching. In the first place, labour for working would be cut down to half. The consumption of fuel would be half, which means the saving of bunker space. The cargo winches and hoists would be more efficient, and would be started up without the draining and heating, etc., which take place with a steam winch.

The wiring for the ship's lighting would be as usual, of the best workmanship and material to ensure success. Mains could be led to each deck, running fore and aft of the ship, with distribution boxes in the most convenient positions for distributing the current to the different winches, small motors, etc., the main cables being properly cased in iron barrel, or by some other suitable means to ensure the installation being watertight.

HEATING.—I think that you all agree with me that the heating of the ship by steam is very unsatisfactory. Steam has to travel through long lengths of small bore pipes to get to the radiators, and by the time it reaches them it has lost anything from 50% of its heat. On the other hand electricity can be transmitted any distance with a loss of about 2%, thus leaving about 98% to be expended in heating the radiators. Again, electrical radiators can be more efficiently placed than steam radiators, and better controlled.

COOKING.—With regard to cooking by electricity it has been found by actual experience that it is far more cleanly, economical and easier to apply than coal. Applied on board ship, coal and ashes could be banished from the galley altogether, and as this is usually anything but a commodious space, it would be a great advantage as well as cleaner.

Another advantage which I wish to point out to you in connection with an electrical installation is that there is no trouble from freezing; those who have been into Russian and Canadian ports, for instance, know what a great nuisance this is, where it is necessary to keep the winches running all night to prevent freezing, as when freezing does happen it causes delay and expense. With the system I propose there would not be any trouble of this sort, as all the steam-pipes for operating the winches and capstans, etc., would be replaced by copper cable, which is, of course, unaffected by the cold, and all deck machinery would be operated by electric motors, which are again unaffected by the cold, and can be made absolutely weather proof.

REFRIGERATOR.—All refrigerating machinery could be very well operated by electric motors. They would, of course, require to have a large range of speed, somewhere about 40 to 120 r.p.m. It would enable the refrigerator to be installed in the most suitable place without regard to the means of getting steam to it with resulting economy.

EFFICIENCY.—I shall now deal with the question of the efficiency of the suction gas plant as compared with the steam plant, as I propose to show the coal consumption

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per h.p. for both types of plants. I propose to take the actual tests taken on a 750 h.p. suction gas engine of the type I have described and compare it and a high-class Corlise steam engine working with condenser and economiser. It is necessary to take this course, as I have not been able to get actual coal tests of a donkey boiler under ordinary working conditions.

In the case of the steam engine the coal consumption under test conditions was 2 lb. of coal per brake horse power hour at the flywheel. To analyse the losses from the coal fed into the furnace, the first are due to radiation, unburnt hydrocarbons and ashes. Of the losses due to excess air in the products of combustion we find that some 35 to 45% of their sensible heat is recovered by the economiser. Of the total heat of the coal fed into the furnace 71·3% appears as steam at the boiler stop valve. Six per cent. of the total amount of heat in the coal is lost by radiation from the steam-pipes connecting the boiler and engines. The greatest loss is found in the latent heat of the exhaust steam, and to condensation in the engine itself, which is approximately 52% of the total amount of heat generated. The total losses, therefore, as you see, amount to no less than 86·82%, leaving 13·18% as indicated horse power. The mechanical losses of the engine amount to about 15%, therefore the total amount of heat supplied to the boiler from the coal which appears as useful work is 11·2%. The mechanical efficiency of the engine is not far out, I think, at 85%, especially as the engine in question drove its own auxiliary pumps.

Dealing now with the gas engine, it has been found in a test of the engine mentioned above that it is possible to obtain one brake horse power per hour for an expenditure of 8,500 b.t.u. from the coal fed into the gas producer. We assume that the coal for the producer has the same calorific value as the coal for the steam engine, that is 13,650 b.t.u. per lb. of coal. The loss due to radiation and ashes in the producer amounts to 28% of the total; allowing for the fact that the steam required for making gas can be raised when running from the heat of the exhaust gases from the engine, which amounts to about 13·6%, we get an efficiency of about 83·6%, which appears as gas at the outlet of the producer. This figure is made up as follows: 28% due to losses in ashes, etc., 2% due to losses in the auxiliary machinery, making a total of 30%, from which must be taken 13·6 % added by the exhaust steam heating, leaving 83·6% efficiency as above. This compares with the efficiency of 71·3% of the steam boiler. There is no loss in the gas after it leaves the producer, as the subsequent scrubbing and cleaning process does not effect its calorific value to any measurable extent. Taking the producer efficiency at the round figure of 80%, from each pound of coal fed into the producer we get 10,900 b.t.u., which appears as gas available for use in the engine; we must, however, take from this figure 9%, which from a number of tests represents the stand-by losses of the producer, leaving 10,000 b.t.u. really available. We therefore get the quantity of coal for one brake horse power for one hour as 8,500, divided by 10,000, which equals ·85 lb. of coal per brake horse power hour for the gas engine. This compares with 2 lb. in the case of the steam engine. You will, therefore, see that the fuel costs of gas engine will not in any case exceed one-half those of the steam engine.

There is no reason whatever why the figures for the gas engine could not be maintained if used for the purpose of driving an alternator for supplying current for the auxiliaries on board ship; whereas the losses due to the distribution of the current, etc., would not amount to more than, say, 20% for the electrical plant, the losses due to distribution of steam to the auxiliaries would be, as I mentioned before, on the most favourable conditions a minimum of 75%. I think that these figures should convince every one that the system I have described has a great future before it for auxiliary work on board ship.

In the earlier part of this paper I mentioned that I did not claim cheapness in first costs for the electrical suction plant power for power, but owing to the fact that only 20% of the power generated in the gas engine is lost in the subsequent distribution, compared with that of 75% in the case of the steam plant, it would only be necessary to install a gas plant of about half the power of the donkey boiler to do the same work. Now assuming for the moment that the coal consumption per b.h.p. hour was the same for both boiler and producer, it follows that the bunker space required for the producer would be only half that required for the boiler; however, as I have shown above, the coal consumption per b.h.p. hour of the producer is less than one half of the steam boiler, and the actual bunker space required would be only one quarter of the space required for the donkey boiler.

I give below a few particulars as to the space and weight of various size plants with the producer plants as below:

Brake h.p.	Tons.	Cwts.	Space occupied.
100	6	15	11 ft. 0 in. × 6 ft. 9 in. × 13 ft. 0 in.
125	10	5	12 ft. 0 in. × 7 ft. 6 in. × 13 ft. 0 in.
150	10	10	13 ft. 0 in. × 8 ft. 6 in. × 13 ft. 0 in.
175	12	0	12 ft. 0 in. × 8 ft. 0 in. × 16 ft. 0 in.
200	13	0	12 ft. 0 in. × 8 ft. 0 in. × 16 ft. 0 in.
250	16	0	14 ft. 0 in. × 9 ft. 0 in. × 16 ft. 0 in.
300	18	15	14 ft. 0 in. × 10 ft. 6 in. × 16 ft. 0 in.
350	21	15	14 ft. 0 in. × 12 ft. 0 in. × 16 ft. 6 in.

From these figures you will observe that the weight of a 300 h.p. producer is approximately 19 tons, and occupies 14 ft. × 10 ft. 6 in. × 16 ft.

VERTICAL FOUR-CYLINDER TYPE GAS ENGINES.

Brake h.p.	Weight in nett tons.	Length.	Width.	Height.
100	11½	10 ft. 6 in.	7 ft. 0 in.	8 ft. 6 in.
125	13½	11 ft. 0 in.	7 ft. 6 in.	8 ft. 9 in.
150	17	11 ft. 6 in.	8 ft. 0 in.	9 ft. 6 in.
175	19½	13 ft. 6 in.	8 ft. 6 in.	11 ft. 0 in.
200	22½	14 ft. 0 in.	8 ft. 6 in.	11 ft. 3 in.
250	25	15 ft. 0 in.	8 ft. 6 in.	11 ft. 6 in.
300	30	16 ft. 0 in.	9 ft. 0 in.	12 ft. 0 in.
350	35½	16 ft. 6 in.	10 ft. 0 in.	12 ft. 6 in.

From this table you will see that the weight of the engine is 30 tons, and occupies 16 ft. × 9 ft., and is 12 ft. high; thus the total weight of combined producer and engine is 30 tons plus 19 tons, total 49 tons.

In a recent paper it was stated that the breakdowns in steam engines is one in eight, while the breakdown in gas engines is one in twelve.

The cost of upkeep of a producer plant of course varies somewhat, but from my experience it should not exceed more than £10 to £11 per annum in a well-designed and constructed plant of 300 b.h.p. The items which wear out are the fire-brick lining of the generator, and bottom fire-grate. The coke in the scrubbers should only require renewing once a year, and this only if the producer has been working constantly for this period.

The producer requires a certain amount of water. This is used for two purposes, viz.: for converting into steam for the production of gas, and for cleaning the gas in the scrubbers. The total consumption for both these items varies from 1½ to 2 gallons per b.h.p. hour. The greater proportion of water is used in the scrubbers, but as there is no objection to the use of sea water for this operation, the amount of fresh water required would be very little. Suction gas is non-odorous and poisonous, but as the whole plant is working below atmospheric pressure and the producer only generates just sufficient gas for the load on the engine, there is no possibility of escape when at work or standing by. When starting up a small quantity of gas is blown to waste through a properly constructed waste-pipe, so that there can be no danger from this source.

The usual method of shutting a gas plant down for standing by is to open the waste-pipe cock and the ash-pit door to allow a draught of air to pass through the generator to keep the fire alight. The stand-by loss is the amount of fuel consumed during this period of rest. In Mr. Dowson's book, recently published, on "Producer Gas" will be found a complete comparison of the stand-by losses between gas plant and steam boilers, which shows an enormous difference in favour of the gas plant. When I say that for a given power the gas producer has far less radiating surface than a boiler and occupies less space, has less external settings to be heated up, and, moreover, requires less fuel to make up this loss than in the case of a steam boiler, the enormous difference in the stand-by losses will be more readily understood.

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I will only tabulate a few of the figures, which will be quite enough to show the gas plant compared with a boiler in this respect.

CONSUMPTION OF FUEL IN BOILERS DURING STAND-BY HOURS.

Type of boiler.	Max. h.p. of boiler.	Coal consumed per standing hour.
Various	..100 ..	14·0 lb.
Lancashire	..450 ..	37·5 ,,
Babcock & Wilcox	..210 ..	67·0 ,,
Ditto	..550 ..	180·0 ,,
Niclausse	..400 ..	50·0 ,,

This gives an average of ·2 lb. of coal per hour.

FUEL CONSUMPTION IN PRODUCERS DURING STAND-BY HOURS.

Locality	Maximum h.p. of Producer.	Coal consumed per standing hour.
Openshaw	..250 ..	5·1 lb.
Leicester	..100 ..	2·1 ,,
Small Heath ..	..250 ..	4·5 ,,
Limerick	..225 ..	3·8 ,,
Walthamstow ..	..375 ..	1·8 ,,

This gives an average of ·017 lb. of coal per b.h.p. hour.

In a paper read by Mr. E. Shackleton before the Institute and reported in Vol. XX. of the Transactions, he gives some very interesting figures relating to the coal consumption required for loading or discharging cargo by steam; he bases his figures on a steam plant of 200 b.h.p., and gives the fuel consumption of this for 12 hours as 5 tons 7 cwts. 16 lb., and goes on to say:—

"Referring to the cargo discharge consumption, the writer is of opinion that the majority of engineers are acquainted with the excessive fuel consumption of the average steam winch, which (on account of its very low efficiency, owing to condensation losses, etc.) may probably be put at 5 lb. per h.p. per hour as not too high an estimate." Comparing this figure with the coal consumption of the electrical winch driven from the suction gas alternator, I will refer you to the coal consumption of the gas plant which I gave at ·85 lb. per b.h.p. hour on the gas engine. To arrive at the consumption for the winch, we have to take into consideration the distribution losses of the electrical system. I stated this figure was 20%. Supposing that we take this at 25%, we shall get a coal consumption of 1.06 lb. of coal per brake h.p. hour on our electrical driven winch, as compared with 5 lb. of coal for the steam driven winch. This means that the coal consumption on, say, 24 hours continual work with 300 b.h.p gas engine would be just over 4,800 lb. of coal, while the coal for the steam engine would be 24,000 lb., or just five times as much.

Dealing with the amount of mechanism in the two forms I have described, that is between the producer and the steam boiler, the producer is a comparatively simple piece of apparatus, as no parts of it are subject to any pressure, and after the gas is cleaned and scrubbed no physical change takes place until it reaches the engine, no feed water pumps are required, and the amount of cleaning required is extremely small. On the other hand, the steam boiler has to be well maintained, as it has to work under high pressure. Care has to be taken with the feed water, and the interior of the boiler must be kept free from scale, etc. The steam can lose a great amount of its heat in the steam-pipes. The valve gear of the gas engine is extremely simple, and when once set cannot be tampered with.

As for the alternating current generator and induction motors, these are simplicity itself, far more simple than continuous current motors. The losses that occur in the distributing cables at the most only amount to about 2%, and these cables require absolutely no attention when once installed.

Below I give the actual test figures taken on a Hornsby Stockport suction gas engine of 200 b.h.p. showing cost of working, including capital expenditure and maintenance, &c.

A test on a 200 h.p. Hornsby Stockport suction gas engine showing the cost of working, including allowance for depreciation and capital expenditure:—

Coal.—·85 lb. per b.h.p. hour, 170 lb. per hour at 12s. per ton	11	pence
Labour.—One man with labourer assistant, 53 hours at 40s. per week	9	,,
Water.—Two gallons per b.h.p.h. at 6d. per 1,000 galls.	3	,,
Capital Expenditure.—Engine and plant, £1,680. Interest 5%. Depreciation 7½%, and maintenance 2½%, making a total of 15% ..	23	,,
Oil waste and stores	3	,,
Making a total cost of per hour ..	49	pence

49 pence for 200 h.p. per hour equals ·25 pence per hour or one farthing per brake horse power hour.

From an article written in *Cassier's Magazine* by the Marquis of Graham, on the gas engine experiments in the *Rattler*, the gunboat stationed on the Clyde for the use of the Clyde division of the Royal Naval Volunteers, and usually cruises at the week end, we gather the following:—

Her description is as follows: Composite construction, single screw, length 165 ft., beam 29. Mean draught, 11 ft. 2 in.; displacement, 715 tons; i.h.p. with forced draught, 1,000 h.p., speed, 13 knots; with natural draught, 600 h.p., speed 11·5 knots. She was launched at Elswick, October 8, 1886.

Her old boilers and steam engines have been removed and a single set of vertical Beardmore Chaplain suction gas engine and producer installed in their place. The engine is 500 b.h.p., five-cylinder single acting bore, 20 in. stroke, 24 in. 120 r.p.m. The five cylinders are independent of each other. One cylinder could be knocked off for examination if required, while the other four are working. A magneto is fitted to each cylinder, the ignition being of the low tension make and break type, this type of ignition being considered the most suitable for marine work, as there is so much moisture to contend with. This form of ignition has been running two years without a single failure. The producer is of the usual type, the fuel being anthracite; the steel shell of the generator being lined with fire bricks and with the feeding hopper on the cover, the cover being water cooled. The fire bars are trough shaped and placed radially round the producer; the inner ends are supported on a frame. Water is kept circulating through this, and so prevents the edges of the fire bars burning away. The gas after leaving the producer enters the bottom of the cooling tower and leaves at the top. The gas in its upward course comes in contact with water sprays, and is thus cooled and cleared of any grit that may be in it. After leaving the cooling tower the gas passes to the centrifugal drier, in which the fan is revolving at a high rate of speed, and any water that is in the gas is thrown off to the walls of the casing and is drained away to a water seal. The gas being lighter remains in the centre of the fan, and is then drawn through the cleaner to the mixing valve on the engine and then to the various cylinders. The exhaust gas passes into a nest of tubes through which water is circulating, and the heat from the gas generates steam which is used for the producer.

The engine is started by means of a mixture of gas and air pumped up to 90 lb. per square inch, which is admitted to the cylinder through a specially constructed valve and then fired. The engine invariably starts up with the first impulse and gets sufficient way on to draw in gas from the main mixture. As regards the performance of the vessel, she has run up to date over 1,800 miles at an average speed of 8 to 9 knots per hour. There is no shovelling coal in a dark and confined space. The feeding of the gas producer is intermittent, and can be done automatically instead of by hand. The heat from the producer is nothing compared to the heat arising from boilers in a stokehold. As regard weight and space, the gas producer saves from 25–30% of the corresponding item of a steam outfit, but it is in the cost of labour and fuel that one of the chief benefits is to be found. The *Rattler* as a steam vessel had 13 stokers and 4 engineers, now as a gas ship she has 3 engineers and 4 helpers. The producer only requires a few minutes' attention every two hours. It was found that starting from all cold took 30 minutes. Consumption of fuel compared with the steam plant was 50% less for the gas plant.

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My desire in giving you the particulars of the *Rattler* is to illustrate the actual proof of saving.

First in the labour we have—

Steam.	Gas.
13 men	4 men, giving a saving 9.
4 engineers	3 engineers, giving a saving 1.
Coal..	50% less.
Space	25% to 30% less.
Weight	25% to 30% less.

At the Powell Duffryn Aberdare Collieries Electrical Equipment, started up in 1905, the alternators are as follows :—

	No. 1.	No. 2.
Output	2,000 k.v.a. ..	1,000 k.v.a.
Pressure	3,300 volts ..	3,300 volts.
Frequency	50 ..	50.
Speed	83 revs. ..	94 revs.
Height above floor	17 ft. ..	13 ft.
Floor space with horizontal engine	988 sq. ft. ..	720 sq. ft.

The motors are as follows :—

	No. 1 Variable Speed.			No. 2. Constant Speed.		
B.H.P.	150	75	50 .	100	50	25
Volts	3,000	3,000	3,000 .	3,000	3,000	3,000
Diameter of Rotor ..	42½	30	25 .	42	24	19½
Speed (full load)	290	365	365 .	290	485	485
Efficiency :—						
Full	89·5%	89 %	85% .	90%	91%	87·5%
Three-quarter	89 %	88%	84% .	91%	90%	88 %
Half	87·5%	86%	82% .	91%	88·5%	87 %
Power Factor :—						
Full	·78	·82	·72 .	·87	·83	·85
Three-quarter	·71	·78	·63 .	·86	·77	·80
Half	·6	·68	·5 .	·82	·65	·7
Temperature rise Centigrade	35	39·5	45 .	37	60	30

These are induction motors, and those working below ground are totally enclosed. All switch-gear below ground works under oil. The fans are rope-driven by 180 b.h.p. 3,000 volts motors, and deliver 150,000 cubic ft. of air per minute with 3¾ in. on water gauge. The cost per unit delivered to the transmission lines with an output of 4½ million units per annum, load factor 37%, using unwashed coal, small (13,000 B.T.U.), at 4s. 2d. per ton is—

Works cost	0·18d. per unit.
Int. and dep. on Station, 10% ..	0·185d. ,,
Total	0·365 per unit.

It is hoped to bring this cost below 0·3d. per unit with 45% load factor. There is no danger whatever in any electrical system, if it is used with ordinary care. Here we have 3,000 volts motors, mains, and switchgear below ground; four years have elapsed, and there have been no accidents; 500 volts have killed people, and, of course, so will 2,000, but 2,000 volts is treated with greater care, and is better installed, and leak indicators, etc., are kept working.

In conclusion, I might mention that the maintenance and depreciation in sea-going installation such as I have attempted to describe would not be at all heavy. I think that an allowance of 7½% is usually reckoned as a fair margin to allow for depreciation of the plant on land installations; perhaps at sea this might be a little heavier, say 10%. As for maintenance I think that 2% would cover this item. So we get 12½% as an annual charge on the capital outlay of the installation. I think that the comparison which I have endeavoured to make between the two systems, that is the donkey boiler with its scattered units and long lengths of steam piping, and the suction gas-plant with its centralized generator, gives the case fairly for each system.

PRIZE FOR INVENTORS.

In connection with the International Labour Exhibition to be held at Turin in 1911, the Turin Chamber of Commerce offers a prize of £2,000 to be given to the author of any invention of whatever kind which in practice will prove advantageous to national economy. But such invention must not be of older date than 1908.

ELECTRICAL PROPULSION OF SHIPS.*

By WILLIAM P. DURTNALL, M.I.Mar.E., M.I.Auto.E.

The present century is pre-eminently one of daring. The new age, with its clearer thought, its wider scope of action, and its humane and liberal institutions, has proved itself an excellent foster mother for the springing up of new ideas and countless inventions which, under earlier ages, would have been stifled at birth, as direct emanations from the evil one. Released from the swaddling clothes of error and superstition, the inherent maturity and strength of man has re-asserted itself, and to the untrammeled vision and ripened energies of the scientist the mysteries of nature have been gradually disclosed.

Foremost amongst these has been the discovery of that most magical and mysterious agent, Electricity. The prosecution of this comparatively crude and untried science was at first attended by laborious thought and imperfect results, and little real progress was discerned until about 76 years ago, when the eyes of the world were turned to London, on the most interesting exhibitions of one, Thomas Davenport, who had constructed his design of electric motors, working from primary cells. It was clearly shown that rotary motion could be given to such a machine, and thus formed the basis for the future as regards electrically propelled ships.

For the first time in the history of the world of electrical engineering—nearly 72 years ago (1838)—Prof. Jacobi, a distinguished electrician residing in St. Petersburg, made a demonstration as to what could be accomplished with the electrical motor as a means of propulsion of boats.

Towards the expenses the Emperor Nicholas contributed about £2,500. Prof. Jacobi employed the type of electric motor that Davenport had brought out, and which had attracted considerable attention at the Academy of Sciences at Paris in 1835. The attempt was the first on record of its nature, and was a proof of the originality in electrical investigation that made Prof. Jacobi one of the discoverers of the great modern art of electrical engineering.

Since that time, the later work in England of Robert Hunt and G. E. Dering in 1856, and Count de Moulins in France, in 1866, there have been many other attempts to apply batteries to the propulsion of boats, but these experiments have nowhere resulted in lasting commercial results; the prospects of seeing a large ship laboriously hauling an acre or two of batteries through the surf was almost too much to expect, and although many attempts have been made from time to time, it remained for the introduction of high speed and efficient prime-movers such as internal combustion engines and steam turbines, together with the tremendous advance in the art of designing and building dynamo-electric machinery, before the application of the electric motor could be reasonably put forward as a means of propeller shaft driving for main marine work.

The next important step in this direction took place in 1903, also at St. Petersburg, when a vessel was constructed and put into service by Messrs. Nobel Bros. In this craft was a tank vessel of 1,150 tons displacement, intended to carry oil on the Volga and in the Caspian Sea. The propulsive plant of this interesting vessel consisted of three Diesel engines, driving three continuous current motors, each serving to drive one of three propellers fitted, the control for which being carried out from the bridge. The regulation was effected by means of varying the exciting current of both the generators and also the motors, by which means also the reversing of the propellers was carried out. The vessel speed was, however, only very low: when light, 8 knots, and when loaded, 7·4 knots; the total power of the engines was 360 b.h.p. 120 h.p. each. The generating plant was situated about amid-ships, while the motors were placed right aft in a separate motor room. The control being arranged from the bridge, the engine-room staff did not know in what direction the propellers were running, whilst the staff in the motor room knowing it, were unable to bring about any change. The complete control of the drive was carried out by the engineer on the bridge, and he steered and manœuvred the ship without having any contact with the engine-

* Abstract of Paper read before the London Association of Foremen Engineers and Draughtsmen, on Saturday, September 4.

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room staff. The consequence of this was that no such thing as mistakes in either receiving orders, or misunderstanding same, has been known to occur on ships where the ordinary signals have to be given to the engine-room and attended to before any alteration in the speed or direction of the propellers can be made. The importance of such a method of control is self-evident, and it will be remembered as to how a great German liner was a few years ago driven on to Dover Granite Pier by mistaken orders, and sustained severe damage in consequence. As stated before, the advent of the internal combustion engine and the high speed steam turbine has brought about conditions which now make the commercial possibilities of the electric motor for main marine propulsion appear well within sight, and some very interesting suggestions have during the last few years been made as to its application to such very important work and exacting conditions; in America and on the continent of Europe some of the most important members of the engineering world have been at work on this subject.

Some hesitation may at first be apparent as to "why" introduce electricity between the prime-mover and the propeller? to which point we all wish to apply the power of the prime-mover with the least possible of losses; and, on the face of the matter, it certainly does appear that if compared with the existing slow-running marine engines, with their slow-running propellers, etc., under those circumstances, the application of electricity, or any other intermediate, would be a wasteful and unnecessary, if not a ridiculous, idea.

But as the march of science goes on we find that prime-movers are introduced (such as steam turbines, etc.), which, to be economical in fuel, must be run at such revolution speed—many times that of the efficient propeller—in order that it may produce the utmost thrust per h.p. delivered to it. As you all know, the modern reciprocating engined cargo boats have propeller speeds of from 60 to 120 r.p.m., and work with great comparative economy as compared with steamers that have been fitted with steam turbines. In some cases the propellers have been raised in speed to meet the high speed of the turbine. It is a well-known fact that the steam turbine to be economical in fuel must be run at a high blade speed and be supplied with dry or superheated steam, and must be run also on a high vacuum; on the other hand, the propeller is a piece of mechanical machinery that to be efficient must be run at low speed, so that it becomes very evident that direct-coupled turbines mean for main marine propulsion a compromise of a very wasteful nature, *i.e.*, the turbine being brought down in revolution speed, and the propellers are raised in revolution speed to meet same, the consequence is that the propeller cannot produce the maximum of thrust, and the turbine cannot produce the utmost amount of h.p. from a given amount of steam or fuel burnt, as compared with what is possible if some such reduction gear, such as electrical power transmission, is introduced between the high speed steam turbine, and the, say, slow speed propeller that could then be used. As an example, take the *Lusitania*. The trial figures show that the propulsive efficiency worked out at about 48%, that with the turbines and propellers running at 186 r.p.m., and the power was about 16,375 h.p. in each of four shafts. Now Dr. Caird, who, as you all know, is a great authority on the subject of shipbuilding and propulsion, gives it out that had the *Lusitania* been fitted with slow speed reciprocating engines with the propellers only running at 80 r.p.m., and, of course, larger in diameter than those used at present, that the power required by the propellers for the same vessel speed of 25 knots would only have been 52,830 h.p., or only 13,207 h.p. on each shaft, and that the propulsion efficiency for the above power would be about 60% instead of 48%; so you see what the running of the propellers at slow speed means, as it is not the fact that it is essential that the reciprocating engine is more economical than the turbine, but the fact that by running the propeller at a comparatively low speed, making large blades and low pressures per sq. in. of propeller blade possible, and consequently taking better grip of the water. and producing the maximum of thrust per unit of power, It will thus be seen that if electric motors be coupled to slow speed propellers that the same propulsive efficiency may be obtained per h.p. delivered by the motor shaft to the propeller shaft. Now we will come to the matter of steam consumption, and we will leave the matter of auxiliary driving out, so as to get the proper comparison for the fuel burnt per h.p. for propulsion only in each case.

The figures stated in the trials of the above vessel go to show that the amount of steam per shaft h.p. was 12·77 lbs. per hour, therefore requiring 836,435 lbs. of steam (this for propulsion only). Now if the propellers were driven by induction motors (say two 8,188 h.p. each) on each shaft, these motors can be made with a mechanical efficiency of, say, 93%, which to supply them with sufficient electrical energy to do this work of 16,375 h.p. on each shaft would require, say, 52,403 kw. (leaving out the small amount of loss that would of course take place between the generators and the motors). To meet the above conditions, we will assume to put on board five 10,480 kw. turbine alternators running at 1,000 r.p.m., and these when supplied with steam at, say, 160 lbs. pressure, superheated by 100° Fah., and running on a vacuum of 28 in. (which can under these circumstances be obtained at sea in the Atlantic, but, of course, not in the Red Sea), the guaranteed steam consumption can be 11 lbs. per kw. hour delivered to the terminals of the generators, which means that 576,433 lbs. of steam per hour would be used for propulsion only, which is a saving of no less than 31% in steam and, therefore, fuel, that is taking the speed of the propellers and motors as at present, namely, 185 r.p.m. A further reduction in the power required, and, therefore, fuel, is quite possible, insomuch that it is quite within the range of practical possibility to build motors of this size that would run with economy at, say, 150 r.p.m., and at the same time to be of such diameter that they would get into the narrow after lines of the vessel, at least, in the same places as the present space occupied by the present turbines. It must be remembered that I do not propose to use motors with a lot of different windings on them to be able to change the revolution speed, as this is done in my "Paragon" system by means of the generation current at various periodicities, which in turn allow the motors to run at such a speed which may be desired in practice, with the consequent absence of complicated controllers and without the necessity of wasteful resistances, etc.; so it will be very evident to you that the power transmission efficiency will be the highest possible electrically.

I will leave to your own imagination what this tremendous saving in fuel will mean, and the following items will be at least reduced by a like amount: boilers, stokers, trimmers, feed-pumps, draught-fans, funneling, coal bunkerage, dead water in boilers, smaller steam and exhaust pipes, condensers and their circulating water, and pumps, air pumps, and many other things that make up the steam plant of a modern liner.

Ship owners will be well advised to look right into this matter, and I am of an opinion that the coming competition in the shipping trade, from foreign sources, will compel the ship-builders to employ high speed superheated steam turbines to produce the power, and to adopt electrical means to transmit same to slow speed propellers, and for the before-mentioned reasons; and when this is done, such low coal consumption per ton of displacement per mile at any given vessel speed will then be recorded that it will be a most difficult thing for shipping firms to commercially exist without it.

There is another prime-mover that is now making very rapid headway to the front, *i.e.*, the internal combustion engine, with its light weight and high thermal efficiency, will in the next decade be extensively adopted for the purposes of propelling of ships and also for working auxiliary machinery on same, in conjunction with electrical power transmission. These interesting prime-movers will show further economies, especially in those vessels that only require power up to, say, 1,000 shaft h.p. At present, above that power the high superheated speed steam turbine is top dog as regards its practical application, the reversing and speed regulation being carried out electrically, so that the engines may run at high speed (much above that of the propeller) always in the same direction, and at constant speed rotation, irrespective of the speed of the propeller, or whether the vessel is going "ahead" or "astern," and this control can be very efficiently brought about either from the engine-room or from the bridge, as may be desired. I hope in the very near future to be able to publish

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some tests of a 500 h.p. single screw vessel that it is suggested that my system shall be adopted on for propulsion, with suction gas plant, and engines running at about 450 r.p.m.; the propellor will run at about 100 r.p.m., and the economies that will follow are quite obvious.

However, I hope that these small endeavours have been the means of raising some train of thought in the direction indicated, which will show the real investigator what is in store for the progressive ship-owner who gives that system a trial, and which will be the forerunner of the general adoption of electrical power transmission for the propulsion of ships.

DISCUSSION.

Mr. Durtnall illustrated his paper with about 200 lantern slides, showing machinery and plant on existing turbine and reciprocating engined steam vessels, and pointing out the large dimensions and, consequently, their great weight and cost.

A short discussion followed the paper. Mr. George W. Knight (President) observed that it behoved engineers to think thoroughly on the subject of electrical power for marine propulsion. He drew attention to the very large and heavy reciprocating engines that had been made and the vast number of working parts which had to be kept in good order by marine engineers. If the lecturer's claims could be realised in practice he was inclined to think that great economies must ensue.

Mr. Hill (an electrical engineer) mentioned that he came to the meeting with feelings of doubt as to the possibilities of electrical propulsion for large ships, but, after hearing the paper and details given by Mr. Durtnall, he must admit that his views had altered. Take, for instance, he said, the question of rapid reversal. There was no question as to the speed in which this might be brought about by means of the control which Mr. Durtnall had suggested and embodied in his scheme.

Mr. Reed thought is was quite evident that the electric motor could be made of such power and speed as required for propeller driving.

THE CARE OF A BATTERY.

French industry in, at least, three important centres Rouen, Lille and Mulhouse, is assisted and encouraged by technical and industrial societies. We are not forgetting that the last of these towns is in Alsace, but the industry is Gallic and the proceedings of the Mulhouse Society are still reported in French. Among the useful parts played by the Rouen Society is an arrangement by which its members can have the disinterested services of a first class engineer, who is ready to give advice on the installation of machinery and steam-power, and to make periodical visits of inspection or to advise on an emergency. An electrical engineer of high standing is also at the service of members. The report of this official, M. G. Thullier, for last year is now before us. In addition to supervising the reception of new plant and assisting at several installations, he made 28 emergency visits. These are charged at the modest rate of 35 francs per half day to the member of the Society, and users of electricity in Rouen frequently become members of this excellent Society in order to take advantages of this expert service. From the result of his observations, M. Thullier makes some interesting notes on the use and care of a battery of accumulators.

M. Thullier notes that the working capacity and durability of a battery of accumulators depends upon constant inspection of the battery and the regularity with which the charge of electricity is renewed each day, allowing for waste. It is well understood that a battery which has yielded 500 a.h., for instance, should be charged with more than this amount, say about 600 a.h.

In order to be able to charge a battery then, we must know how many ampere hours it has given out since the last charging, if we are to save time and avoid hesitation and uncertainty in the operation. We must also know what proportion of the total output has been yielded. If the battery has been nearly exhausted, it must be recharged slowly, *i.e.*, with a comparatively weak current. In short, the attendant of the battery must keep a proper record, so that he may know each day what has been done with the battery the day before.

When the battery is charged the attendant tests the voltage, seeing with his voltmeter that it is about three volts, and ascertains by examining them one by one that none of the cells are short circuited.

As in general the charging is done with a number of amperes sensibly constant, he has to increase the voltage as the charging proceeds, for the voltage at the limit of each cell ought to increase uniformly, except in the case of the reduction cells which have worked more or less.

As the charging proceeds, and as the voltage at the limits increases, the readings of the voltmeter enable us to see whether or not the separate cells are being equally charged. This is the most effectual kind of supervision and gives the best tests of the condition of the battery.

As the charging proceeds the attendant knowing exactly the number of cells in the circuit, and knowing that he ought not to exceed 2·65 volts per element, allowing for such as may be in a bad state, ought to succeed in diminishing his amperage, bringing it almost to nil by the time the charging is finished, *i. e.*, when the voltage of the battery is equal to 2·65 multiplied by the number of cells. For example, if the battery is working with 56 cells, the charging is finished when the voltmeter shows $56 \times 2{\cdot}65 = 148$ volts, and the amperage ought to be practically nil. At this moment the electrolyte should mark 26° B, but this will not be the case unless each cell shows 22° B at the commencement of the charging. This is, therefore, a very important point, and care should be taken that on charging the electrolyte has a density of 22° B in each cell.

Finally, effervescence of the electrolyte is a sign that the charging is finished, but it may not occur. Again a chocolate brown colour of the positive pole, contrasting with the matt grey of the negative pole, is another useful indication, but we must repeat that the readings of the voltmeter are the surest guide in this delicate part of the management of a battery.

We may sum up in the following rules :—

1. Keep the electrolyte in all the cells at the same density, from 22° to 26° B.

2. Never allow the voltage to fall below 1·8 per cell, nor the maximum number of amperes.

3. Never charge to above 2·65 volts per cell, nor the maximum number of amperes.

These two maxima should be fixed by the supplier of the battery and recorded in writing.

4. Cut off the current when the battery is given out more amperes than it is made to supply.

This is a strong measure, but it is the only thing to do if the cells are to be kept in good order.

THE INDIAN ELECTRICITY ACT.

The Indian Electricity Act, which has gone before the Viceroy's Council, is in amendment of the Act of 1903. The modifications as set forth by the member of Council in charge, include the appended :—

The existing provision making licenses compulsory has been taken out, the question of supply to the public without license being otherwise dealt with. It is by no means certain that licenses are either necessary or desirable in the case of industrial companies of certain classes. Provision is made for the grant of licenses for "bulk supply"; that is to say, to meet cases where the applicant company proposes to generate energy and supply it in large quantities to distributors, who would retail it under a separate license to small consumers. The amendment of licenses has been provided for. At present it is necessary to revoke a license and grant a fresh one in order to effect this object. The question of compulsory purchase has been dealt with, in regard both to the splitting up of undertakings and to those cases where purchase may be impracticable.

Many difficulties have arisen owing to the hard and fast limits of the area of supply over which a license operates, consumers just outside the boundary being debarred from participation in the benefits conferred by the public supply. A new section is proposed to deal with the matter and remove obstacles which are likely to impose quite unnecessary hardships on individuals. It is proposed to amend the provisions of Part III. of the Act so as to make them applicable to mines and binding on the Crown. As regards railways and tramways, the proviso to sub-section (1) of section 3 in Part II. and the first proviso to sub-section (1) of section 31 in Part III. of the Act as it stands lay it down that nothing in these Parts respectively relating to the supply or use of energy shall apply to any railway or tramway subject to the provisions of the Indian Railways Act of 1890. The extent to which it is proposed to modify the latter of these provisions is explained in the Notes on Clauses (Clause 30), while it is proposed, as already mentioned, to repeal the former. A slight amendment of the Land Acquisition Act, 1894, has been proposed with a view to facilitating its application to electrical works.

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THE

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CONTENTS.

	PAGE
Notes	325
"Poulsen" Wireless Telegraphy	326
Electrolysis of Winnipeg Water Mines	327
Extended Uses of Electricity on Board Ship	328
Electrical Propulsion of Ships	334
The Care of a Battery	336
The Indian Electricity Act	336
Ethics of Power Production	337
Correspondence	338
Educational	339
Lightning Conductors	339
Research Scholarships	340
Electric Domestic Appliances	340
Personal	340
Publications Received	340
Mining Electrical Association	340
Refuse Destructor at Electricity Station	340
Butter Factory and Electricity	340
An Employers' Association	340
Patent Spiral Self-Centring Chuck	341
The Siemens Selective Call	341
"Therol" Electric Water Heater	342
Suckling Water-Tube Boilers	343
Boddy's "Metalik" Lamp	346
Electric Timing of Motorists	346
Electrified Textile Mill, North Carolina	348
The British Columbia Electric	348
Tyneside Notes	349
American Notes	349
Technical Problems, with Solutions by Practical Men	351
Companies' Meetings and Reports	355
Companies Registered	356
Contracts Open	356
Results of Tenders	357
Tenders Accepted	357
Lighting & General Notes	357
Traction Notes	359
Patents	360
Companies' Stock and Share List	362

ETHICS OF POWER PRODUCTION.

Only last week we dealt with the duty of the community to utilise water-power in the generation of electricity in order to economise nature's exhaustible stores of energy, such as coal and oil. This conservancy problem is greatly exercising many advanced thinkers, perhaps markedly so in the United States. Quite recently Mr. Lewis A. Ferguson, in his presidential address before the American Institute of Electrical Engineers, told his audience that: "It is for the commercial electrical engineer (which really includes nearly all of us) to educate the layman, and particularly the power user, to an appreciation of the superiority and desirability of electric service, and to emphasise the material and ethical advantages to a community of centralised power production." Though using different language, and viewing the question from a slightly different standpoint, substantially the same message was the burden of Sir Joseph Thomson's address at Winnipeg. This anxiety for the future is an excellent sign of the times, and though it may cause the unthinking majority and the selfish few to scoff, it means sound business economy. By looking ahead and taking count of futurity, we shall be benefiting ourselves. At present we pollute the atmosphere with smoke, we allow furnace gases, and other gases produced in the process of manufacture, to escape and become a nuisance. All this is extremely bad for the community. It is equally so for the individual manufacture, for smoke pollution and escaping gases betoken waste. It may take some time to educate men to the truth of this, but the fact remains, obscured though it may be by questions of capital investment, custom, and so on. The waste, however, goes on, causing loss to the manufacture, expense and annoyance to the community. It may be that the community, in order to protect itself, may force wise economy on the manufacturers. And so the altruist and the

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egotist may work towards the same end. Certain it is these problems of conservancy are steadily being pushed to the front. As Mr. Ferguson says, they touch the electrical engineer closely, demand his attention, and his furtherance. There are many ways in which this furtherance can take place besides that of centralisation, which is now so much in men's minds. The use of water-power is one phase of the solution. The use of coal under scientific conditions is another. We could certainly produce gas suitable for power purposes far more cheaply near the mines themselves than we do now by conveying it long distances, arresting distillation too early, and purifying the gas for illuminating standards. This is true social work, but it is also sound business reasoning, the ethical course in this matter of conservancy speedily bringing its reward. While the higher view should by no means be lost sight of, the electrical engineer may well devote his educating energies, first to the reduction of the cost of production, and secondly to showing the business man how he can utilise electricity in endless ways, to his own comfort and profit. But there is no room for doubt that the electrical engineer should seriously take up this duty of educating the community at large, and especially the power user, of the many ways that the current may be used. The consumer does require to be taught, and he can only be brought to recognise his own interests when they are thrust before him with the indefatigable zeal that characterises at once good salesmen and the pioneers of a budding industry.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "THE EDITOR, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

WHAT IS ELECTRICITY?

Sir,—It is, I think, some fifteen or sixteen years ago, that you allowed me to enunciate in your columns, a theory of electricity which I then supposed to be enunciated for the first time, viz., that electricity is a mode of motion, similar to, but necessarily with different rates and possibly forms of motion, to heat and light. I learned afterwards, from one of his pupils, that Prof. Rucker, now Sir William Rucker, had enunciated precisely the same theory in his classes before I had done so. It is, perhaps, natural that the final argument which led me to enunciate the theory, was provided by Prof. Rucker himself, in his lecture to the British Association at Cardiff, upon Electrical Stress. In some very beautiful experiments upon a glass plate, he showed that under the stress of electrical charge, the molecules of the glass were compressed, exactly as the molecules of other bodies are compressed, when exposed to pressure from bodies, expanding under the influence of heat.

In these days, and for some years now, we have heard of only the new theory of electricity, the theory upon which its advocates hope to base an explanation of gravity. As your readers know, according to the new theory of electricity, the atom is supposed to be built up of positive and negative electrons, and what we know as an electric current is supposed to be a procession of negative electrons or corpuscles. Upon this supposition, a large amount of other theory has been built up, and some really splendid work has been done, but may I ask, is it safe to continue building upon such uncertain foundation? May one ask Sir Joseph Thomson, Sir Oliver Lodge, and those who think with him, to furnish proof that the electrically charged corpuscle is electricity? If proof of that is not forthcoming, it appears to me that the whole theory falls to the ground.

I have very carefully studied everything that has been written upon the subject, since the inception of the theory, and as I read the work that has been done, there is nothing that has been observed that is inconsistent with a wave theory of electricity, similar to that which holds for heat and light, but with the necessary corrections for the difference in the two forces. No one can help admiring the splendid work upon radio-active material, which Prof. Rutherford has done, and though one would like to be sure that his measurements of the α particle were correct, one cannot help admiring the ingenuity and skill of the work, and yet we cannot help asking again, where is the proof that an electrically charged particle is electricity?

As I have pointed out before in your columns, the range of the spectrum that has been explored is comparatively small, and there is an enormous range outside of the spectrum that is also unexplored. Is it not at least probable that forces propagated by waves, and themselves consisting of modes of motion, exist, of which we have no knowledge? Necessarily modes of motion at different rates, and with different wave lengths, and possibly with different forms of waves to those of which we have knowledge, would have different properties. Does not all the work that has been done in wireless telegraphy, tend in the same direction, viz., that electricity is a mode of motion, and not that electricity is matter? Is it not again going back to the days of the corpuscular theory of light, to endow electricity with a corpuscular theory?

I trust that those who support the theory which has been advanced will furnish evidence to bridge the hiatus I have pointed out.

SYDNEY F. WALKER, R.N.,
M.I.E.E., M.I.M.E., M.C.S.I.A.,
M.Inst.M.E., Consulting Engineer.

Bloomfield Crescent, Bath.
September 6th, 1909.

UNIVERSITY GRADUATES AND APPOINTMENTS.

Sir,—It may be of interest to many of your readers to know that an Appointments Board has been constituted by the University of London. The terms of reference to the Board are "to assist Graduates and Students of the University in obtaining appointments, and to co-ordinate and supplement the work done by the Schools and Institutions of the University with this object." I am directed by the Board to express their hope that, through the medium of the Press, the objects of the Board may be brought to the notice of Graduates as well as of those who are able and willing to assist in furthering the work of the Board, the aim of which is to encourage the selection of University men for all posts in the work of which the possession of a University Training on scientific methods is an advantage. They wish to assist Graduates to find employment, and to assist employers to find, in the University ranks, suitable men for vacancies.

It would assist the Board if, whenever your readers know of any vacant appointments suitable for University men, they would communicate with the Secretary of the Board, so that he may put forward selected candidates. In this way the work of the Board as an employment exchange would be greatly helped.

Yours faithfully,
HENRY A. MIERS, *Principal*.

University of London,
South Kensington, S.W.

PRUSSIAN MAIN-LINE ELECTRIFICATION.

Sir,—Referring to your Editorial Note in issue No. 10, pertaining to Prussian main-line electrification, you might be interested to know that in the "E.K.B," of April 24, on page 222, is a map of the said electrification. It might be well, too, to state that the trolley potential will be 10,000 volt; your account might give the erroneous idea that not only the transmission potential, but also the trolley potential amounts to 60,000 volt. The "E.K.B." issue 26, to appear on September 14, will contain a complete list of new electric motor cars ordered by the Prussian

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Government Railway, including 25 cars for the Hamburg Altona single-phase lines, to be equipped with 2 × 180 h.p. motors each; furthermore 33 storage battery rail motor cars and 3 benzol electric rail motor cars.

EUGEN EICHEL.

"*Elektrische Kraftbetri be und Bahnen*,"
Berlin, S.W., 68, den, *September* 6, 1909.

ELECTRICAL PROPULSION FOR SHIPS.

Sir,—As an important organ of the electrical industry, I am anxious to draw your attention to a letter signed by a leading member of the electrical profession in the *Times* "Engineering Supplement" of to-day, in which he complains of "extravagant claims made for electrical power transmission for the above important problem," accompanied by other uncalled-for remarks.

As one who has made a close study of this important matter in co-operation with some of the leading naval architects and marine engineers in this country and abroad, and also one who has endeavoured to enlighten marine engineers as to the "truthful" position of the problem, and drawing their notice to the growing possibilities of co-operation with electrical engineers, and to the opening up of new fields of operation for efficient means for the generation and transmission of power, which if taken up will make a tremendous increase in the business of electrical plant manufacture, I think the subject should be thoroughly investigated by the leading plant manufacturers of this branch of engineering. If they will do so, I shall be most happy to lay before any member the system as advocated by the writer of the letter referred to, and that which I have designed for the purpose. They will then be in a position to judge of the merits of the respective systems and form their own conclusions as to which is capable of fulfilling the claims made. If such investigations were made, I would esteem it as a favour if the results were published for the guidance of others.

WILLIAM P. DURTNALL.

11, Bush Lane, Cannon-street, London, E.C.

The following is the letter referred to:—

TO THE EDITOR OF THE *TIMES*.

Sir,—Your recent *Engineering Supplements* have contained an exposition by a contributor, a warning editorial, and an appeal by a correspondent.

Pointed reference having been made to my advocacy of this method of marine engineering, you will permit me to dissociate myself from the extravagant claims made for electric propulsion and very properly deprecated in your editorial notes. Such claims are undoubtedly based, as you say, on fundamental misconceptions of the problem, and will not stand expert investigation.

The appeal to "members of the shipbuilding industry" is unnecessary. British marine engineers know their business and are keenly alive to the importance of new developments. No one who can show them a feasible proposition need be in the position of "wondering that nothing is done."

Something has been and is being done. Experimental work is in progress of application to the propulsion of a ship of upwards of 1,000 h.p. These experiments are difficult and costly, and cannot be hurried, but not a moment has been lost. The results of these experiments belong to those who pay the price of the knowledge. They will be made public in due time and place, but much patient work must precede any reaping of the fruits of real success.

New Club, Glasgow, Sept. 3. Yours, &c., H. A. MAVOR.

WIRING NEW ZEALAND MINES.

DEAR SIR,—As Consulting Engineer to the New Zealand Mines, permit me to correct a statement which appears in your issue of August 20, 1909, page 225, Publicity Section, with reference to the electrical equipment of the mines, and which reads as follows:—

"The use of bare cables seems a mistaken policy of economy, which may lead to serious trouble."

The facts are that the mine cables throughout are of the three-core type paper insulated, lead covered served with jute, armoured with steel wires, and taped outside the armouring. The cables were supplied by Messrs. Johnson & Phillips to a rigid specification, and are of the highest quality. Further there are no exposed terminal contacts or conductors of any kind inside the mine, no fuses are used, and all contacts are made and broken in oil contained in cast-iron cases properly sealed. You will see, therefore, that there is no foundation for your statement, but that, on the contrary, exceptional means have been provided to ensure absolute security.

Possibly the use of bare overhead conductors for transmission between the water power station and the mines has led to the error of your correspondent and given him a mistaken idea that bare conductors were used in the mine.

Yours faithfully,

H. F. PARSHALL, M.Sc., M.INST.C.E.,
Salisbury House, London Wall, E.C. Consulting Engineer.

EDUCATIONAL.

MANCHESTER.

The calendar for 1909–10 of the Municipal School of Technology and School of Art, Manchester (*Guardian* General Printing Works, Manchester, Reddish and London), forms a large and attractive volume. The institution gives a course of instruction for day students in Electrical Engineering extending over three years, and offers a carefully graduated training to those who intend to enter into the industry. The department contains three lecture rooms fitted with electrical experimental projection lanterns; four laboratories for work in physics and electro-technics; two dynamo and motor-testing rooms; a standardising laboratory; a high-tension room; electro-chemical engineering, photometric and optical laboratories; together with instrument testing and accumulator rooms. Particulars are given of the syllabus, and space is also found for views of some of the laboratories. There is a special laboratory course for day students in the applied chemistry. For evening students systematic courses of instruction in electrical engineering extending over five years are given, and on the results of these examinations the Diploma of the School is awarded. A special course for wiremen and foremen in electrical wiring and fitting, extending over two years, is also arranged. Students taking up technical electrical work are urged to take the organized courses arranged for them as far as they possibly can. Entrance examinations for day students are arranged for September 13, 14, and 15, and five days later the Day Session and Evening Departments open. The Electrical Engineering Department forms a Faculty of the Victoria University.

LONDON.

A letter from the Principal of London University appears in our correspondence columns, respecting the constitution of an Appointments Board, which appears to be an excellent idea.

NORTHAMPTON POLYTECHNIC INSTITUTE.

The new building, which was in process of erection at this time last year, has since been finished, and is now available for the extending work of the Institute. It provides a much-needed enlargement of the mechanical engineering workshop and of the mechanical laboratory, besides two entirely new power laboratories. There will be in the electrical engineering department a new class on the Testing of Electrical Plant, conducted by Dr. C. V. Drysdale, in place of the advanced class on Electrical Instruments, which will not be held this session. There will also be a new class on Electrical Engineering Quantities and Estimates, conducted by Mr. E. Kilburn Scott. In the section of electrical engineering devoted to Telephony and Telegraphy, the pioneer class on Submarine Cable work, started last session, now takes its place among the regular classes of the Institute's work, and the class on Radio-Telegraphy and Telephony, conducted by Dr. J. Erskine Murray, will be continued. There will also be special classes for the members of the Postal Telegraph Service adapted to the departmental requirements. Technical Chemistry Day Courses in Electro Chemistry now take their place in the regular work of the Institute. These courses extend over three years, and give thorough training in the subject similar to that which is given in Heavy Electrical Engineering in the Engineering Day Courses. In this department a class on Metal Colouring is also announced.

LIGHTNING CONDUCTORS.

ELY CATHEDRAL.

Lightning conductors were first fitted to Ely Cathedral about the year 1859, to the specification of Sir William Snow Harris, F.R.S., Advisor on Lightning Conductors to the Crown, but doubts were entertained as to whether these were still in an efficient condition. Mr. Alfred Hands, F.R.Met.S., author of "Lightning and the Churches," was therefore instructed by the Dean and Chapter to make tests and report as to the advisability of adopting more modern methods. Snow Harris' conductors, formed of short copper tubes screwed together, proved to be so defective that it has been found necessary to instal an entirely new system of copper tapes. This comprises two conductors on the Western Tower, with branches from the flagstaff and four turrets, two from the towers over St. Catherine's Chapel, and four from the Eastern or Lantern Tower, as well as from the Nave, Choir, Transepts and Lady Chapel. The system has been arranged so as to be scarcely noticeable, and does not detract from the appearance of the Cathedral, the work having been admirably carried out by Messrs. J. W. Gray & Son, of 91, Leadenhall-street, London, E.C., under Mr. Hands' direction.

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RESEARCH SCHOLARSHIPS.

The Government of Victoria having placed the sum of £2,000 at the disposal of the Council of the University for Research Scholarships and bursaries, the following among the awards, recommended by that body,have been approved by the Governor-in-Council:—

U. J. Nicholas, B.Sc., Working Men's College and Massachussets Institute of Technology.—The action of electric currents on reinforced concrete, £150.

H. R. Hamley, B.A.—Magnetic research, with wave analyser, £100.

A. L. Rossiter.—1. Primary and secondary batteries and possible improvements thereon viewed from a commercial standpoint. 2. Research on the properties of Australian iron, with a view to its use for electrical purposes. 3. Research on the radio-active properties of Australian minerals, £50.

Supplementary grants have also been made for the purchase of apparatus and material required by the students in the prosecution of their researches.

ELECTRIC DOMESTIC APPLIANCES.

Under powers recently granted by the Corporation, the Aberdeen Electricity Department have opened at Union-street an exhibition of various cooking and heating electric appliances in use for domestic purposes. Some of the latest and most up-to-date appliances are here on view, and from Mr. Robert W. Sherrit, the attendant, any information regarding the working, as well as initial and running cost of the apparatus, may be obtained. Among the appliances are radiators, ovens, fans, kettles, laundry irons, hot plates, and grills. In one of the windows is a cooking table with all accessories. Over the sign above the door there are brilliant illumination lights. The public are invited to visit the showrooms and examine the various appliances.

PERSONAL.

Mr. Charles Vere Seaman, Shift Engineer, Gravesend Corporation Electricity Works, has been presented with a marble clock by the staff and employés to mark the occasion of his recent marriage.

Mr. Pedrialli, general manager of the Anglo-Argentine Tramway Co., has left for Europe on a business trip.

Mr. E. H. W. Westwood, A.M.I.E.E., 369, Collins-street, Melbourne, has been elected as secretary of the Electrical Association of Victoria.

PUBLICATIONS RECEIVED.

"Some Useful Tables, also some of our Standard Sizes and Types of Motors" (Langdon-Davies Motor Co., Ltd.). Of handy size, suitable for a pocket book, this pamphlet contains some useful tables. The table giving a comparison between watts, horse-power, force de cheval and kilogrammetres is believed to be quite new, and will doubtless be of much use to engineers. The pamphlet also includes some of the standard ratings of direct and alternating current motors, the latter both two and three phase as well as single phase.

MINING ELECTRICAL ASSOCIATION.

A branch of the Institute of Mining Electrical Engineers is in course of formation for the Warwickshire and Staffordshire districts. The presidency has been accepted by Mr. Arthur Hall, M.E., of Nuneaton, consulting mining engineer to the Electrical Construction Co., Wolverhampton, with Mr. Harry Arnott, of Bedworth, as hon. secretary. The general object is to advance technical knowledge relating to the application of electricity to mining, and "to extend the experience and increase the efficiency of those engaged in such applications, and generally to form a meeting point for a rapidly growing, but hitherto unorganised section of electrical engineers and craftsmen." The membership is restricted to qualified electrical engineers or those associated with electrical mines, although associates are admitted upon another basis. A dozen branches similar to the local one are being formed in the principal mining centres throughout the kingdom, and one of the objects will be the formation of a diploma class for electrical engineers to increase the qualification for employment.

ALTERATION IN STYLE.

We understand that the New Brotherton Tube Co., Ltd., Excelsior Works, Commercial-road, Wolverhampton, have altered the style of their firm to that of Brotherton Tubes & Conduits, Ltd., which name has been duly registered with the Registrar of the Joint Stock Companies.

REFUSE DESTRUCTOR AT ELECTRICITY STATION.

The refuse destructor works at the Farnworth Council's Electricity Generating Station have been opened by Councillor Green. The considerations which induced the Council to adopt this site were threefold. In the first place it was appreciated that the heat generated in the process of combustion could be utilised for raising steam, which could be led to the existing main at the generating station; secondly, the existing chimney was large enough to take the volume of gases from the destructor as well as from the existing boiler; and, thirdly, the cost of cartage would not be materially increased. It is estimated that the heat from the destructor will be capable of generating approximately 400,000 electrical units per annum, and this represents a fairly large proportion of the total output of the station. Mr. R. B. Leach, A.M.I.E.E., A.M.I.Mech.E. (Electrical Engineer and General Manager), has forwarded to us an attractive souvenir of the opening of the new destructor works, as well as a description of the machinery installed at the electricity undertaking. "Some 300 consumers," it is explained "are connected to the supply (lighting and power), the motor load at present is 485 h.p. Extensions became necessary, and the Council on the advice of their Electrical Engineer decided to purchase current in bulk from the Lancashire Power Co., whose high pressure mains are laid through Farnworth and pass the Electricity Works, instead of building a new works in another part of the town, or extending the present works from the steam side; the cost of coal and carting is a serious item for a works of any magnitude, and the present works are nearly a mile from the nearest railway station It was observed that the Council could not generate electricity as cheaply as a power compay for many reasons; mainly, the Company having a very large undertaking built upon cheap land, modern plant, also cheap water, and economical coal handling, etc.; and especially bearing in mind the short period for the repayment of loans now granted by the Local Government Board, whereas a private Company would not allocate such heavy repayments. Hence an arrangement was entered into by the Farnworth Council with the Lancashire Power Co. to purchase a minimum amount of 400,000 units annually at a favourable price. In addition to the works bulk supply, the Council can now electrically drive large cotton and other mills, etc., at lowest competitive rates with alternating 3-phase current, 50 periods."

BUTTER FACTORY AND ELECTRICITY.

Mail despatches from Australia show that application has been made by the South Gippsland Butter Factory, Yarram, Victoria, to the Chief Justice for an alteration in the memorandum of association permitting it to follow the example of similar companies and supply electricity for power, lighting and heating. The company claimed that this would enable them to carry on their business more efficiently and economically. In an affidavit the chairman of directors stated that the company had decided to erect a new plant before the question of supplying electricity was raised. He further stated that the shire council had passed a resolution in favour of entering into a five years' contract with the company to light the town of Yarram at an annual cost of £150. An affidavit was also sworn by Mr. B. G. Nicholl, of Messrs. Siemens Bros., electrical engineers, Melbourne.

AN EMPLOYERS' ASSOCIATION.

An Electrical Employers' Association of New South Wales has been formed in Sydney. One of the objects of the association is to represent the employers in connection with the application made by the Electrical Employees' Union for a Wages Board. The office-bearers, as elected at the first meeting, are as follows:—President, Mr. E. J. Erskine; vice-presidents, Messrs. W. A. Gosche and A. J. Hanson; committee, Messrs. H. R. Forbes Mackay, F. Bell, A. W. Kendall and J. E. Donoghue; auditors, Messrs. E. Murray Gibbs and G. T. Stowe; trustees, Messrs. J. D. Handley and S. Warren; treasurer, M. H. W. Ramsay Sharp; secretary, Mr. R. Burgin.

CHANGE OF ADDRESS.

We are requested to announce that the Offices of the Underground Electric Railways of London, Ltd., the Baker Street and Waterloo Railway Co., the Great Northern, Piccadilly and Brompton Railway Co., and the Charing Cross, Euston and Hampstead Railway Co. have been removed from Hamilton House, Victoria Embankment, London, E.C., to St. James's Park Station Building, Broadway, Westminster, London, S.W.

THE GAZETTE.

RECEIVING ORDER.

J. Herbert Burdett, electrical engineer, 32, Earl-street, Coventry; August 28.

NOTICE OF INTENDED DIVIDEND.

Francis Aaron Scottorn, engineer and motor expert, Portman-road; September 18 last day for receiving proofs; Fredk. Messent, official receiver, 36, Princes-street, Ipswich.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

Patent Spiral Self-Centring Chuck.

We give below illustrations of a Patent Spiral Self-Centring Chuck, which is being placed on the market by Mr. Charles Taylor, Bartholomew-street, Birmingham. The need has long been felt for a really serviceable and reliable appliance of this kind at a moderate price. The body of the "Spiral" Chuck is made of a special mixture of cast-iron, and has its front face in the form of a hollow cone; in this face the ways in which the jaws slide are cut. In all sizes above 8 in. the central portion of the body passes right through to the back of the chuck, giving the maximum of strength with the minimum of depth. In these sizes the adapter is bolted direct to this portion of the body instead of the back, as is usually the case. The back retains the internal working parts of the Chuck in position, and in sizes up to and including 8 in. it contains the

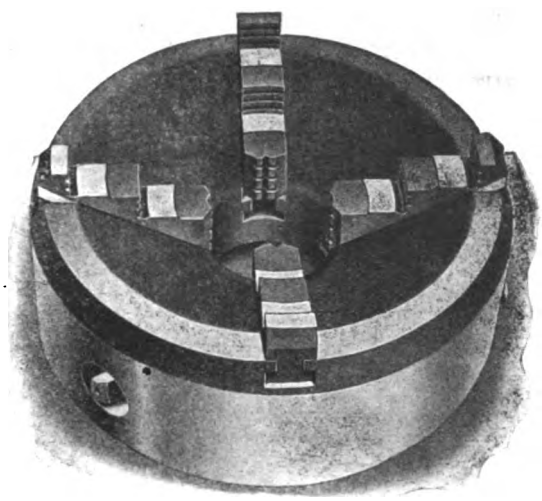

FIG 1. CHUCK FOR GENERAL LATHE WORK.

recess for locating the adapter. The spiral is made of steel, hardened and ground up perfectly true (in all sizes except the 18 in. and 24 in. chucks, which are made of a specially hard steel), and has machine cut teeth in the back face; it is revolved by means of any one of the three pinions. The front face has the form of a hollow cone, and has cut upon it a Spiral Vee thread, which engages with the teeth cut in the back of the jaws, thus advancing or withdrawing the jaws simultaneously, and gripping the work true, without setting. The jaws are thus supported immediately behind, and at right angles to the line of pressure caused through gripping the work. This gives great rigidity and strength, making it impossible to strip or bend the teeth at the back of the jaw, or tear out the jaw ways in the chuck body. It is this construction which enables the important working parts to be hardened—impossible with Scroll Chucks. The jaws are made of a special steel, hardened all over and ground perfectly true in position after hardening, on the two parts that grip the work, and on the parts that slide in the ways in the chuck body. Two styles of jaw are usually supplied with the chuck, as shown in Figs. 1 and 2. Fig. 1 style of jaws are used for general lathe work. Fig. 2 style of jaws are used for holding bars, etc. The bevel pinions for revolving the spiral have machine-cut teeth of special design; they are in all cases hardened and tested before assembling. The chief advantages of the four-jaw chuck, illustrated, over the three-jaw are its special adaptability for holding square or octagon bars, forging, castings, etc., and additional efficiency for very heavy work on round

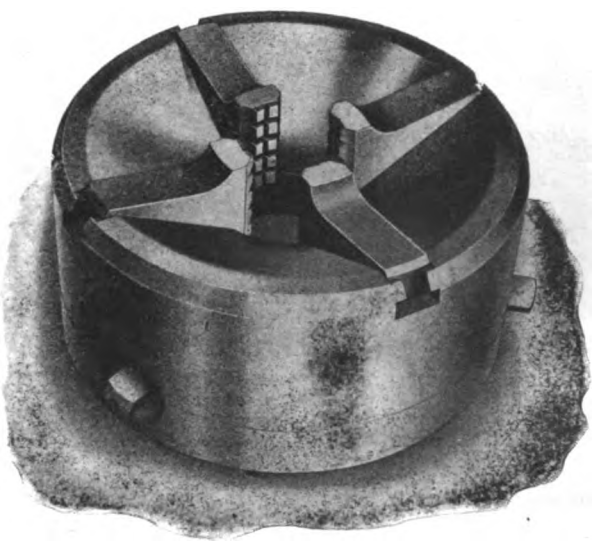

FIG 2. CHUCK FOR BAR WORK.

bars that are practically true, such as drawn steel. The principal tendency of the bar under a heavy cut in a three-jaw Chuck is to wedge itself sideways between the jaws, putting great strain upon them and loosening the grip. Neither of these actions take place when using four jaws to anything like the same extent, while the initial grip is the same in both cases.

THE SIEMENS SELECTIVE CALL.

An ingenious arrangement, which will supply a long-felt want, is the Siemens Selective Call for Telegraph Stations. The apparatus makes it possible on a telegraph line with many stations to call up any individaul station by means of a bell signal without disturbing all the other stations. It is particularly adapted to telegraph lines where, owing to special working conditions, the operators are obliged to attend to other duties, and are, therefore, not able always to give their instruments close attention. The leading features of the Siemens Selective Call are that no alterations are necessary to the existing apparatus; the Selective Call being merely an accessory, the working of the telegraph is independent of the working of the Selective Call, which is operated by means of the existing Morse Key; the instrument is absolutely reliable; and a call bell can be fixed at any convenient distance from the apparatus. The call is automatically restored by the ordinary telegraph working.

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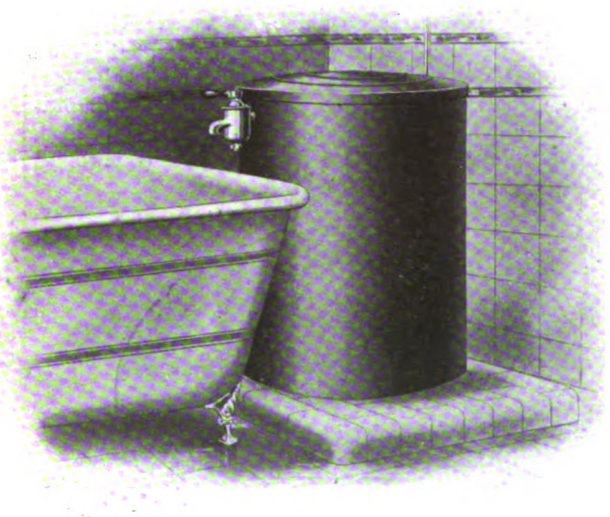
"THEROL" ELECTRIC WATER HEATER.

A notable development in the application of electricity for domestic purposes is the invention of the "Therol" Patent Electric Water Heater. The apparatus is distinctly novel, and opens up a fresh field for the consumption of current, at the same time giving an ideal load factor. At the invitation of the sole licensees and manufacturers, Messrs. Spagnoletti, Ltd., Goldhawk Works, Goldhawk-road, London, W., the whole apparatus was demonstrated and shown in actual operation before representatives of the technical Press at their West-end show-rooms in Charing Cross-road. The system, which we illustrate, has the charm of simplicity itself, and its undoubted advantages are likely to be immensely appreciated by electricity supply stations and consumers alike as soon as the device becomes generally known.

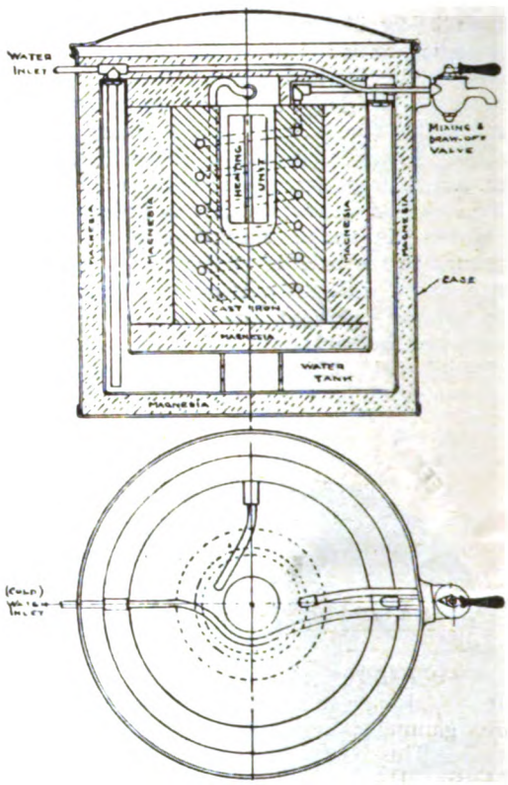


No. 1. Front View of Heater.

The basic idea of the system is to meet the demand for a 24 hours' constant supply of electricity to enable the central station to reach a 100% load factor, and thus allow of an exceedingly low rate per unit. The "Therol" principle is to store heat, and the complete system provides that the constant supply of electricity will be available for lighting, cooking, heating and other domestic appliances, while those are required, and at all other times during the 24 hours it will be stored in the "Therol" heater for the supply of hot water. The consumer takes the same constant current day and night, and, consequently, it is claimed, the central station can supply at rates hitherto unheard of, allowing it to successfully enter into competition against gas and coal for all domestic purposes. In its simplest form the apparatus consists of a block of iron, cast about a coil of pipe, and encased in a thick coat of heat insulating material. The block of iron is continuously heated by means of electricity, and water, when required, is passed through the pipe. By this means a constant current is taken from the mains, and hot water is always available in any quantities, provided the average daily amount does not exceed a certain quantity depending upon the fixed amount of electricity consumed.

By placing the apparatus in the centre of a tank of water which is also well lagged, and from which the water which passes through the block of iron is drawn, the efficiency is greatly improved, for the heat escaping from the iron is mostly stored in this water jacket, and the final escape of heat is only that due to the difference of temperature between the water and the atmosphere. In this way it has been possible to obtain an efficiency well over 90%, on an average wait of eight hours, and with an apparatus of reasonable dimensions. The No. 1 Therol Heater is cylindrical, and 2 ft. in external diameter and height. This heater, when consuming 200 watts, gives, if the initial temperature of the water is 50° F., 25 gallons of water per day at 110° F., that is at the temperature of a very hot bath. The capacity of the apparatus increases much more rapidly than the size, for since the volume varies as the cube and the surface varies as the square of the linear dimensions, it is evident that if one doubles the dimensions, eight times the quantity of heat is stored at the same temperature with only four times the leakage area, while if the thickness of insulation is also doubled, the actual leakage of heat is only doubled, so that the block can be run at a considerably higher temperature and a proportionately larger amount of heat stored with the same efficiency.

Since the coil of pipe through which the water passes must have sufficient surface for heating the water when the block is comparatively cool, it follows that when the block is very hot the water will be converted into steam, and possibly into very hot steam. It is necessary, therefore, to mix the issuing steam with water, and a special valve has been designed, which, it is claimed, completely and effectually mixes the steam and water, and has the additional advantage that the temperature of the mixture can be adjusted at will. The 25 gallon heater is designed to have an overload capacity of about 7 gallons of hot water, and much more of warm water, so that considerably more hot water may be obtained any one day if less is taken the next day, or was taken the previous day. Moreover, the heating resistances are made readily accessible, so that if the supply should prove inadequate it can be increased within limits by the simple substitution of a larger heating resistance. The apparatus is entirely self-contained; its installation



"Therol" Heater: Section and Plan.

involves little or no change to existing pipes; it generates no poisonous gases and there is no danger of explosions; and even a child may use it with safety. This ideal load, as it is termed, is calculated to have an important effect on the station load factor, and it is urged that electric supply companies might with advantage buy this heater and hire it out to consumers in the same way that gas companies do with cooking stoves, but with the additional advantage that, since the consumption of electricity by this device is always the same, no meter is required, and the rental may include both the apparatus and the electricity consumed by it. The disconnection of the heater from the mains for short periods does not interrupt the consumer's supply of hot water, but only slightly reduces the average amount available. This diversion of the current may be accomplished by an ordinary two-way switch or by an automatic device, which reduces the current flowing through the heater as that in the other circuits increases.

"VICTORIA" TURBO PUMPS.

Messrs. Willans & Robinson, Ltd., have recently taken up the manufacture of centrifugal pumps, for dealing both with high and low lifts, and have at the present time some 12 pumps under construction. A series of tests has recently been completed on one of these pumps, the results showing that the high efficiency estimated by the designer (Jens Orten Boving) can be fully realised in practice. The pumps in question are of a particularly simple design, and are being built with a view to requiring the minimum amount of attention in working. In view of the large number of high lift sinking pumps imported into this country, there would seem plenty of room for a well-built reliable British-made pump.

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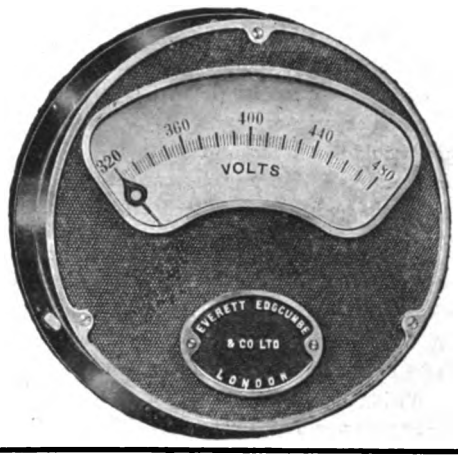
The Student's Guide to Knowledge.—*Chap. II.*



"MOVING-COIL" AMMETERS & VOLTMETERS.

Round Sector and Edgewise Patterns.

These instruments are generally considered the most satisfactory for direct-current circuits, for which alone they are suitable. They are distinguished by evenly divided scales, and by the fact that the use of shunts obviates the necessity to carry heavy currents to and from the ammeters themselves. They are spring-controlled, dead-beat, highly accurate, magnetically shielded, well insulated, of handsome appearance, and moderate in price.

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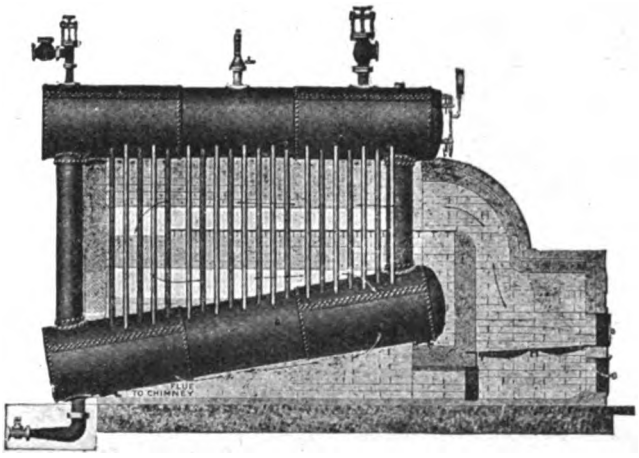
"SUCKLING" WATER-TUBE BOILERS.

The "Suckling" Water-Tube Boilers (patented) are rapidly gaining popular favour for land and marine purposes. This particular type of boiler, manufactured by Messrs. Hawksley Wild & Co., Ltd., Brightside Boiler Works, Sheffield (London Offices: Queen Anne's Chambers, Westminster, S.W.), has many interesting points, and can be recommended as a quick steam-raising plant of the highest class. Two "Suckling" Boilers, each having a heating surface of 1,050 sq. ft. and constructed for a working pressure of 200 lbs. per sq. in. were shipped to South America and are working at a height of 16,000 ft. above sea level at Silver Mines in the Andes.

To enumerate some of the distinctive features of the "Suckling" Boiler, we may point out that circulation is attained by means of the large tubular connections at the extremities of the drums, the uptake at the front end being exposed to high temperature, the down-comer at the back end which is outside the furnace being comparatively cool. The circulation thus set up is rapid, certain, uniform, and continuous. The tubes of the "Suckling" Boiler being expanded directly into the steam and water drums have each their own full area available for the free escape of the steam formed in them. There is no possible restriction, and consequently steam pocketting with its attendant evils is entirely obviated. The heating surfaces are arranged at right angles to the travel of the hot gases, and are therefore much more effective, and the tubes being vertical keep much cleaner than in other water-tube boilers where the tubes are simply inclined. The interior of the tubes is kept quite free from accumulations of scale, and the exterior from sooty deposits, and this accounts for the high efficiency obtained in the "Suckling" Boiler. By reason of its free and easy liberation, the perfect circulation of the water, and the ample steam capacity of the boiler, the steam produced is absolutely dry, a matter of the utmost importance. Only two manhole joints have to be broken to afford access to every part of the interior of the boiler for cleaning and examination. All parts of the boiler are circular in form without stays. Headers with their numerous joints are entirely dispensed with.



The boiler with external furnace, as illustrated, is claimed to be unrivalled for cleaning and examination. By means of this furnace and combustion chamber the gases are thoroughly mixed and ignited, thus giving complete combustion before coming into contact with the cool surfaces of the boiler. It is adapted for any kind of fuel or methods of firing; also suitable for utilising the waste gases from furnaces, etc. Every tube can be removed and replaced without disturbing those surrounding it. The large connections entirely support the upper drum and its contents and so relieve the small tubes from all strains, the trouble so frequently encountered where the bottom drum is suspended by means of the water tubes being thus entirely obviated. Any "Suckling" Boiler can be modified to suit space available and can be shipped in small sections to facilitate handling in up-country districts where transport is difficult. These boilers can be supplied with chain grate or underfeed stokers, superheaters, steel casings, chimney stacks, feed pumps, injectors, etc., if required.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

PATENTS.

THE PROPRIETOR of PATENT No. 19979, of 1904, for "Improvements in Magnetic Wheels for Electro-Magnetic Motors," is desirous of entering into arrangements by way of licence, and otherwise, on reasonable terms for the purpose of exploiting the same, and ensuring its full development and practical working in this country.

All communications should be addressed in the first instance to HASELTINE, LAKE & CO., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

THE PROPRIETOR OF BRITISH PATENT No. 23172 of 1905, for Improvements in or relating to ELECTRO-MECHANICAL SYSTEMS FOR THE PROPULSION OF AUTOMOBILES, is desirous of entering arrangements with British Manufacturers with a view to the granting of licences under the patent so far as the application of the system to TRACTION ON RAILS is concerned.

In this propulsion system a separate explosion motor and a dynamo, connected to a battery of accumulators, are provided for each driving wheel of the vehicle.

Interested parties are invited to communicate with the undersigned for further particulars.

HENRY SKERRETT,
Chartered Patent Agent,
24, Temple Road, Birmingham.

THE PROPRIETOR of the PATENT No. 18125, of 1905, for "Improvements in Electric Motor Control Systems," is desirous of entering into arrangements by way of licence, and otherwise, on reasonable terms for the purpose of exploiting the same, and ensuring its full development and practical working in this country.

All communications should be addressed in the first instance to HASELTINE, LAKE & CO., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

THE PROPRIETOR of the PATENT No. 18408, of 1906, for "Improvements in Electric Insulators for High Tension Conductors," is desirous of entering into arrangements by way of licence, and otherwise, on reasonable terms for the purpose of exploiting the same, and ensuring its full development and practical working in this country.

All communications should be addressed in the first instance to HASELTINE, LAKE & CO., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

TO MAKERS OF ELECTRICAL HEATING APPLIANCES.—The PROPRIETOR of PATENT No. 14256/05 for "Electric Heating Cartridges" is desirous of having the same manufactured under licence or otherwise in this country in accordance with the terms of the Patent Act, 1907.

Communications, in the first instance, to be addressed to H. D. FITZPATRICK, 100, Wellington Street, Glasgow.

TO ELECTRIC LIGHT ENGINEERS.—The OWNERS of the Patent No. 23,501, 1899, relating to "Improvments in Vacuum Tube Lighting," and the Patent No. 12,582, 1902, relating to "An Improved System of Electric Lighting," desire to negotiate with Electric Light Engineers with the view of granting licences under them on reasonable terms.—For information apply to MESSRS. LLOYD WISE AND CO., Chartered Patent Agents and Consulting Engineers, 46, Lincoln's-inn-fields, London, W.C.

PLANT WANTED AND FOR SALE.

Advertisements under this heading:
Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words. 4d.

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FOR SALE.—PAIR L.E. TYPE CROSSLEY GAS ENGINES Nos. 43265—43266, complete with "Tyne" compound dynamos, carbon brushes, 220 v., 15 amps, £95, or separate, W. B. GROVE, Cricket Bat Manufacturers, Hall Road, Peckham Rye, London, S.E.

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THE SESSION COMMENCES on OCTOBER 11th, 1909, and ENDS on MARCH 17th, 1910. Students usually spend the summer months in practical work, thus receiving their training on the "Sandwich System."

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LAMPS.	Watts per c.p.	B.O.T. Units	Cost of Current	Cost of Lamps	Total Cost
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ELECTRIC TIMING OF MOTORISTS.

A novel system of timing motorists over a measured distance was described at Stoke-on-Trent in the course of the hearing of the first prosecutions of motorists in Staffordshire for exceeding the speed limit. Mr. W. H. Breton, who prosecuted, explained that the police placed an electrical apparatus on the road at Trentham. The distance was exactly 600 yards, and the timing apparatus consisted of two electrical bells, with a wire connecting them. When a car was approaching or entering the section a warning ring was given. The man at the other end then got ready to time the car, and as soon as it entered the section a ring was given again. When the car reached the end of the section the man at that end, who was also supplied with a mechanical appliance to communicate with the other end, pressed an electric button, ringing a bell. Consequently, the times in each case were checked. On the particular day 52 cars altogether were timed, and there were prosecutions in respect of cars travelling at the average rate of over 24 miles an hour. All the defendants were convicted, and fines up to £4 and costs were imposed.

WANTED TO PURCHASE from Electric Lighting Companies and Electrical Engineers. — **Dynamos Motors, Cable, Wire, Instruments,** and every description of Electrical Material, also Manufacturer **Surplus Stocks.** The bulk being for re-use, High Cash Prices can be paid.—A. VEREY & Co., Dove Telegraphic Address: "Verey, Dover."

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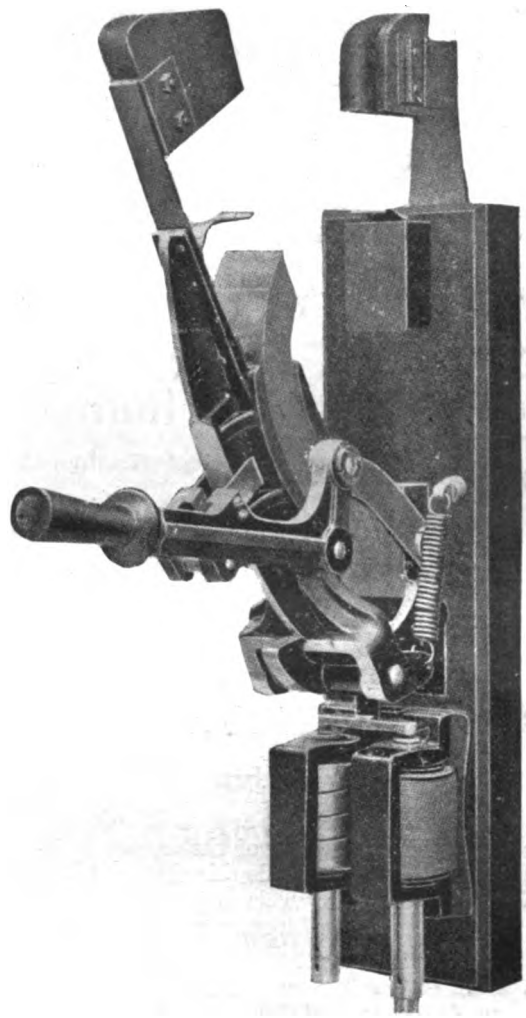

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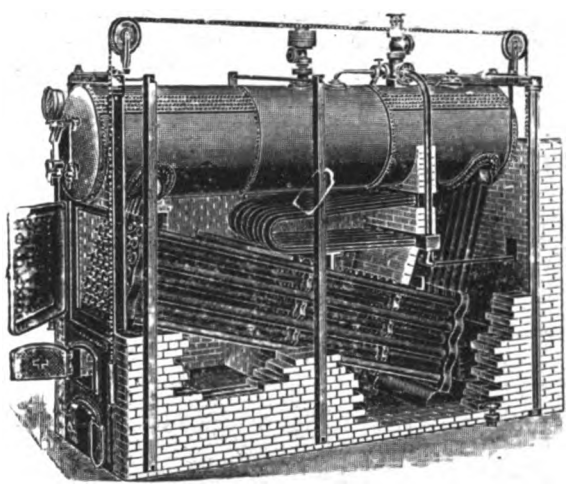

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ELECTRIFIED TEXTILE MILL, NORTH CAROLINA.

In view of the keen attention being paid just now to the question of the use of electricity in textile mills, and of our recent articles and notes, the following details, borrowed from the New York *Electrical World* come most opportunely.

It appears that one inherent in the nature of the material handled, the working out of the application of these motors is a matter of interest. One of the largest mills in the Southern States which has made this change is Loray Mill, Gostonia, North Carolina. This mill, which was formerly driven by steam engines with rope transmission in connection with lineshafts, is now operating successfully by electric motors throughout. The Loray Mill has 37 motors in operation with an aggregate rating of 3,000 h.p. The motors are all three-phase, 60 cycle, 2,200 volt Hawthorn induction motors, manufactured by the Western Electric Co., and the Southern Power Co. supplies the energy.

It was the experience of the company with rope transmission which caused it to change to electric transmission and motor drive. The principal reason, and the one which is causing rope-driven installations to be replaced by motor-driven equipments, is continuous operation. In large plants shut-downs for repairs of ropes frequently last for from one to two days. The energy consumed must also be kept down to the lowest possible point. Electric motors have come nearest to fulfilling the requirements of continuous operation and low energy consumption. The man standing at the switchboard in the engine-room or at the distributing board is able to tell at once by simply looking at his indicating or recording instrument when the amount of energy is increasing over that required for normal operations. By inserting indicating meters in a motor circuit, checks can be made on each individual operator's work and the processes made a scientific study.

The size of the Loray Mill makes it an excellent example of a motor-driven equipment, since approximately 58,000 spindles and 1,650 looms are driven by electrical motors. In the spinning room of this mill are installed 14 75-h.p. motors suspended from the ceiling in a row extending down the centre bay of the section. Each of these motors has two pulleys attached from which two belts extend in opposite directions to counter shafts extending down each side of the bay at the end of the two rows of spinning frames. As already stated, this mill changed from steam drive and rope transmission to electric drive throughout, so that the shafting and methods of operating by the former equipment remain the same as originally installed. The change, therefore, occasioned a minimum of expense, which consisted principally of the motor equipment, wiring and changes in belting.

In each case the motors are rigidly secured to beams, which are in turn fastened by bolts to the floor beams. In the weave room five 125 h.p. motors are installed, each operating two groups of frames. Mounted on a column at the right of each of these motor installations are the starting and controlling devices. Each motor is equipped with an auto-starter and line panel, the line panel being equipped with a three-pole, single-throw, automatic oil switch.

A 10-panel switchboard is used, each panel being equipped with the necessary indicating meters and an oil switch.

THE BRITISH COLUMBIA ELECTRIC.

Discussing the Canadian outlook, a correspondent to *The Financier* incidentally remarks: "The British Columbia Electric Railway appears to give perfect satisfaction in its service to the residents, and it is reported to be on excellent terms with the municipality. I understand that several further extensions are contemplated—in fact, these must be undertaken to keep the system abreast of the city's growth. The company's extension to Chihiwack, I learn, is opening up a rich and fertile alluvial plain, which will prove a most valuable feeder in time to come. Already it was stated to me that houses had sprung up all along the road between Vancouver and New Westminster. With such enterprising policy shown by the Board, no one can begrudge the company its steady annual increase of 30 per cent. in its traffic receipts."

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TYNESIDE NOTES.

(From our Correspondent.)

NEWCASTLE.

A most important development, which will considerably affect the condition of electrical engineering in mining circles, is the formation in the Newcastle district of the local section of the Institution of Mining Electrical Engineers. This organisation has, as readers will be aware, been formed in consequence of the necessity of establishing the electrical engineers in collieries on a more important footing than they at present occupy as technical and responsible individuals. The inaugural meeting of the local section was held some four weeks ago, and since then several committee meetings have been held by the gentlemen who have been elected to serve in this connection. Among these may be mentioned Mr. A. M. C. Field, the electrical engineer of the Consett Iron Co., Ltd.; Mr. H. W. Clothier, of Messrs. Reyrolle & Co., Ltd.; and Mr. H. J. Fisher, of Fence Houses, who is the Secretary to the local organisation. The prospect of the institution is extremely bright in this area, as, although sufficient time has not yet elapsed for the complete drafting of rules and regulations, and thus the institution is in an almost nebulous condition, upwards of ninety members have already been obtained in the Newcastle district. As the mining electrical engineers of Northumberland and Durham are, as a class, of a somewhat superior technical type, the institution has in Newcastle a dominant centre which in the near future will be a source of considerable strength.

A most interesting electrical equipment, having regard to the recent discussions upon auxiliary supply of electricity from a central station, is one which has recently been completed at the works of the Blake Boiler, Wagon & Engineering Co., Ltd., of Darlington, by Messrs. Verity's, Ltd. For some three years these works have been operated electrically by means of a 500 amp. isolated plant, driving the motors for cranes, machine tools, etc. Owing, however, to the very satisfactory state of trade in connection with these works, and the indication that further extensions of plant will be necessary, the question of duplicate supply came to the front. At the time, the boilers would give no extra power for this purpose. An extension of the private generating station would have involved considerable expenditure of capital; it was, therefore, decided to take an auxiliary supply from the Corporation mains, and for this purpose a six panel switchboard has been installed, each panel being provided with throw-over switch, maximum automatic circuit breakers, etc. The reason for this switching arrangement is that, whereas the works pressure is 230 volts, the town supply is on the three-wire system at 460 volts between outers. Each panel controls a section of the motors, and the load is thrown either on to the positive or negative, according to the balance required. The board, which is an addition to the existing switchboard, is designed to allow of considerable extension, most of the panels being of 200 amps. capacity.

In addition, a balancer, also constructed by Messrs. Verity's, has been installed, capable of dealing with an out of balance load of 180 amps., in order to cope with crane and boiler shop loads. The town supply is found extremely useful in connection with Sunday work, where repairs have to be executed and cranes operated. The foresight of the management of this firm was demonstrated only a week after the installation of the duplicate supply. Although the generator had been running without trouble for three years, an accident which occurred to it within the first week of the new system of running would have stopped the works had not the Corporation supply been available. Experiments were made as to the possibility of changing over the motor circuits from the positive to the negative side of the Corporation supply, while the motors were running by throwing over the knife switches, and it was found that this could be done without any trouble or interruption to the running.

The House of Lords have just passed the third reading of a Bill promoted by the Newcastle-upon-Tyne Electric Supply Co., the County of Durham Electric Power Co., and the Cleveland and Durham Electric Power, Ltd., to enable them to enter into agreement with each other in order to connect up their systems at their generating and sub-stations. This means that it will now be possible for these Companies to transmit power, if considered feasible from an engineering point of view, from one or more of their generating stations to any part of the combined power supply system, which extends over an area embracing the counties of Northumberland and Durham, and including a portion of North Yorkshire, altogether including an area of over 600 square miles. This latest coalition, therefore, places this group of companies in the position of being certainly the most widely extended electric power supply system in Great Britain, and probably one of the first in Europe, and great facilities for economic working may in consequence be expected.

It is now a matter of common knowledge that Mr. Bernard Price, who has for some years been prominently identified with the consulting firm of Messrs. Merz & MacLellan, of Newcastle, has obtained a most important appointment in a managerial capacity in connection with the Victoria Falls and Transvaal Power Co., and shortly leaves to commence his new duties. It will be remembered that during the present year there has been considerable increase of capital of this Company in connection with the formation of the Rand Mines Power Supply Co., Ltd., formed for the purpose of supplying power to the Witwatersrand Mines, and great developments are expected in the near future. Mr. Price's connection with the recently introduced Merz-Price system of cable control for electrical power supply will be remembered by our readers.

A somewhat interesting application of the recently introduced C.M.B. auto converter, manufactured by Messrs. Crompton, has been made in two or three cases in the North-Eastern area by its use in connection with cinematograph shows. At the Palace Theatre, West Hartlepool, for example, the converter runs on a 230 volt supply, giving a current of 60 amps. at a terminal pressure of 50 volts. The advantage of the use of this apparatus in such a connection is that no severe fluctuations of voltage are experienced even when the arc is first being struck. In view of the restriction usually made by supply authorities that no motor over 5 h.p. can be connected between neutral and outer, in order to avoid heavy out-of-balance currents, especially of an intermittent nature, it is interesting to note that, although the converter is started up by an ordinary starting switch and regulating resistance, the initial current does not exceed that taken by an ordinary 3 or 4 h.p. motor. Messrs. Crompton, therefore, recommend the installation of these converters for cinematograph work between the outer and neutral, inasmuch as this course saves 15% of the initial cost and 10% on the running cost, due to the higher efficiency of the lower voltage machine. In another cinematograph hall, in North Shields, a C.M.B. converter has been installed on the 4-60 volt supply, in order to give 60 amps. at 50 volts, and, in addition, by the use of a shunt regulator, a current of 20 amps. can be obtained for magic lantern service without using heavy and wasteful resistances. It will, therefore, be seen that this appliance is overcoming a trouble which, with the development of this form of amusement, is becoming quite serious in lighting supply networks.

AMERICAN NOTES.

(From our Correspondent.)

NEW YORK.

There has been a good deal of congratulatory talk in electrical circles here over the fact that this country has secured the first big telephone contract for China—which, according to the scientists, was the country which first discovered the principle of telephony, though, perhaps, in a rather crude kind of way. I know English firms have supplied that land of mystery with a certain amount of telephone material in the past; but except for an installation (now pretty well out of date) in the British Legation at Peking, the English work has been done for the most part in the Treaty Ports. What has happened now is the conclusion of a contract to supply the holy city of Peking with a complete common battery plant. It has taken the Western Electric Co. something like fifteen months to get this deal through, and if we are shaking hands with ourselves, it is only because this first big entry into the Celestial Empire has been negotiated in face of tremendous competition from England. What it may lead to is on the knees of the gods. China is a vast country, and its people are mysterious folk, but if American manufacturers can get their feet inside the Peking door of the Great Wall there is no telling how extensive the ultimate developments may prove. The Western Electric Co.'s order is for plant and cable to the value of $150,000, and delivery is to be effected by the beginning of next February.

The Electric Navvy.

The comparatively recent application of electrical energy to the old type of "steam navvy" or excavator is making substantial headway. Two contracts of this kind were noted a week or two ago from Canada, and this week it is announced that the Stanley-Morrissey Co., which is cutting the new eight-mile canal from the Oneida-Herkimer county line to the Oriskany Road, has given to the Utica (New York) Gas & Electric Co. the contract to supply current for the electrical operation of the two big excavators which will be employed on the work. The Stanley-Morrissey Co. propose to carry on the excavation work night and day, for some six or seven weeks, and the Utica Co. will also supply current for lighting purposes.

Electric Mining Work.

Another notable contract in this direction is that which has been secured by the Westinghouse Co. They are supplying to the Dolese and Shepard Co. of Chicago two 110-ton electrically-operated shovels for mining limestone rock. Each machine carries buckets with a holding capacity of 4 cubic yards, and the hoist movement of each machine is actuated by a 200 h.p., 220 volt, series-wound, direct-current mill motor running at 415 revolutions per minute. The thrust motor, controlling the movement of the dipper handle is an 80 h.p. machine of similar type. While the swing boom is operated by an 80 h.p. motor. Each motor is controlled independently by an automatic magnetic switch controller, which secures the greatest nicety of operation of the heavy bucket. This form of control protects the motors from any heavy overloads which may result from the bucket striking solid rock or other obstructions, by opening switches to introduce resistance into the motor circuit.

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Mode of Action.

The control panels and resistances are mounted in the rear of the cab, while the controller handles are conveniently placed under the hand of the operators. The hoist and swing-boom motors are mounted within the car. The thrust motor is placed out on the boom, communicating its motion to the bucket staff through reducing gearing connected to a pinion engaging a rack on the staff. The circuit to the shovel is completed through a feed cable, carried on a retractile reel on the shovel cab, and through the rails on which the shovel advances. The shovel may also be fitted with a standard trolley, and may then attain a speed of 5 miles an hour. Compared with the steam shovel, the electrically-driven excavating apparatus has been found to present marked advantages of simplicity, economy, and ease of operation. The hauling of water and coal is avoided, fewer operators are required to handle the machine, and a considerable saving of time is noted.

Linesmen's Risks.

The dangers to which linesmen are subjected in their daily work and the means by which they may be minimised are well summarised in a petition which has just come before the City Council of South Bend, Indiana. The petition asks that all high-tension wires be placed on yellow cross-arms; primary and arc light wire on black cross-arms, and low-voltage wires, such as telephone, telegraph, police and fire alarm, on red cross-arms. Where high and low-voltage wires are on the same poles, the petition asks that a clearance of 6 ft. be made. All cross leads should have a clearance of 4 ft. with proper guards. High-voltage wires should be placed on the tops of the poles and no street railway lines should carry more than 1,000 volts on their wires.

Variable Speed A.C. Motor.

In connection with a recent note in your columns, readers of THE ELECTRICAL ENGINEER will doubtless be interested in the progress of the Kimble variable speed alternating-current motor. The *Electrical Review and Western Electrician*, referring to the Kimble motor, points out that printing press requirements necessitate a variable-speed motor which has been obtainable only by the installation of costly and intricate auxiliary devices. These were expensive, were not easy of control, and many times did not possess ruggedness of construction to make a good showing in service. The increasing demand for alternating-current networks for other services made imperative the development of a thoroughly reliable alternating-current single-phase motor; and this demand the Kimble Electric Co. of Chicago has met. The motor starts with a full-load current, and is started, stopped and reversed, and its speed controlled all from a single lever contained within the motor itself. The lever is operated by a foot treadle, and outside of the wiring connections there are no exterior apparatus or devices. The speed range is from 300 to 3,000 revolutions per minute, and the motor runs very quietly.

Trade and the Tariff.

Now that the provisions of the new tariff have been absorbed, business in the electrical world is going ahead again with renewed vigour, and the present year promises to be a record one in almost every department of electrical activity. Retailers have had time now to digest the new rates, and they are laying in heavy stocks, while manufacturers are working overtime to keep pace with the demand. The general view, as already mentioned in these notes, is that the Payne Tariff leaves us very much in the *status quo ante*, and with no painful speculations or misgivings to worry them, manufacturers are concentrating themselves on the needs of the season in progress and to come. Several firms are already so busy that they have had to close down on new orders. Thus the Automatic Electric Co., of Chicago, the well-known makers of automatic telephones, announces that it can take no fresh orders for delivery prior to the beginning of the New Year, having already in hand the manufacture of 85,000 telephones and switchboards.

Some Large Orders.

Among recent orders of the Dayton (Ohio) Globe Iron Works are: two double-wheel units to Pine City (Minn.) Electric Power Co.; single-wheel units to the Orion (Mich.) Light & Power Co, the West Milton (Ohio) Electric Co. and the Camden (Ohio) Electric Co.; one double and one single-wheel unit to the Osceola Light & Power Co, at Reed City, Mich. The United Electric Co., Chambersburg, Pa., has contracted with the Ball & Wood Co., Elizabethport, N.J., for two 750 kw. Rateau-Smoot high-pressure turbines and 60-cycle three-phase generators, to be installed in its plant at Lemoyne, Pa. The United Illuminating Co., Bridgeport; Conn., is installing a Westinghouse 500 kw. turbine for driving a 2,400 volt, three-phase, 60-cycle Westinghouse alternator, which is to feed into the distribution system serving the city of Bridgeport and surrounding territory with light and power. The present installation is an addition to the existing equipment of a 300 kw. Westinghouse turbine driving a Westinghouse alternator, besides several small belted units. The Crocker-Wheeler Co. has booked several large orders for direct-current apparatus. One of these, from the Indiana Steel Co., calls for 70 mill motors, totalling about 2,400 h.p. This order is an addition to the 11,000 h.p. employed at the present time. An order from the Gould Paper Co., of Lyons Falls, N.Y., calls for electric drive for a new paper-making machine. A sale has been made to J. M. Kohler Sons Co., Sheboygan, Wis., of one 750 kw., 250 volt direct-current generator. Other sales are to the King Bridge Co., Cleveland, Ohio, one 150 kw. compound-wound, 250 volt generator; to the American Lace Manufacturing Co., Elyria, Ohio, one 100 kw. generator; to the Bethlehem Steel Co., a 225 h.p., compound-wound motor, to be installed at its Saucon plant; to Beadleston & Woerz, New York City, 187 h.p. in compound-wound, 115 volt motors and one 150 kw. 125 volt, compuond-wound generator. Among orders for induction motors recently received is one from the Roessler & Hasslacher Chemical Co., Perth Amboy, which totals 295 h.p. in three-phase, 60-cycle, 480 volt motors of the squirrel-cage type.

Butterine by Electricity.

The new butterine factory of the John F. Jelke Co., of Chicago, is installing electric motors for driving the whole of the machinery of the factory. The generating plant will consist of two 250 kw. 250-volt units of simple Corliss engines made by the Vilter Manufacturing Co., Milwaukee, directly connected to Sprague direct-current generators. There will also be a 50 kw. dynamo of the same manufacture directly connected to an Ames high-speed engine, which will be used for night service. Practically all of the electricity generated in this plant will be supplied to electric motors, and the factory will be equipped with between 400 and 500 h.p. in motors for driving various kinds of machinery as well as electric elevators.

Electric Railway Developments.

Steady progress is reported on the new passenger terminal of the Chicago & North-Western Railway in Chicago. The contract for the conduit and wiring of this large railroad station has been awarded to Kohler Brothers, of Chicago, and will amount to over $140,000, one of the largest wiring contracts ever awarded in Chicago. The Kehm Brothers Co., of Chicago, is the contractor for the heating and ventilating equipment, the contract calling for the expenditure of nearly $275,000. The Link-Belt Co., of Chicago, will supply the coal-handling and ash-handling machinery in the power-house.—It is announced that the first 1,200-volt direct-current electric railroad system in New England will be between Presque Isle and Washburn, Me., with an ultimate additional extension of 110 miles north to St. John River. The Aroostook Valley Railroad, affiliated with the Canadian Pacific Railroad, are the promoters.—The directors of the Portland, Gray & Lewiston Electric Railroad have raised the necessary capital, and the new road will be practically a straight line from Main and Lisbon-streets in Lewiston to Monument-square in Portland.—The proposed electric line between Marietta and Wheeling, West Virginia, is to be an electric railroad, equipped with electric locomotives for the hauling of freight and passenger trains.—The city of Quincy, Ill., is asking the Illinois Traction Co., which owns the local street railway, to build an inter-urban from Quincy as the price of the extension of the local franchise. The city wants a line to Peoria, Springfield, to East St. Louis *via* Roodhouse, to Galesburg, and from Quincy to Carthage, Nauvoo and Fort Madison.—An electric railway is to be built from Carmi (Illinois) to Fairfield, for both passengers and freight traffic. Kansas City (Mo.) capitalists are financing the road, which will ultimately connect with the Evansville (Ind.) line.

Recovery from Shock.

Details are given in the *Electrical World* of a remarkable recovery from a shock of 15,000 volts, of which Professor Henry G. Gale, of the Chicago University, was the victim in March last, at Pasadena, California. The Professor was working with a 5 kw. transformer in the laboratory of the Mt. Wilson Solar Observatory at Pasadena. The transformer was adjusted to give about 15,000 volts in the secondary, with about 20 amp. at 110 volts flowing in the primary circuit. The high-potential current was used as a source of spark spectra under pressure, which were under experiment. In some manner, Professor Gale, who was alone at the time, came in contact with the 15,000-volt circuit in adjusting some self-induction in that circuit. The shock rendered him unconscious and threw him violently to the floor and some distance away, so that his body came in contact with the rheostat in the primary circuit. This rheostat is made of strips of sheet-iron on a wooden frame, and in falling upon it Professor Gale received very severe burns from the hot metal. How long this contact lasted is not known, for when the injured man was discovered by Professor Hale, of the observatory, about half-an-hour after the accident, he had rolled away from the rheostat. For 24 hours after the accident Professor Gale was practically unconscious. He was removed to a hospital in Pasadena, and it was discovered that there were over 20 burns on his body, some of them very deep. He recovered from the electric shock within a few days, but the burns were slow in healing, and it was not until late in June that he was removed to his home in Chicago, and he is still confined to the house.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

"If thou hast knowledge, let others light their candle at it."

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should be *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

Question No. 1198.—Are there any homopolar dynamos at present in use, and for what purpose? Give a sketch showing the principle on which this type of machine is designed, and how is the voltage obtained.

Answer to Question 1,198 (*awarded* 10*s*.).—The earliest machine which has a right to be called a dynamo is Faraday's rotating copper disc, described by him in a paper read before the Royal Society, on November 24, 1831. This machine is shown diagrammatically in Fig. I.,

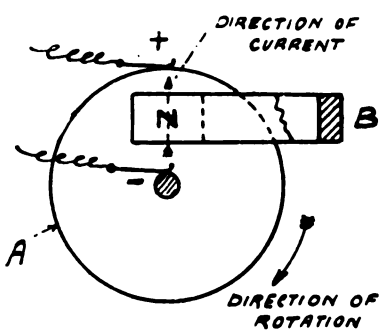

Fig 1.

and it is referred to because it is essentially a "homopolar," or as it is sometimes called, a "unipolar" type of dynamo. By this is meant one in which the conductor or conductors move continuously past poles of one kind only, as distinguished from the "heteropolar" or "multipolar" type of machine in which the conductors are opposite a north and south pole alternately. The principle of operation of a homopolar dynamo is extremely simple, there being theoretically only one conductor and consequently no commutator. It can be readily understood by reference to Fig I. The copper disc "A" which constitutes the armature, rotates at a high speed between the poles of a permanent magnet "B," rubbing contact being made with the disc by means of copper strips which press on the hub and on the periphery. When the disc is rotated in a clockwise direction with the direction of the flux away from the observer, a difference in potential is set up between the centre and periphery of the disc, and as soon as the external circuit is completed, current will flow in a radial direction shown by the arrow. The value of the E.M.F. produced is readily calculated from the formula :—

$$E = \frac{v\,l\,B \text{ volts}}{10^8}$$

where,

v = mean linear velocity of active part of disc in inches per sec.

l = active length of disc at right angles to motion in inches.

B = flux density of field in lines per sq. in.

In building a machine of this type for practical use the armature is usually made in the form of a cylinder free to move between the tubular poles of an electro-magnet, as illustrated in Fig. II. The best results are obtained by

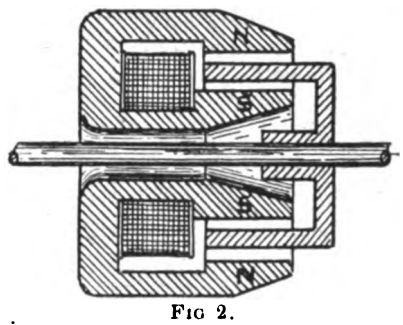

Fig 2.

making the armature of wrought-iron or steel. This design is fully dealt with in a paper by Prof. F. B. Crocker and C. H. Parmley, on "Unipolar Dynamos for Electric Light and Power," presented to the Amer. Inst. of Elect. Eng., May 16, 1894. Assuming that a steel armature is employed the flux density in the air gap can be quite easily run up to 40,000 lines per sq. in.

Suppose, the active length of armature = l inches
the diameter of armature = d inches
the speed ,, ,, = n revs. per sec.
the flux density in air gap = B lines per sq. in.
the thickness of armature = b inches
and the winding space for electro-magnet = c sq. in.

Then good practical dimensions are obtained by making,

$$l = \cdot 3\,d$$
$$b = \cdot 2\sqrt{d}$$
and $$c = \cdot 0125\,d^2.$$

The E.M.F. generated can now be readily calculated, for obviously

$$v = \pi\,d\,n$$

and assuming B = 40,000 lines per sq. in.

we have, using the formula previously given :—

$$E = \frac{\pi\,d\,n \times \cdot 3d \times 40{,}000 \text{ volts}}{10^8}$$

or $$E = \cdot 000376\,n\,d^2 \text{ volts.}$$

The output of the machine is limited only by the carrying capacity of the armature, and this in turn by the current carrying cross section of same. Assuming a safe working current density in the armature of 200 amps. per sq. in. we get :—

current capacity $= C = 200 \times \pi\,d \times \cdot 2\sqrt{d}$

$$\therefore C = 126\,d^{\frac{3}{2}} \text{ amps.}$$

The output in watts is then given by :—

$$W = C\,E = 126\,d^{\frac{3}{2}} \times \cdot 000376\,nd^2$$

$$W = \cdot 047\,nd^{\frac{7}{2}} \text{ watts.}$$

The scope of a homopolar type of dynamo must of necessity be limited, as the voltage obtainable is extremely small; on the other hand, the current capacity is very large, and for this reason it finds application in metallurgical and electrolytic work where heavy currents at small voltages are required.

Rankin Kennedy has designed a homopolar dynamo to give a comparatively large voltage by splitting the armature, which is in the form of a cylinder, into a number of longitudinal parts and joining them in series by means of collector brushes, so that the voltages of the separate parts are added together. His method of doing this is shown in Fig 3, which is a developed view of the armature

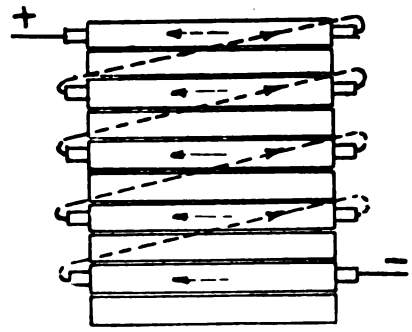

Fig. 3.

and collector brushes. He obtained 2·5 volts per bar, and a current of 200 amps, so the terminal voltage of the machine was 12·5 volts, there being five bars in series. In this connection it is interesting to note that all attempts

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to group the conductors in series by coupling up ends of opposite polarity in the moving armature have been futile, for the simple reason that the correctors used for this purpose themselves form inductors, the voltage induced in each being the same as that per bar, so that no matter how many conductors are coupled up in this way the resultant terminal voltage is simply that due to one bar.

Although a great deal has appeared on the subject of homopolar machines during the past 15 years, this type of machine cannot yet be said to have been commercially developed, and the limited number of machines in use at the present day are more or less novelties. If "H.D." wishes to pursue this subject further, I would refer him to "Dynamo Electric Machines," by A. E. Wiener, from which Fig 2 is taken, and in which the calculations for a number of typical machines are given.

A. P. Y.

Answer to Question No. 1,198 (*awarded* 5*s.*).—The homopolar dynamo is, historically, one of the oldest extant, but its demerits were early realised, and the present-day common or "standard" types were worked towards for many years, the homopolar machine being relegated to the status of a scientific curiosity. With the ever extending sphere of applications of electrical energy, both as regards number and magnitude of such, there have arisen special services which are particularly difficult to satisfy with the ordinary standard type of machine, but which may easily be filled by homopolar generators.

As their name denotes, homopolar machines are those in which the adjacent poles are of *like* polarity, and the types of construction enabling such machines fall into two main groups : homopolar machines may be of the "disc" or "drum" type.

Disc Machines.—The Mordey alternator is quite typical of a disc homopolar machine ; referring to Fig 1, which

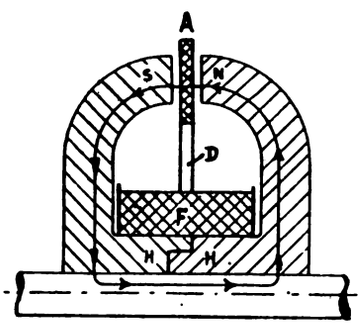

Fig. 1.

shows the essential features of this early form of generator, *A* is one of a series of armature coils connected in series and mounted round the periphery of a stationary disc *D*. The claw-like magnet system NS is made in two parts, keyed on to the shaft and engaging as shown ; the "claws" are placed exactly opposite to each other, and all the poles in one crown are N, all those on the other being S. The field coil F excites the whole magnet system (which is of C.I. or preferably C.S.), and may be stationary or rotate with NS as desired. The coils A usually contain no iron. Though this is advantageous in reducing the armature losses, it makes the machines very unsuitable for running in parallel with others, makes them uneconomical of material and conisderably reduces the E.M.F. per coil below the value that would obtain were an iron core fitted. The pitch of the armature coils is half the pole pitch, and thus half the armature copper is idle (this applies to all homopolar machines). Leakage is naturally slight in this construction, but the unmechanical nature of the armature, as well as unsuitable electrical characteristics, have caused disc machines to become obsolete.

"*Drum*" *or* "*Cylindrical*" *Machines.*—It is in this form that the homopolar dynamo will probably always be constructed should it ever come into extensive use. All the units of recent construction (see Table II.) are of this type, the essentials of which are shown in Fig 2. Two field coils as cross-hatched are usually employed, being placed as near the pole faces as possible to minimise leakage. The armature bars are divided into three parts arially, two equal sections a, a_2 running under N poles and to central section a_3 (of twice the length of a, a_2) running under S poles. Slip rings are connected as shown, and it is clearly a matter of some difficulty to arrange the slip-rings accessibly and yet so as to fulfil the requisite electrical conditions. The armature coils now contain iron, and though the mechanical design is far better than in the "disc" type, the utilisation of material is still very imperfect. The field in homopolar machines is always unidirectional, through every part of the magnetic system, so that there is no need to laminate the yoke or core. This would be a great advantage, as regards improving the suitability of the machines for turbo drive and lessening the cost of their construction, were it not that the rotor is inevitably so large and heavy as to make turbo drive a matter of considerable difficulty in any case. Again as Pohl has shown, higher r.p.m. are

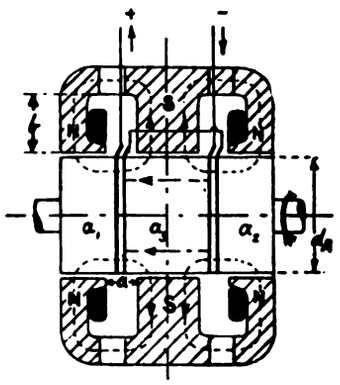

Fig. 2.

actually disadvantageous in homopolar machines unless the peripheral speed of the armature can be proportionately increased. This at once follows from the *E.M.* increased. This at once follows from the *E.M.F. Formulæ :*

Assuming a machine of the type shown in Fig 2, the maximum possible number of useful lines is—

$$N_{max.} = 2\pi . d_a^2 \frac{}{4} B_a \text{ max. (I) where } d_a \text{ is as shown Fig. 2}$$

and B_a max. = maximum armature core flux density = say, 20,000 lines cm^2.

The highest possible voltage induced per conductor is therefore—

$$l_{max.} = N_{max.} \cdot \frac{n}{60} \cdot 10^8 \text{ volts (fundamental formula)—II.}$$

And the peripheral velocity of rotor, assumed constant throughout is—

$$v = \frac{\pi d_a}{100} \cdot \frac{n}{60} \text{ m. per second} \quad \text{——————III.}$$

And substituting for $N_{max.}$ and d_a in II :—$l_{max.} = 19\frac{v}{n}$ and v being constant by assumption, $e_{max.} \propto \frac{1}{n}$ *i.e.*, the higher the h.p.m. the greater the number of conductors required to give a certain terminal voltage, and the greater the number of slip-rings required to collect the current. Already some of the limitations of homopolar generators are apparent. The voltage generated per conductor can only be increased by permitting a higher peripheral velocity, or by running at a lower r.p.m., but increasing the armature diameter to maintain the same peripheral velocity. The limiting rotor peripheral speed for absolute safety is about 75 miles per sec., though 100 miles per sec. is not considered impracticable by some authorities.

Where very high peripheral speeds are adopted the usual difficulties connected with turbo machinery are experienced ; binding wires and end clips have to be provided and all soldered or brazed joints must be rivetted.

Ventilation of Homopolar Machines.—The iron losses in homopolar generators are usually so low as to render artificial cooling entirely unnecessary, but, largely on account of the copper losses and collector losses, a good natural ventilation should be ensured. Ventilation ducts should be formed through the rotor core discharging radially by centrifugal force and sucking in air over the slip-rings and brushes, so aiding in cooling the latter.

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The two great difficulties in the design of acyclic generators, the one the cause of their peculiar characteristics, the other the result of them, are respectively the limitation of the ampére conductors per cm. of armature periphery to 30–35 as a maximum, and the difficulty of collecting the enormous currents generated by machines designed on this basis.

The ampére conductors per cm. are limited to about this value by the excessive temperature rise which would otherwise occur, and by the correspondingly high slip-ring and brush wear which would be entailed unless more massive, bulky and costly collector gear were fitted. Could the ampére conductors per cm. be increased to 100 or 200, the design of homopolar generators for voltages of 500–1,000 v would be much more practicable than at present. Assuming (with Pohl) that B_a = 20,000 lines per cm^2 and the amp. cond. per cm. = 32 then—

$$\text{Output} = \frac{v\, d_a^2}{1{,}000} \text{ k watts} \qquad \text{IV.}$$

from which equation the curves in Figs 3 and 4 have been plotted for values of v of 100 and 200 miles per sec. respectively (these being the present extreme safe limit of rotor peripheral velocity, and the limit were peripheral speeds approaching those of the Laval turbine permissible).

Current Collection from Homopolar Machines.—From the curves of Figs. 3 and 4, and the data of Table 2, it will be seen that homopolar generators, ranging in output from 40 to 18,000 k watts, produce currents of from 2 to 30,000 ampéres, the collection of which requires such elaborate gear as to justify the statement of several authorities who have spoken of the practicability of homopolar generators are being essentially a question of heavy current collection from a slip-ring surface moving at up to 200 miles per sec. Other designers claim homopolar collecting gear to be more reliable than turbo commutators. Be that as it may, the magnitude of the currents available at once suggests as the *Chief Uses of Homopolar Dynamos*, all those applications demanding a heavy current at low pressure, chief among which are, of course, electric furnaces and electrochemical processes. Table 2 giving the leading particulars, as far as published, of several of the few homopolar machines at present in service, shows how very suited the characteristics of these generators are for the above loads. Without exception, the machines tabulated were initially designed, or are now used, for electrolytic or electric furnace work. Clearly the most probable field of future utility of homopolar dynamos is as the *complement* of the present "standard" designs; homopolar machines can rarely, if ever, satisfactorily replace normal standard designs, but for specially heavy current demands, particularly at low pressures, homopolar units offer superior convenience and even higher efficiency, less weight and less cost. In the units for higher pressures these advantages are lost.

The overload capacity of homopolar generators is very considerable; heavy short circuits in the external circuit do not damage the generators (within limits) and 200% overload can be withstood for fairly long periods. In conclusion, may be made a few notes on the *Weight of Materials* required by homopolar dynamos, and the *Utilisation of this material*, and a comparison between the latter and several other types of electric machines. The weight of steel required by homopolar machines is certainly very great, though as to its exact amount, there is insufficient practical data to enable definite conclusions. For approximate calculations the following rule by Pohl may be employed, though it is admittedly unfavourable to the larger units (probably to a very considerable extent).

Pohl's rule:—Assuming B_a = 20,000 B_g = 10,000 B_{pole} = B_{yoke} = 15,000 (without leakage) a = 20 cm. b = $\frac{1}{2}$ d_a (Fig. 2)

$$N_{steel} = 7{\cdot}8\ (5{\cdot}8 d_a^3 + 74\, d_a^2) \times 10^{-6} \text{ tons} \qquad \text{(V.}$$

From this are calculated the weights shown in Fig. 3, and, the output being already known from Equation (4), thence the k watts per ton of steel. From these curves and the data of Table 1, it will be evident that the low voltage homopolar machines compare favourably with other types of electrical machines as regards utilisation of material. This further confirms the remarks already made regarding the sphere of utility of homopolar dynamos.

TABLE I.—UTILISATION OF MATERIAL.

Machine.	K. Watts.	Volts.	R.P.M.	Cycles	Kgs. Iron per Kw	Kgs. Copp'r per Kw	Kgs. Copp'r + Iron per Kw
D.C. Motor	60	220	600	—	12·45	2·85	15·30
Homopolar*	60	25	8,400	—	16·60	—	—
Induction Motor	37	2,000–3ph.	750	50	14·80	2·70	17·50
Homopolar*	37	20	9,800	—	15·25	—	—
Turbo generator	2,000	5,000–3ph.	1,000	50	2·475	0·853	3·33
Homopolar*	2,000	143	1,150	—	70.2	—	2

* Assuming peripheral rotor velocity = 100 miles per sec. and using curves Figs. 3 and 4.

TABLE II.—CHARACTERISTICS OF ACTUAL MACHINES.

	Date.	K. Watts.	Volts.	Weight.	R.P.M.
C. E. L. Brown	1893	50	10	—	1,200
Law ..	1904	50	5 to 7	—	—
Chapman ..	1906	64	4	4f d.c. m–c o = output	750
G.E.C. ..	1904 to 1907	500–2,000	50–600	—	—
Schulz ..	1907	≥ 1,000	600	12 tons	—

"R."

Answer to Question 1,198 (*awarded* 5*s*.).—

For High-Speed Work.—With the advent of the steam turbine into generating station practice, considerable attention has been directed, particularly in America, towards improving the homopolar type of machine. With slow-speed prime movers it is impossible to obtain sufficiently high voltages for most commercial purposes without resorting to a prohibitive number of conductors and collecting rings. Homopolar machines, however, are particularly adapted for direct coupling to high-speed turbines, as their construction is simple and further they give a continuous current without the use of a commutator, that troublesome adjunct which often gives so much trouble at high speeds. One form of modern homopolar field structure is shown in Fig. 1. The armature A is provided with several conductors B each of which is joined

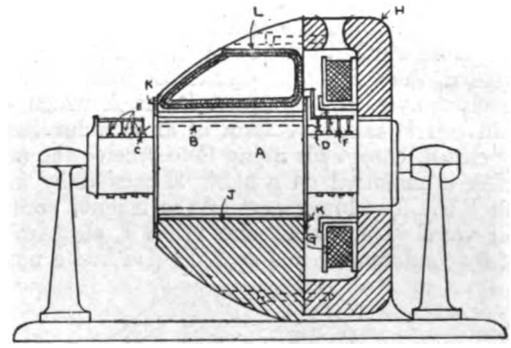

FIG. 1.

to a pair of collecting rings C D. The brushes E F pressing on these rings are connected up so as to join the conductors in series. The field coil G, which is mounted in the magnet frame H in which the armature rotates, generates lines of force which pass up the armature core and then spread out radially as shown in Fig. 2 across the air gap into the magnet frame, which is linked in the field coil. The motion of the conductors through this field generates an E.M.F. in them, and as the lines of force are always in the same direction relative to the conductors, an E.M.F. of constant value is produced across the slip-rings. However, the armature reaction inherent in this type of machine produces such a drop of voltage under load as to render them wholly unsuitable for work in which a constant potential is required. So that all practical machines have some device for compensating for this drop. As shown in Fig. 2, the current in each conductor produces a circular magnetic field which has a two-fold effect—firstly they produce an uneven distribution of the flux owing to the fact that they help the radial no load flux on one side and oppose it on the other, and secondly, in the magnet frame they all act in the same direction, tending to produce a circular polarization of the field as shown by the arrow x. The uneven distribution of the flux produces eddies in the face of the magnet frame which can, of course, be obviated by embedding conductors J in the magnet and short circuiting

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them by rings K. The circular polarization results in an increased flux density, therefore, a reduction of the total flux and a consequent decrease of the terminal voltage of

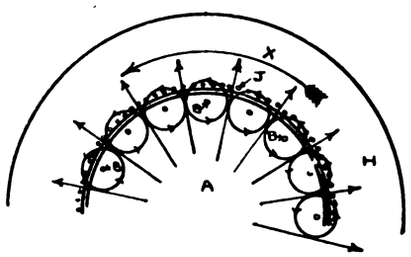

FIG. 2.

the machine, an effect which increases with load. In the machine illustrated this effect is compensated for by increasing the impedance to circular polarization by cutting wedge-shaped slots in the magnet and placing in these slots compounding coils L (Fig. 1), which are arranged as a shunt across the main terminals and tend to produce a circular field opposing that due to the armature reaction. Not only is the homopolar type suitable for high speed direct current work, but by laminating its field structure and properly proportioning and arranging the parts it is capable of efficient commercial operation on alternating current. When arranged as a generator, the frequency depends entirely on the frequency of the field flux (*i.e.*, field current), and, therefore, independent of variations in speed which only alters the voltage. This is important in high-speed work, as it allows ordinary frequencies to be obtained with as high a speed as is desired. Further, it possesses the advantage of having no synchronous speed, and also that it makes it commercially possible to obtain alternating currents of very low frequency, such as 3 or 4 cycles per sec. As a motor, the machine starts under load and will operate sparklessly at all loads and speeds. One form of laminated magnet frame is illustrated in Fig. 3, and is wound to produce a radial field across the air gap as in the direct current machine.

For Electrolytic Work.—An extremely compact electrolytic device employing an homopolar generator has been designed by Mr. Elmore, of Bishopsgate, and is illustrated in Fig. 4, from which it will be seen that all rubbing contacts are avoided, the current passing direct from the armature to the electrolyte. The magnet frame A which encloses the field coil B is in the form of an annular box, completely closed, except for a gap C to receive the armature D, which is mounted on a shaft E carried by insulated bearing F G. The lower part of the magnet contains an annular vessel H and a circular vessel I, electrically connected by conductors J and each divided into a number of

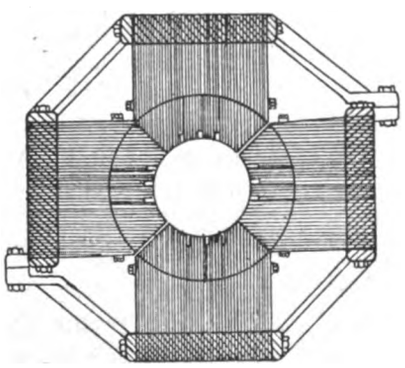

FIG 3.

compartments by concentric cylinders K K^1, similar cylinders L L^1 being supported by the armature disc in each compartment. When the armature is rotated, current is generated in it and flows, depending on the directions of rotation and of the flux, either from the disc through cylinders L^1 which thus become anodes through the electrolyte in H to the cylinders K^1 which become cathodes, through conductors J to cylinders K which become anodes to cylinders L which become cathodes and thence back to the disc or *vice versa*. When using this apparatus for the preparation of caustic soda and chlorine by the electrolysis of brine, brine is admitted by the pipe M, and after circulating through all the compartments in vessel I, passes out by pipe N. Mercury is introduced from a tank through a pipe O on to flanges P on the rotating cylinders, which by their rotation cause it to rise up the sides over flanges Q which ensures a certain depth, then through the air gap and down the cylinders in the outer vessel and thence out by a pipe R to a pump which raises it to the tank again. Water is admitted by pipe S and escapes at T. When the direction of rotation of the disc and the direction of the flux is such as to make cylinders L cathodes, the action is as follows:—The sodium chloride in vessel I is decomposed, the sodium being dissolved by the mercury rising up the cathode surfaces, while chlorine is evolved at the anodes (*i.e.*, cylinders), passes pipes U and is drawn off through pipes V. The mercury containing the sodium passes over into the outer vessel, where it is converted into caustic soda, the hydrogen evolved escaping by means of opening W.

For Transmitting Power.—Another useful application of the homopolar machine is that of employing it as a slipping magnetic clutch for use with synchronous motors driving a load at varying speeds, instead of the ordinary commutator machine usually employed which often gives trouble with large machines and suddenly varying loads. Since a unipolar machine requires no commutator, commutator troubles do not arise, and as the rotating parts may be

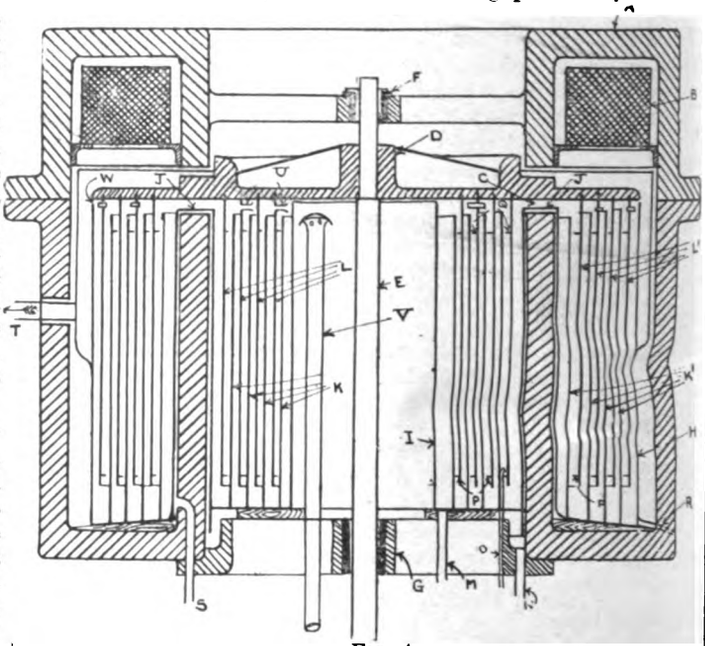

FIG. 4.

designed with very small inertia, rapid acceleration is possible. The B.T.H. Co. has a machine of this type, in which the homopolar generator is built in the synchronous motor, so that the same field winding which produces the alternating poles of the synchronous motor produces the homopolar field. The currents induced are arranged to increase the field of the synchronous motor, and since the current induced is approximately proportional to the load, the synchronous motor may be compounded to run with unity power factor at all loads, or with a leading current at full load. Sometimes a second homopolar machine supplied with current from the first is arranged to assist the driving, so that the induced currents are not all wasted in heat, a proportion of them being converted into useful work. When using an ordinary direct current generator on a telephone system, it is found that the pulsations in the current produced as the different commutator segments pass under the brushes are sufficient to upset the satisfactory working of the telephones, unless auxiliary apparatus, such as storage batteries or choking coils are employed. To obviate this difficulty, homopolar machines have been used for supplying the current, as these machines deliver a perfected uniform current they may be connected direct to the telephone circuit. The machine is either driven mechanically as a generator or electrically as a convertor. In the latter case, the supply voltage, such as that from lighting mains, is applied across the total armature conductors placed in series, while the leads for the telephone circuit are joined across a few of the conductors. The machine thus acts as a rotary transformer, stepping down to the required voltage and smoothing out any pulsations derived from the lighting circuit. "H."

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COMPANIES' MEETINGS AND REPORTS.

ABERDEEN SUBURBAN TRAMWAYS.

At the half-yearly meeting of the Aberdeen Suburban Tramways Co., Mr. George J. J. Walker, Portlethen (Chairman) presided.

In moving the adoption of the report, which recommended a dividend of 2%, the Chairman referred to the dispute between the Company and the Corporation as regards the Company's supply of electricity. He explained that in negotiating for a new agreement the Corporation had insisted on an arbiter. In the previous agreement the Company was not bound to take any fixed supply of electricity, but had merely to pay for the electricity actually used and supplied from time to time. The arbiter nominated by the Board of Trade was to fix the price per Board of Trade unit of electrical energy supplied by the Corporation to the Company, and to fix the period of agreement. The arbiter in his decree had gone entirely beyond his power by ordering the Company not merely to pay a price per Board of Trade unit actually supplied, but, in addition, a standing charge of £900 per annum irrespective of the amount of electricity supplied to the Company, and whether the Company took any supply at all. That award, he thought, was clearly bad. The Corporation asserted that the Company was barred from objecting to the award on the ground of the award having been submitted to them before it was signed by the arbiter. There was nothing whatever in this contention, as the Secretary of the Company had objected to the standing charge, and protested against it immediately the arbiter's finding was disclosed to them. The Company had offered to consider any reasonable proposal which the Town Council might make for getting them out of the difficulty which the arbiter had put them into, and they were waiting such proposals.

The report was adopted.

RIVER PLATE TELEPHONES.

The report of the United River Plate Telephone Co. for the year ended March 31 last states that the gross receipts, in sterling, in the River Plate were £287,064, against £250,750 for the previous year. Deducting expenses in Argentina and London, debenture interest, dividend on preference shares, and interim dividend on ordinary shares, and adding interest on investments, transfer fees, etc., there remains a profit of £89,233, to which must be added £4,904 brought forward, making an available balance of £94,138. After applying £32,000 to the reduction of the special replacement account and £25,000 to reserve, the directors recommend that a final dividend of 5% be paid on the ordinary share capital of the company, making, with the interim dividend paid on December 31 last, a return of 8% for the year, free of income-tax, that a sum of £2,000 be voted towards a staff provident fund, which is being formed among the company's employees in Argentina, and that the balance of £5,138 be carried forward.

UNDERGROUND ELECTRIC RAILWAYS.

The report of the directors of the Underground Electric Railways Co., of London, for the half-year ended June 30, states that the net revenue from investments and rents, after deducting general expenses and interest, amounted to £62,879; the net income from the operation of the power house was £40,659; and the interest on £775,000 4½% Power House Debentures amounted to £17,437, leaving a surplus from the power house of £23,222, and making a total of £86,101. The service of the £1,000,000 5% Prior Lien Bonds required £26,349, the service of the £2,808,000 4½% Bonds required £66,589, and the payment under the guarantee on Metropolitan District Railway Assented Extension Preference stock amounted to £9,403, making a total of £102,341. The net revenue was, therefore, insufficient to meet the half-yearly charges by £16,240. To cover this deficit, Messrs. Speyer have purchased from the company, in accordance with the agreement of April 7, 1908, £10,700 4½% Bonds of 1933 and £16,050 6% Income Bonds for the sum of £16,050. The deficit is apparently larger by £4,403 than that shown in the first revenue account submitted in February last—viz., £11,836. That account, however, included more than one half-yearly dividend on the company's holding of shares in the tube companies, and a large part of the fixed charges had been charged to capital under the scheme of readjustment. The income from investments for the six months showed an increase of £22,065, or about 40% over that in the previous half-year. This result had been obtained notwithstanding the fact that the three tube companies from which the company received dividends had set aside for contingencies and renewals out of the net earnings of the last six months the following amounts:—Baker Street and Waterloo Railway Co., £4,000; Great Northern, Piccadilly, and Brompton Railway Co., £6,000; and Charing Cross, Euston, and Hampstead Railway Co., £3,000; total, £13,000. The Metropolitan District Railway Co. have also set aside for renewals out of the net revenue of last half-year the sum of £10,000.

BRITISH THOMSON-HOUSTON.

The report of the British Thomson-Houston Co., Ltd., for the year ended March 31 last, to be submitted to the meeting on the 14th inst., states that at Rugby the buildings and machinery have been maintained in first-class condition, and while the directors have not been able to make depreciations, except as hereinafter mentioned, they have made a number of improvements and additions, the most important being the extension of the steam plant at a cost of £8,766. They have also followed their usual practice of making reserves to cover risks in connection with bad debts, depreciation of shares held by the company, and for other contingencies. As stated in the last annual report, the company now owns all the patents for the United Kingdom for Curtis steam turbines, excepting the marine rights. During the financial year the company sold twelve turbines, aggregating 15,000 kw. In this connection it is interesting to note that since the end of the year under review the company has sold 18 turbines, aggregating 18,569 kw. Under the terms of the trust deed securing the issue of the Debentures, the company had to pay to the trustees on February 28 last the sum of £3,339 to be applied by them in purchasing Debentures in the market. Debentures of the par value of £3,500 were purchased prior to March 31 (the end of the year under review), making the total par value of Debentures retired to date, £7,060. The balance-sheet shows a loss of £824, the result of the year's working after paying interest on Debentures and on loans. The directors deem it wise, however, to write off certain items, and to that end have carried into the profit and loss account the balance brought forward from last year—namely, £2,466—and the reserve of £15,409, which have been applied as shown in the profit and loss statement.

AUCKLAND ELECTRIC TRAMWAYS.

At the annual meeting of the Auckland Electric Tramways Co., Ltd., it was reported that the total revenue for 1908 amounted to £165,655. The traffic receipts, which totalled £163,848, showed an increase of £26,129, and after deducting all expenses, including £15,718 for debenture and other interest, etc., and setting aside £12,500, compared with £10,000 last year, to the depreciation account, there was a surplus of £32,755, to which had to be added £2,165 brought forward. The directors recommended the placing to reserve account of £10,000, and after meeting the preference dividend, a dividend of 6 per cent. per annum was recommended on the ordinary shares, carrying forward £3,920. Large additions had been made to the plant during the year, and they had further considerable capital expenditure in view. As a result of the report of a commission, the Public Works Department had called for a new and more efficient brake system to be installed on all cars, and to the submission to the Department for approval of full details of the brake proposed.

KALGOORLIE ELECTRIC TRAMWAYS.

The report of the Kalgoorlie Electric Tramways states that the gross receipts for 1908 amounted to £47,368, as compared with £48,008 for the previous year, and the net profits to £15,400, against £16,270 for 1907. The improvement set in during the last four months of 1908 is being maintained, and the recent excellent developments on some of the Kalgoorlie mines give every promise that the result of the current year's working will contrast favourably with that of the past twelve months. It is probable that the surplus profits, after payment of debenture interest and sinking fund, will be sufficient to deal with depreciation and renewals, and for the present, therefore, all such surplus profits must be retained in hand for this purpose. A further sum of £5,155 of A debenture stock has been purchased for redemption, making the total stock redeemed £14,016.

ELECTRIC SUPPLY IN COBAR, N.S.W.

The Provincial Electric Supply Co., Ltd., has issued a prospectus, in which it is stated that the company will take over the concessions obtained by Mr. E. M. Grant for the lighting of Cobar and other towns in N.S.W. Mr. H. G. Finley, of Sydney, is the secretary.

CANADIAN GENERAL ELECTRIC CO.

The directors of the Canadian General Electric Co. have declared a dividend of 1¾% on the common stock for the three months to the 30th inst., being at the rate of 7% per annum. The dividend is payable on October 1, and the transfer books will be closed from the 15th to the 30th inst., inclusive.

A PUNJAB ELECTRICAL SYNDICATE.

At a meeting of the Punjab Electrical Distribution Syndicate a resolution was adopted in favour of the liquidation of the company. The question of future lighting of Lahore and Amritsar is now under further consideration.

UNITED ELECTRIC CAR CO., LTD.

The report for the year ended June 30 last, to be submitted to the eleventh ordinary general meeting of the United Electric Car Co., Ltd., Preston, to be held at Preston on Wednesday next, states that the works have been efficiently maintained as regards buildings and machinery, the cost of which has been

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charged against revenue. After paying debenture interest amounting to £2,500, and charging £5,645 18s. 11d. for depreciation, the profit for the year is £8,896 7s. 4d., to which is added £6,187 1s. 8d. brought from last year, making a total of £15,083 9s. Deducting preference dividend for the six months ended December 31, 1908, £3,000, there remains an available balance of £12,083 9s. The directors recommend that this amount be dealt with as follows: preference dividend less income tax for the half-year £3,000, dividend of 2½% less income tax on the ordinary shares for the year ending June 30 last £3,750, and to be carried forward to next year £5,333 9s. Two directors retire, viz., Mr. Richardson and Mr. Prestwich, and being eligible, offer themselves for re-election. The auditors, Messrs. Chiene & Tait, chartered accountants, retire, and offer themselves for re-appointment.

BRITISH COLUMBIA ELECTRIC TAILWAY.

The directors of the British Columbia Electric Railway Co., Ltd., have issued a statement to the effect that owing to the increase in earnings for the financial year ended June 30, to $335,854, or 17% in excess of the earnings of the previous year, they have undertaken many extensions for the purpose of meeting the requirements of transportation in its territory, necessitating a still further increase in its supply of power, rolling stock, etc. They have, therefore, decided to make an issue of £500,000 of fresh capital, divided into 200,000 5% cumulative perpetual preference shares of £1 each, at a premium of 1s.; 200,000 5% non-cumulative preferred ordinary shares of £1 each, at a premium of 2s.; and 100,000 deferred ordinary shares of £1 each, at a premium of 3s. These shares are offered to the existing preferred and deferred stockholders in the proportion of two 5% cumulative perpetual preference shares, two 5% non-cumulative preferred ordinary shares to one deferred ordinary share for every complete £9 of preferred ordinary or deferred ordinary stock held by them.

COMPANIES REGISTERED.

BOWERS & BARR, LTD.—Registered August 23. Capital, £2,000, in £1 shares. Objects: To take over the business of electrical engineers carried on by F. C. Bowers and E. V. Barr, as Bowers & Barr, at Great Yarmouth. Private company. Table "A" mainly applies.

E. M. F., LTD.—Registered August 24. Capital £20,000, in £1 shares. Objects: To adopt an agreement with J. M. Bein, A. J. Grose, T. H. Satchwell and O. H. Bishop, and to carry on the business of electricians, mechanical and electrical engineers, suppliers of electricity for light, heat, motive power or other purposes, etc. Private company.

ETNA LIGHTING & HEATING CO., LTD.—Registered August 16. Capital £1,000, in £1 shares. Objects: To adopt agreements (1) with J. Warry and G. N. Arculus, and (2) with H. R. Prossen, for the acquisition of certain patents, rights, tools, blocks and electros analogous thereto, and to carry on the business of electrical and gas fittings manufacturers, etc. Private company.

INTERNATIONAL ELECTRIC TRANSPORT & ENTERPRISE CO. OF ALSACE-LORRAINE, LTD.—Registered August 21 by Flux Thompson & Quarrell, 3, East India-avenue, E.C. Capital £200,000, in 195,000 Preferred shares of £1 each and 100,000 Deferred shares of 1s. each. Objects: To undertake and develop electric carriage and other enterprises in Alsace-Lorraine and elsewhere, and to carry on the business of constructors of electric tramways and railways, motor vehicles, tunnels, bridges and roads, carriers of passengers and goods, etc. Minimum cash subscription, £2,000. The first directors (to number not less than two nor more than eleven) are C. Simon and A. Sautier (both of Guebwiller, Alsace, Germany) and A. F. Argles. Qualification £100. Each director is to receive £1 per Board meeting attended in addition to travelling and hotel expenses, and also £4 per day "during absence from place of residence." Directors and managing director also to be entitled to a fixed remuneration, to be decided on by the Board. Registered office, 3, East India-avenue, E.C.

MIDLAND ELECTRIC WIRE CO., LTD.—Registered August 14. Capital £5,000, in £1 shares. Objects: To acquire the business carried on as the Midland Electric Wire Co., and to carry on the business of electric cable and insulated wire manufacturers and dealers, electricians, engineers, etc. Private company.

PRESTWICH & BURT, LTD.—Registered August 16. Capital £1,500, in £1 shares. Objects: To acquire the interest of E. C. Lea in the business carried on by him at South-lane, Kingston-on-Thames as Prestwich & Burt, and to carry on the business of manufacturing electricians, electrical and mechanical engineers and contractors, founders, dealers in electrical accessories etc. Private company.

VIVO VIBRATOR CO., LTD.—Registered August 11. Capital £1,000, in 5s. shares. Objects: To adopt an agreement with G. L. Hogan, J. W. Walker, Jun., and Sir Edward Sullivan, Bart., and to carry on business relating to massage treatment, also as chemists, druggists, manufacturers of electrical and other scientific apparatus, etc. Private company. Registered office, 329, High Holborn, W.C.

CONTRACTS OPEN.

HOME.

DUBLIN.—Meters.—For the supply of the following:—750 alternating current meters, single phase, for the Lighting Committee. Specification with terms and conditions and form of tender may be inspected at the office of the city electrical engineer, Fleet-street, Dublin, and may be obtained from the latter on payment of £1, which sum will be refunded on the return of the specification, filled up, with a *bona fide* tender. Tenders, sealed and marked "Tender for Electricity Meters," must be addressed to the Chairman, Lighting Co., 3, Cork-hill, Dublin, and be delivered by 12 noon on September 13. Each tender must contain the names of two sureties, who will be prepared to execute a joint and several bond for the performance of contract in a sum of 20% of the contract price.

LONDON, S.W.—London County Council.—Tenders are invited for roadwork and platelaying for reconstruction of tramway in Highgate-hill. Length equivalent to about 1·4 mile of single track. The track rails, fastenings, the slot rails and conductor rails, and special work for the junctions, cross-overs, etc., will be provided by the Council, remaining metal work and other material is included in the contract. Spec., Chief Engineer, County Hall, Spring-gardens, S.W. Dep., £5. September 7.—Also for the following:—(1) Manufacture, delivery, and erection in certain of the Council sub-stations of two 500 kw. and one 150 kw. motor generators; (2) manufacture, delivery and erection of high and low tension switchgear for Woolwich and other sub-stations; (3) manufacture, delivery and erection at the Greenwich electricity generating station of steam, exhaust feed and drain pipes, valves, water tanks, etc. Persons desiring to submit tenders may inspect drawings and obtain specifications, bills of quantities, form of tender, and other particulars at the County Hall, Spring-gardens, S.W., upon payment to the Cashier of the Council of £2 for each section. This amount will, after the Council or its Committee shall have come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a *bona-fide* tender and not have withdrawn the same, but in no case will the fee be returned unless a *bona-fide* tender is submitted. Full particulars of the work may be obtained on application at the County Hall before payment of fee for specification, etc. Rate of wages, etc., clause to be observed. Each tender is to be delivered *at the* County Hall in a sealed cover, addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked "Tender for Motor Generators." "Tender for High and Low Tension Switchgear," "Tender for Pipes, Valves, Water Tanks, etc.," as the case may be. September 21 (by 11 p.m.).

OVERSEAS.

BRAZIL.—At the Municipal Offices, Corumba-Matto Grosso.—Instal the electric light, October 5.

BRUSSELS.—At the offices of the Société Nationale des Chemins de Fer Vicinaux.—To supply the aerial electric equipment of the Anderlues-Lobbe section of the Carnières-Thuin Light Railway. September 20.

CONSTANTINOPLE.—Admiralty.—Insulated copper cable, commutators, incandescent lamps, brackets, etc. (Part., Ministère de la Marine, A.).—Treasury.—Installation and exploitation of (underground) telephone service for town and district for 30 years. (Part., Ministère des Finances, A.). October 14.

FRANKFORT-A-M.—Two electrically worked movable cranes of 20 tons each and 12·260m. span; one ditto five tons and 13·840m. span; two ditto hand or electrically worked, two three tons and 7·195m. span each. Spec., 2s. 6d. (P.O.O.) Eisenbahndirection Hohenzollernplatz 35.

GERMANY.—At the District Offices, Merschweller.—To instal electricity. At an early date.

NEW SOUTH WALES.—At Petersham telephone exchange.—Supply, delivery, and erection of a branching metallic multiple magneto switchboard. November 10.

NEW ZEALAND.—The Golden Bay Cement Works: For an electrically driven Portland cement plant, with an output of 400 tons per week.

NORTH SYDNEY TELEPHONE EXCHANGE.—For the supply, delivery and erection of a common battery switchboard at the Exchange, and also for the supply and delivery of apparatus for use on subscribers' premises, in accordance with specification No. 266. Specifications, general conditions, plans, etc., may be seen at the General Post Offices, Sydney, Melbourne, Brisbane and Adelaide. The work must be tendered for in accordance with schedule, New South Wales, E.E. 144/08, and the shortest time in which the apparatus would be delivered, and the country of manufacture, must be stated. Tenders must be endorsed "Tenders for Switchboard and Apparatus, North Sydney," and addressed to the Deputy Postmaster-General, Sydney, by 2.30 p.m., January 12, 1910. A deposit, or receipt for deposit, must be enclosed with each tender, of 5% on the amount thereof up to £1,000, and 2½% on the amount over that sum. Tender forms, specification, etc., may be obtained, and preliminary deposits paid, at the Commonwealth Offices in London, 72, Victoria-street, S.W.

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TORONTO (Canada).—The City Council.—For the following electric motors:—Four 1,500 h.p. synchronous motors, two 1,500 h.p. induction motors, four 500 h.p. synchronous motors, four 500 h.p. induction motors, two 225 h.p. synchronous motors, with exciters, switchboards, connecting material, etc. For specifications, etc., apply to the City Engineer, by noon, October 14.

RESULTS OF TENDERS.

PONTYPRIDD.—The tender of Messrs. Siemens Bros. has been accepted by the Electric Light and Tramway Department of the Urban Council for the supply of one 500 kw. combined generator, consisting of one 720 b.h.p. engine, together with one 350 kw., and 150 kw. dynamos (Siemen Bellis set), £2,894 10s. Fourteen other firms submitted tenders. The Department have also selected for acceptance the tender of the Worthington Pump Co., £1,560, for independent surface condensing plant. There were thirteen other tenders.

TENDERS ACCEPTED.

WISHAW.—The tender of Messrs. Ferranti, Ltd., £149 18s. 6d., for a three-wire switchboard, has been accepted by the Electricity Department. Other tenders received were as follow: Braulik, Ltd., £150 15s. (incomplete); Johnson & Phillips, £153 (incomplete); Whipp & Bourne, £154; Shagnoletti, £157; Everett & Co., £158; Electrical Construction Co., £160 (without testing); the B.T.H. Co., £160; the Universal Co., £163; Dorman & Smith, £168; Siemens, Ltd., £172; Veritys, Ltd., £173; Cartwright, £175; Crompton, Ltd., £176; Westinghouse, Ltd., £179; General Electric Co., £180; Kelvin & White, Ltd., £203; McGeoch, Ltd., £205; Balchin Schulz, Ltd., £215; and G. Hill & Co., £229.

BUSINESS NOTES.

LIGHTING AND GENERAL—Home.

ABERDEEN.—At a meeting of the Churches Committee of the Town Council, it was decided to put in an installation of electric light in St. Clement's Parish Church at a cost of £64 15s. It was agreed to put in metallic filament lamps both in the Greyfriars Parish Church and the session house.

ABERDEEN.—The City Electrical and Tramways Engineer (Mr. J. A. Bell), reporting on the working of the Electricity and Tramways Department for the year ended July 31 last, states that during the period under review they started supply in two new districts, one in the west and one in the north, which has meant large cable operations and erection of sub-stations, plant, etc. The year just completed has been unique in the experience of the department, being the first since the start of the undertaking that the units generated show a decrease on the preceding year. Due, however, to economies in distribution, etc., the output sold shows a small increase on the year 1907–8. This small increase in output is partly due to the general depression in trade, but is principally the result of the installation of metallic filament lamps by the present consumers; and, while the department has coupled up more new consumers during the year than the average for the preceding four years (excluding the consumers taken over in the Cults district in 1908), these consumers do not balance the drop in output caused by the change from carbon to metallic filament lamps. It is estimated that the department already has on the mains some 25,000 metallic filament lamps which have displaced the older type of carbon filament lamp. The Town Council have recently sanctioned the department's hiring out heating and cooking apparatus, and it is expected that this will assist the undertaking considerably in the future. In the Engineer's opinion the Council will continue to feel the effect of metallic filament lamps for at least two years more. It is expected, however, that the additional consumers obtained, due to the more economical lamp, will eventually mean a largely increased output to the undertaking. The total number of units sold for the year for all purposes amounts to 5,170,421, being an increase of 66,385 over the preceding year. At a meeting of the Electricity Committee the question of the introduction of a flat rate charge for electricity was under discussion. It was resolved to make a uniform charge of 3¾d. per Board of Trade unit for lighting purposes, with the alternative to the consumers of over 5,000 units per half-year, whereby they can elect to be charged at the same rate as at present. Lighting for arc lamps was fixed at 2d. per unit. A sliding scale for power consumers ranging from 2½d. for the first 250 units and as low as ⅛ of a penny, to consumers of over 10,000 units per half-year, was agreed upon. A flat rate of 1½d. per unit for heating and cooking was fixed. The estimated income for the year was fixed at £45,812, £43,984 being derived from sale of current, and £1,828 from other sources. The expenditure was fixed at £44,929. After providing for interest and sinking fund a sum of £1,883 was agreed upon to be carried forward to the reserve account.

BARNES.—The Urban Council has appointed a sub-committee to consider the advisability of holding an electrical exhibition to advertise its electricity supply at the time of the reduction of charges to 3½d. per unit for lighting and 1½d. per unit for heating and cooking.

BELFAST.—On behalf of the Tramways and Electricity Committee, Councillor R. Johnson announced at the Council meeting that the two departments were in a most prosperous condition. The tramways undertaking had made a great increase in income, and the electrical branch was going on well.

BENTLEY (Doncaster).—A Local Government Board inquiry has been held by Mr. E. A. Sandford Fawcett, M.Inst.C.E., as to sanction to carry out a scheme of sewerage for Bentley Colliery model village, Rostall, and also building estates up the Askern-road. The Engineers (Messrs. D. Balfour & Son, of Newcastle-on-Tyne and London) explained the scheme, which consists of laying several miles of cast iron pipe sewers on concrete bed, this method of construction being necessary owing to the treacherous nature of the subsoil. The sewage will all be conveyed to a pumping station, where, after screening, it will be discharged into two separate tanks, from which it will be pumped by centrifugal pumps worked by electric motors, all in duplicate. The pumps will be placed in an underground chamber adjacent to the storage tanks, worked by a spindle from the motors in the motor house, to be built above ground. The motors will be automatically started and stopped by floats. Each pump will be capable of delivering 30,000 gallons per hour of sewage at the existing Sewage Disposal Works, where it will be treated in liquifying tanks and continuous filters with final treatment over land.

BERKHAMSTEAD.—At the Rural Council meeting the Clerk reported that they were not getting on very quickly with the electric lighting agreement. What he wanted was that the agreement should be in the same form as the provisional order, and the other side said that if things were in the provisional order they were not necessary in the agreement. He would not, however, bring the agreement before the Council until it was satisfactory. There was no hurry about it. He supposed they were getting the provisional order through.

BISHOP AUCKLAND.—A miner named John D. Thompson, 27, employed at a colliery electrical pump, took hold of a live wire with his naked hand, and was killed.

BOLTON.—A discussion ensued at the Council with reference to the cost of electrifying an overhead crane. The Mayor said the proposed expenditure was £620. In all ordinary business concerns such a cost would come out of capital, and it was a principle which they ought to consider. The Committee proposed taking the amount out of revenue. An assurance was given that the payment would be put under the proper account. The Town Clerk said the Electricity Committee had no borrowing powers. If they applied to the Local Government Board for sanction after they had carried out the work the Board might decline to give their sanction. Ald. Berry said this alteration had been wanted for years, and if it had been carried out five years ago they would have saved £1,000. The Town Clerk, in reply to Ald. Berry, said the powers possessed by the Electricity Committee were for specific purposes. Ald. Berry: This is part of it.

BRIGHOUSE.—The new system of electricity supply at Brighouse has been inaugurated, the old generating station in Hall-street, which has for a long time very inadequately met the growing requirements of the district for electric light and power, having been superseded by the completion of the new system of receiving electricity in bulk from the Yorkshire Power Co. and distributing it by the Corporation to its customers. For many years the Corporation has suffered serious financial loss by its old method of generating electricity, but it is hoped that this loss will now be avoided. Mr. Amos Aspinall, the Corporation's electrical works manager, turned on the new supply for the first time. The new transforming station is situated nearly in the centre of the borough.

CLEVEDON.—The Urban Council have decided to spend seven guineas in order to obtain the report of an expert as to the use of electricity for the purposes of public lighting.

FRASERBURG.—Permission was given by the Council to the National Telephone Co. to replace the overhead telephone wires going to the standard in Frithside-street, by a cable under the street.

HANLEY.—Extensions of the electric light mains will be made for street lighting in Willington-road and to supply private consumers in Melville-street and Fenton-road.

HASTINGS.—An inquiry has been held by the Local Government Board concerning the application by the Council for permission to borrow £1,100 for electric lighting purposes and £1,002 for providing eight transformers at the electricity station.

KEIGHLEY.—On behalf of the Electricity Committee Mr. Whitehead informed the Council that the armature of one of the motors at the electricity works had burst, and as they had no spare armature he asked that the committee be given permission to purchase one. He pointed out that the breakdown only lasted

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four minutes, but the tramways were not affected, another motor supplying the current for that system. The cost of the new armature was estimated at between £100 and £200. The Council gave the permission asked for.

KEIGHLEY.—Local Government Board sanction has been received by the Council in respect of the borrowing of £375 for purposes of the electricity undertaking.

LLANDILO.—The Urban Council received no fewer than 216 applications for the post of Electrical Engineer. A list of six applicants will subsequently be submitted to the Council.

MANSFIELD.—The Corporation Electricity Committee have recommended that application be made for Local Government Board sanction to the borrowing of £300 for water softening plant and £200 for economiser extension.

MIRFIELD.—The Electrical Engineer (Mr. Lomas) reported to the District Council that he had received an application from the Skating Rink Co. for a substantial supply of current, and the erection of a transformer pillar at the junction of the roads in Stocks Bank would render it very convenient for further distribution of electricity in that part of the district. It would also be useful when they extended the street lighting by electricity.

NORTHAMPTON.—Notices have been served upon the Corporation by the Electric Light and Power Co., Ltd., in respect of proposed considerable extensions of the electricity mains.

OULTON BROAD.—The Urban District Council have approved the draft advertisement for tenders for the working of the electric lighting provisional order, and particulars to be issued in connection with it.

PLYMOUTH.—A return to the Corporation Electricity Committee shows that for the month of July there were consumed 162,571 units, against 149,412 in the same period of last year, the estimated receipts being £1,531 9s., as compared with £1,413 12s. 3d. The Plymouth trams used 103,178 units, as compared with 99,878 units, and the Plymouth, Stonehouse, and Devonport trams 7,332 units, against 6,904 units. For private lights were consumed 29,651 units for motors 13,658 units, for arc lamps 5,400 units, and for miscellaneous purposes 3,354 units. The quantity of power used at the works was 20,084 units, and mains, etc., consumed 9,394 units. During the month there were 212 connections as compared with 208, while the number applied for was 719, against 352. The total number of connections was 80,690, and the total number of consumers 1,041, as compared with 75,500 and 956 respectively. Sixteen applications were received during the month, the number during July, 1908, being 7.

PRESTON.—The decision of the Town Council not to purchase the undertaking of the Preston Electric Supply Co. has been under discussion by the Trades Council. A resolution was passed strongly condemning the Town Council for their refusal to make public their negotiations with the Company, the Trades Council believing this to be in opposition to the desires and wishes of the people.

RAME.—Two zealous churchworkers have in their leisure moments provided an electric lighting installation in the parish church. The village of Rame, near Cawsand Bay, says a correspondent, boasts neither gas nor electric light, but the church is illuminated by electric light. This has been the work of two brothers, Messrs. F. and A. Carne, the one a boat builder, and the other employed on the civil side at Plymouth Dockyard. Between them they erected the necessary plant, and wired up the building, so that now, instead of using candles or oil, the church is supplied with a clean and convenient illuminant.

RUTHERGLEN.—Electric cables will be laid from Rutherglen to Renfrew, *via* Cathcart, Newlands, Pollokshaws, Cowglen Crookston, and Cardonald, by the Clyde Valley Electric Power Co.

SALFORD.—A heated debate occurred at the Town Council meeting when the Tramways Committee minutes were reached. The Committee asked the Council to pass a resolution that they had carefully considered the result of the experimental working of the extension of the various stages on the tramways undertaking, and the extension of the hours during which daily return tickets were issued, and regretted to record that there had not been the additional traffic obtained which was expected, as a result of the concessions, and in view of the fact that the receipts of the undertaking were seriously diminishing—the decrease, in the opinion of the Committee, being mainly due to the issue of return tickets—they recommended that the arrangement in operation prior to the introduction of such concessions, *i.e.*, the issue of workmen's single tickets up to 7 a.m., be reverted to, and the issue of return tickets discontinued, as also the concessions to female employés and school children. Alderman Linsley (Chairman of the Committee) said the total decrease over the mileage run of last year amounted to £14,463 13s. 5d., while the net profits up to March last decreased from £28,000 to £17,263. The great mischief had been done between the additional hour hour of seven and eight o'clock, and they were further handicapped by the price of current. If they could get it on the same terms as Glasgow, they would have something like £30,000 to play with. The minute was referred back by 16 votes to 12.

SWANSEA.—The Corporation electricity mains are to be extended to the Swan Hotel, Morriston, at a cost of £115. The number of electric consumers at the end of last month totalled 1,427.

WEST HARTLEPOOL.—The report of Mr. H. W. Taylor, of Middlesbrough, as to the electric lighting of the borough, has been received by the Corporation Lighting Committee. It was resolved that two recording meters at a cost of £15 each be obtained; also that the question of the incandescent lighting and supply for cinematograph purposes be referred to the following committee to interview the Cleveland and Durham County Electric Power Co. with Mr. Taylor: The Chairman, Councillors Sherwood and T. W. Watson, and the Borough Engineer. At the Council meeting, Councillor Sherwood remarked that the report of the expert, Mr. Taylor, on the electric lighting of the borough had proved that the Corporation were justified in all that they had done in this matter. "If ever," he added, "we spent £10 and got full value we got it in the appointment of this gentleman." Councillor T. W. Watson expressed the opinion that the expert's report had perfectly justified the action the Corporation had taken in making the deductions from the accounts. He believed if they had persisted they would have won.

LIGHTING AND GENERAL—Overseas.

BUENOS AIRES.—For the International Railway and Land Transport Exhibition the Executive will bear the cost of laying the electric cables. The branch piping and wires, together with the connections, meters, etc., for individual stands will be laid at the expense of the exhibitors. The Committee will bear the expense of national and municipal taxation in respect of the services, and they will be prepared to grant specially reduced terms for electrical power in the case of exhibitors taking a large supply. The charges for electric current for lighting purposes will be 0·14 gold dollars and 0·70 francs per kw. hour, and for power 0·06 and 0·30 respectively.

BOULDER (Western Australia).—Mr. H. Edmiston, electrical engineer, Perth, has reported to the Council recommending the provision of one 150 kw. set and one 75 kw. set at the electricity station. It is estimated that about £7,000 will have to be spent to bring the plant up to a state of efficiency. The Council having shown some hesitancy in advising this expenditure, several private offers, it is reported, have been submitted to take over the undertaking.

DENMARK.—The Great Northern Telegraph Co., Ltd., have had to cope with a great rush of Press messages from Denmark since the news of Dr. Cook's arrival from his Polar journey. "This is proving a record time for us," the manager remarked to a correspondent. "Up to 8 p.m. Sunday we received 50,000 words of Press messages about Dr. Cook, and much more is still coming in. We have had to increase out staffs here and at Newcastle, where the Danish cable comes ashore, and we have also had to take in a second cable, which is ordinarily used only for Sweden." The Company has been gratified to hear from various newspapers of the accuracy with which the messages, written in English, and transmitted by Danish operators, have been received.

FREEMANTLE (Western Australia).—Extensions to the municipal electricity undertaking are to be made, and an electric tramway constructed at an estimated cost of £25,714.

GUADALAJARA.—The British Vice-Consul (Mr. P. G. Holmsa reports that the interests of Señor Don Manuel Cuesta Gallardo and the Compañia de Tranvias, Luz y Fuerza de Guadalajara-Sociedad Anonima, (Tramways, Light and Power Co. of Guadalajara, Limited) have now been merged, and that a well-known Berlin firm have contracted to advance 7,500,000$ (£750,000) for the construction of works and the erection of machinery for the production of hydro-electric power on the Santiago River. In addition to the power scheme, 300,000 hectares (about 750,000 acres) of land will be drained and irrigated, and, under the Irrigation Law, the Mexican Government will pay the irrigating company the sum of $25 for each hectare (£1 per acre) irrigated by them. Guadalajara is already supplied with over 10,000 h.p. of electrical energy by the old company, but the new company is installing trubines to give an additional 8,400 h.p., which will be largely used by the mines in the Hostotipaquillo district of the State. It is possible that electric power may even be transmitted from the generating stations to Aguascalientes in the State of that name, where there exist important industries requiring power. The United States Consul at Guadalajara writes to his Government on the same subject, as follows, *apropos* of the regulation requiring all wires in Guadalajara to be placed underground:—"The placing underground of all wires in this city will be accomplished by the union of two strong local corporations: La Compañia de Tranvias, Luz y Fuerza de Guadalajara, with La Empresa Irrigadora y de Producción Electrica de Guadalajara. The former corporation has now a monopoly of the electric power and lighting of this city, and the latter corporation has valuable concessions from the State of Jalisco and the Government of Mexico, through which it controls rights to irrigate a large tract of land in this State and immense water-

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power in near-by rivers, and also to enter Guadalajara with its wires to compete with the former in selling light and power in the city. This will prevent a possibly dangerous competition and will certainly result in benefit to Guadalajara, although prices will probably be kept up to the present standard. Offers of materials for the conduits and for the trolley underground addressed to either of the above companies will no doubt receive consideration, and may result in business."

ITALY.—The British Consul at Palermo (Mr. R. S. Macbean, M.V.O.) reports that two hydro-electric stations are in course of construction on the Cassibile, to the south of Syracuse, and on the Alcantara, near Taormina. It is intended to link the two plants and to supply power by electric transmission wire to the whole of the east coast of Sicily, from Messina to Syracuse and eventually to Ragusa. The length of this line will be about 220 kilom., and for the present it will be fed from the central stations of Cassibile and Alcantara. The requirements of the region are estimated at about 10,000 h.p., viz. :—Catania, 5,000 ; Messina, 3,000 ; Syracuse, 1,500 ; and Taormina, 500. A further project is on foot for the establishment of an electric power station on the river Simato, capable of producing 10,000 h.p. It is calculated that the hydrologic conditions of Sicily would permit of the erection of hydraulic stations over the island capable of generating about 50,000 h.p., and it is thought that it would be possible to link such stations together, so as to embrace the whole island, with the principal stations at Palermo, Messina, Catania and Syracuse.

MADRAS.—The Madras Electric Supply Corporation having brought to the notice of the local Government the considerable delay which occurs in the practical working a Rule under the Electricity Act which requires that consumers desirous of using electric energy at pressures exceeding 250 volts must obtain the written approval of the local Government to a joint application by consumer and licensee, the Madras Government have directed that all such applications instead of being submitted to the Government direct should be submitted through the Electric Inspector, who has been requested to submit his recommendations on the applications to Government without delay.

MELBOURNE.—Following on a suggestion of the South Melbourne Council, a conference of the municipalities has been considering the question of street lighting. A special committee, appointed by them to collect information on the matter, recommends the advisability of procuring a system of electric light and power for the metropolitan municipalities, and that an expert be engaged to report on such a scheme, the expenses of the expert to be paid by the municipalities in proportion to the valuation of their districts.

MEXICO.—The United States Consul at Saltillo advises that the best method of reaching prospective purchasers of steam, electric, and hydraulic machinery and apparatus is by the maintenance of a representative in Mexico who will travel from place to place. By careful reading of the press and from other sources of information a representative would learn of a sufficient number of new enterprises in Mexico to keep him busy looking after them. If the home firm should consider the expense of maintaining such a representative too great, it might join with one or two other firms which have allied lines, so that the expenses of the joint representative could be divided. Very many foreign firms maintain agencies in the city of Mexico.

MEXICO.—A cable message states that the reservoirs of the Mexican Light and Power Co. are now sufficiently full to admit of the discontinuance of the steam plant. The *Financial Times* understands that the work of reservoir construction has now reached a stage which renders the Company permanently independent of the steam plant, and that, except in special circumstances, the auxiliary power plant will not be required again. Dr. Pearson, the President of the Company, stated in the letter which he published regarding the accident to the third reservoir at Necaxa some months ago, that he thought the storage capacity of the reserviors would soon be sufficient to keep the machinery at work all the year round, in dry as well as wet seasons, and this prophecy has now been fulfilled. As the steam plant made a very heavy addition to operating charges, the net revenue account stands to gain considerably through the continuous use of the reservoirs.

NEW SOUTH WALES.—The North Bulli Colliery, New South Wales, is installing a Mersey gas-producer plant for the generation of electricity. A meeting of local traders has been discussing the question of installing electricity in Maryborough, Victoria.

SYDNEY (Australia).—The result of the past year's working of the electricity undertaking has not been so satisfactory as might have been hoped, states the City Electrical Engineer (Mr. H. R. Forbes Mackay) in his annual report. The profit earned for 1908 has been seriously affected by the great sum spent on overhauling the plant at the power house. The units sold amounted to 8,673,942, an increase of 2,577,930 compared with 1907. At the end of the term, motors equivalent to 8,290 h.p. were connected, being an increase of 2,318 h.p. over the previous year. The cost per unit as compared with 1907 shows an increase of ·3 of a penny, principally due to the heavy charges for repairs and maintenance. During the year agreements were entered into with three of the private companies, viz., the Strand Electric Light Co., the Imperial Arcade Electric Light Co., and the Oxford-street Electric Light Co., for the purchase of their respective businesses.

TIFLIS.—A correspondent reports that the local authority will shortly apply for permission from the Government to contract a new loan, which would be the fifth issue of this city, with a view to carrying out some important public works, including electricity works.

TRACTION—Home.

DUNDEE.—The Tramways Committee has been making a series of tests with a car fitted with a new magnetic brake. The brake is designed to operate either electrically or mechanically, or both methods may be used simultaneously, giving great power. The mechanical system is used to control the car on steep gradients, and the electricity is applied for an emergency stop. The brake consists of a number of powerful magnets, which are drawn downwards and pressed on the rails with a force of several tons. On the hill on the Lochee-road, where the tests were made, the brake worked most satisfactorily, the speed of the car being controlled with ease, while the application of the electric current brought the vehicle to a full stop within a dozen yards.

LONDON.—The Hampstead and Highgate routes which are being converted to electric traction will soon be opened for traffic. Work is proceeding both day and night in order that the Hampstead to Holborn line may be finished before the formal opening of Blackfriars Bridge to tramway traffic on the 14th inst. The other North London lines are not in such an advanced state.

LONDON.—The monthly statement of the receipts and expenses of the companies associated with the Underground Electric Railways Co. of London for July last is as follow, the figures for the corresponding period of 1908 being given in parentheses :—Metropolitan District Railway Co., gross receipts, £54,494 (£48,774) ; working expenses, £26,160 (£27,897). Baker-street and Waterloo Railway Co., £15,105 (£13,890), and £6,979 (£6,971). Great Northern Piccadilly and Brompton Railway Co., £25,899 (£24,095), and £11,532 (£12,236). Charing Cross, Euston and Hampstead Railway Co., £17,992 (£15,048), and £9,936 (£9,642). London United Tramways, Ltd., £31,122 (£34,689), and £20,048 (£19,537).

NEWCASTLE.—The revenue of the Corporation Tramways undertaking for the year ended March 31 last shows a considerable decrease both in the gross takings and in the earnings per car mile. The Engineer and General Manager (Mr. Ernest Hatton) states that this is largely accounted for by the unfortunate strike, which embraced the whole of the Tyneside during the year, and also by the extra facilities given to workpeople and in the extension of fare stages. The gross receipts (including the Tyneside Tramway Co.'s proportion) were £209,540 19s. 10d., against £217,080 18s. 5d. in the previous year. The traffic expenses were £56,912 18s. 2d., as compared with £53,583 4s. 11d. ; general expenses, £21,291 11s. 5d., against £17,609 2s. 7d. ; and general repairs and maintenance, £27,924 2s. 3d., against £22,570 6s. 1d. Power expenses amounted to £14,947 3s. 6d., against £16,615 18s. 2d., and the working costs (exclusive of public street lighting) were £121,075 15s. 4d., against £115,378 11s. 9d. The pronounced increase in the general expenses is attributed to the large increase in the rates consequent on the excessively increased assessment. After an appeal the assessment authorities reduced the assessment for the ensuing half-year from £34,746 to £30,798, against which the Tramway's Manager advises the Committee to make a further appeal. During the year 44,439,282 passengers were carried, as compared with 46,203,164 in the preceding year. The surplus for the year amounts to £7,558, against £19,478.

PLYMOUTH.—The Tramways General Manager (Mr. C. R. Everson) presented to the Tramways Committee a statement showing that the number of car miles for the year ending March 31, 1909, was 792,138, as compared with 781,500 miles in the corresponding period of the previous year. The number of cars in use in 1909 was 26 for six months and 27 for six months, as against 25 for three months, 26 for four months, and 27 for five months ; the average units per day per car was 117, against 116, while 1,136,888 units of electricity were consumed for motive power, as compared with 1,109,501, the average per car mile being 1·43, as against 1·41. During the year ended March 31 last the mileage per car per annum was 30,466, and in the previous year 30,057, the average miles per car per day being 89 miles on week-days and 47 on Sundays, as against 88 and 46 miles respectively in the preceding twelve months. The total number of passengers carried was 7,818,759, 633,484 being 1½d. fares, 6,980,580 1d. fares, and 204,695 being ½d. fares. The fact that 10,638 more miles was run by the cars in 1909 than in 1908 was largely attributable to working West Hoe for the full twelve months ending March, 1909, as against nine months in the previous year. The abstract of accounts showed that the income for the year was £34,150 and the expenditure £26,084. The average working expenses per car mile, excluding power cost and permanent way, was 4·100d., including power cost, 6·612d., and including power cost and permanent way, 7·903d. The number of parcels carried was 13,294.

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YORK.—Messrs. Dick, Kerr, & Co., contractors for the new electric tramways that are to be constructed for the Corporation, commenced the operations necessary for laying the line at the Germany-lane terminus on the Fulford-road. The contractors intend employing as many local men as are suitable for the operations to be carried out. A few York gentlemen, including Councillor Hogge, were present when the first pick was put into the ground, and Mr. J. G. Dickinson attended as representing the contractors. Another section is to be started shortly, and the whole of the work will be pushed on as speedily as possible. It is hoped to construct about 600 yards of the track each week. Between 200 and 300 tons of rails have already been brought into York for the purposes of the line and they have been manufactured by a Middlesbrough firm. The Tramways Committee have decided to recommend the City Council to accept the tender of the British Thomson-Houston Co. for 18 electric cars and one motor car, at a cost of just over £10,000. The cars will be of up-to-date pattern, luxuriously fitted up, with uncovered top decks. Each car will carry 22 passengers inside and 28 outside. The motor car, which will run on the rails like a tramcar, is used for repair work.

TRACTION—Overseas.

BRITISH COLUMBIA.—The British Columbia Electric Railway Co. have some important extensions in hand. The first section of the Chilliwack line from New Westminster to Abbotsford, a distance of 38 miles, is now graded and ready for the steel. The rails to be laid will weigh 70 lbs. to the yard and are about 40 ft. in length. A new style of track laying machine is being used, which does away with the necessity of handling the rails so much. As each rail weighs about 933 lbs. this is an important item. It is estimated that fully 60 working days will be required for the steel to reach Abbotsford, making this well on in November. No wiring will be done on this line until the steel has reached Cloverdale, as all the steel for this part of the line is at New Westminster and will have to be taken out over the completed line. It is expected that the line to Abbotsford will be in operation this year, although it will be late in the autumn before the line is completed.

NORWAY.—The British Westinghouse Co. have constructed the first railway with alternating current in the country from Thamshavn to Lokken. Twenty-six miles in length, the railway is used for the conveyance of passengers and goods, and especially for the iron-ore traffic. The current is one of 6,600 volts. The single line has a wheel-base of 1 metre. The rolling-stock consists of 3 engines, 4 passenger carriages, and 21 goods wagons

MELBOURNE.—The Victoria Railways construction branch are considering the question of extending the Melbourne to Sandringham suburban line towards Mordialloc. The departmental officers, it is understood, will recommend the extension of the existing electric line along the beach road from Brighton.

MONTEVIDEO.—During the first half of the current year the Montevideo Tramway (electric section) carried 26,622,750 passengers, as compared with 17,673,326 for the corresponding period of 1908. The traffic by the horse section showed a considerable falling off, 1,383,060 passengers against 5,775,369.

PARA.—The traffic returns of the Para Electric Railways and Lighting Co. show that the aggregate receipts for 1909 total £109,354, as compared with £97,455. The company has only 34½ miles of tramway, and bearing in mind that the returns from the lighting are only about half those from the tramway, the result is very promising. The company took over the old mule tramway and the electric light works in 1905, and proceeded to the electrification of the line. The original cost of the tramway and lighting plant, according to the balance sheet of last November, totalled £886,264. The reconstruction and electrification figures at £424,671.

RIVER PLATE.—The Lacroze Tramway Co. have inaugurated their service from the centre to Villa Urquiza. This suburb has now two lines of electric tramway to the centre. The Company has reiterated a petition to Congress presented in 1905 for a concession for a system of tubes. The electrification of the La Plata and Ensenada Tramways Co. is being rapidly pushed ahead, and it is hoped to have the first section opened by January 5 next.

ST. PETERSBURG.—It is stated on reliable authority, states the *Financial World*, that negotiations are being actively pursued in reference to the offers made a few months ago to the St. Petersburg Municipality by an international syndicate for the reorganisation of the tramway system. The syndicate includes, besides the German General Electrical Co. and Messrs. Siemens & Halske, the English Westinghouse concern, and is being backed by the Deutsche Bank, together with the Société Générale. In brief, the scheme consists in the purchase from the city of all the lines, with the rolling stock and the municipal electrical works, at the price of 20,000,000 roubles; also the extension of the system, for which purpose another sum of 30.000,000 roubles would be reserved. The tramways would subsequently be worked by a company to be promoted by the syndicate, and the municipality would share in the net profits up to a maximum of 7½%.

PATENTS.

Instruments for Measuring the Decrement of Electro-magnetic Oscillations.

185.—1909. MARCONI'S WIRELESS TELEGRAPH CO. & H. C. ROUND, London. The apparatus comprises an oscillation circuit of adjustable frequency, an indicator circuit, means for changing the frequency of the oscillation circuit by a small amount, and means for simultaneously altering the indicator circuit by an adjustable amount.

Electric Induction Furnaces.

8194.—1909. GRONDEL KJELLIN CO., LTD. & J. HARDEN, London. The melting chamber is lined with a mixture of graphite and fireclay, intimately mixed in such proportion that when the furnace is started the primary current will induce currents in the chamber walls sufficiently strong to heat them and thereby cause the charge to become fused by conduction until it becomes a continuous conducting mass. The furnace may be allowed to cool at any time and be reheated without damage. Moreover, the melting chamber can be cleaned out after each melting operation.

Friction Couplings for Use with Electro Motors for Driving Machine Tools.

6850.—1909. LA SOCIÉTÉ ANONYME ELECTRICITÉ ELECTRO-MÉCHANIQUE, Brussels. One member of the friction coupling is carried on the shaft of the motor, while the second member is carried by a freely turning sleeve covering the shaft. The tool carried is mounted on the opposite end of the sleeve to that which carries the second friction member. The outer surface of this member has a V shaped groove into which friction blocks, carried by the first friction member are pressed. The power transmitted from the motor to the tool depends upon the frictional resistance of the blocks, which can be regulated proportionally to the power of the motor, by means of screws which press upon the springs carrying the blocks. When the load becomes too heavy the friction blocks will slip and prevent the motor from being overloaded. The coupling is small and light in weight. The arms of the coupling member are extended to form wings which act as fans as the member revolves, and by drawing a current of air through the motor, cools the various parts.

Varying the Position of Electric Lights.

18408.—1908. G. THOMSON, Edinburgh. The apparatus comprises a bracket pivotted to a support so that the bracket is free to rotate. The bracket is operated by a pulley. To the other end of the bracket a quadrant is adjustably connected, to which is fitted a guide piece. The jib for supporting the lamp comprises a number of bars arranged in pairs in such a way as to render the jib extensible. The jib is contracted or extended by the action of a rope and pulley.

Quick Make and Brake Electrical Switch.

20646.—1908. VERITYS LTD. & W. G. PIPKIN, Birmingham. The switch comprises a blade pivotted to a stationary bracket of the base of the switch at a short distance inwards of its one end. The other end provides the contact end in respect of the terminals of the switch. The one end of the blade has a spring arrangement which operates each side, the centre of the pivot of the blade for moving the latter quickly into engagement with the terminals, and for holding the blade out of engagement, and, for helping the quick movement of the blade away from the terminals. A second spring is provided for closing the switch. This second spring also serves to hold the switch arm open by acting each side of the pivot of the arm.

Regulation of Speed of Electric Motors.

18017.—1908. SIEMENS-SCHUCKERTWERKE, Berlin. This is an improved method for regulating the speed of direct and single or polyphase alternating current commutator motors with separate or shunt excitation, or for improving the power factor in the case of alternating current motors. The object of the invention is to maintain a high electrical efficiency under all conditions of load and speed. The method consists in simultaneously varying the strength of the field and the voltage applied to the armature without varying the resistance in the armature circuit.

Electric Starting Switches Using Liquid Resistance.

18623.—1908. SANDCROFT FOUNDRY CO., LTD. & T. M. DUTTON, Sandycroft. In liquid resistance, switches wherein the resistance is varied by immersing the two electrodes more or less in the liquid, the heating takes place largely at the surface of the liquid, particularly when the plates are in position for maximum resistance. The object of the invention is to avoid this by so arranging the plates that at all resistances the heating takes place at or near to the bottom of the liquid in the containing vessel, whilst there is a considerable column of liquid above which will allow the heated liquid to rise and circulation to take place, so that the whole amount of liquid in the vessel is used effectively and risk of boiling or overheating avoided.

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Electrical Ignition Devices.

18811.—1908. E. Denieport, Luresnes. The condenser, the trembler, the armature, and the distributing switch, comprising this device are combined in a single casing. The armature is of cylindrical shape, the condenser is wrapped round it and occupies an annular space formed between the armature and the casing.

Electrical Driving Gear.

22377.—1908. G. F. C. Pollet, Antwerp. An arrangement is provided whereby the speed and power of the prime mover is regulated in relation to the current required by the motor. The rotation of the armature acts indirectly upon the supply to the prime mover, by means of a centrifugal governor in such a manner that when the armature is rotating at a high speed under a high load the pole casing being held stationary by a shunt solenoid brake in the working circuit, the supply to the prime mover is increased for such a period of time as the current required permits, whereas for only a small power, and when the armature is rotating at a slow speed, the same arrangement effects the rotation of the pole casing for the purpose of obtaining the necessary relative speed between the armature and the poles.

Brush Gear for Dynamo Electric Machinery.

23709.—1908. P. L. R. Fraser & The Tudor Accumulator Co., Ltd., London. The invention consists in mounting the bearings which support the frame carrying the brushes upon the dynamo shaft itself, or on a prolongation of the same so that on change of the direction of the rotation of the shaft the brushes almost immediately move over to their new position.

Ironclad Electric Switches.

22768.—1908. F. S. Horrocks & T. C. Letts, Manchester. Combined with the switch handle is a pin or bolt fitted within the switch casing operated by the handle, and adapted to lock the cover to the casing when the switch is in the current "on" position. When the switch is in the current "off" position the bolt moves out of a slot in the cover and permits the cover and casing to be opened.

Polarised Morse Sounders and Inkwriters.

8533. C. C. Vyle, London. The permanent magnet is of greater length one side than the other and between it and the electro-magnets an air gap is provided. The poles of the permanent magnet are bent back and this permits a much larger magnet being used without unduly increasing the size of the base of the sounder.

Electrically Operated Cranes.

8456.—1909. Allgemeine - Elektricitats - Gesellschaft, Berlin. This is an improvement in the device for limiting the speed of cranes, and consists in arranging the limit switches in such a way that one switch is closed during a part of the travel only to complete the circuit of the tractive coil of the other limit switch, which acts to automatically reduce the speed when it reaches a predetermined limit.

Electricity Meters.

15802.—1908. G. Hookham, Birmingham. The improvement consists in means to eliminate temperature errors in these instruments. Fig. 1 is an elevation of a resistance element. Fig. 2 is a transverse section on the line 2—2 Fig. 1. Fig. 3 shows diagramatically the application of the device to an electricity motor meter. An oil chamber *a* has at one side a diaphragm *b* of celluloid. At the outside of the diaphragm is a bulging piece of metal *c* forming a chamber containing mercury, and into this chamber is fitted the thermometer tube, *d*. The resistance wire, *e*, passes down this tube and is provided with a number of kinks, *f*, which are amalgamated so that when the mercury rises in the tube these kinks make successive contacts with the mercury column. The wire may if desired be placed outside the tube and the kinks brought through the tube, the wire being sealed into the glass. It is important that there should be no communication for mercury between the kinks and therefore when the wire is inside the tube iron or steel wire is used, with copper deposited on the kinks the spaces between them being stopped off. Terminals, *g h*, are provided, the terminal, *g*, making contact with the mercury column and the terminal, *h*, with the upper end of the wire. It will be seen that in this arrangement when the liquid in the chamber, *a*, expands the diaphragm, *b*, is forced outwards and forces the mercury column up the tube, *d*, making successive contacts with the kinks, *f*, in the wire, *e*. When the mercury falls a small drop of mercury remains in each kink so that on the mercury column again rising an immediate contact is made with the wire when any kink is reached. As shown in Fig. 3 the compensating resistance *h*, is placed in shunt across the mercury chamber, *k*, the current to be measured passing through the armature by the thick wire, *l*, and through a compensating coil, *m*, the compensating resistance, *h*, being in series with this compensating coil and in shunt with the armature. Instead of a diaphragm, part of the thermometer bulb may be made flexible, for instance as by the use of a plunger working fluid-tight in a cylinder or by the use of a flexible metal or leather bag and if of leather this may be soaked in glycerine or gelatine to protect it from the oil. The top of the tube in which the mercury rises may terminate in an air tight chamber or may be open at the top and may be partially closed by means of a porous plug. In the outer chamber a cheap liquid having a considerable rate of expansion when heated should be used and olive oil is found to be very suitable. In some cases it may be desired to arrange the resistance element so that its resistance increases instead of diminishes with rise in temperature as for instance in the case of a shunted meter. This may

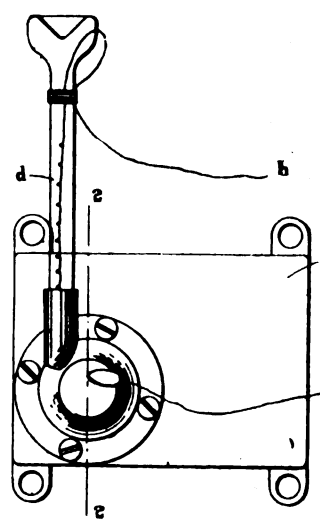

Fig. 1.

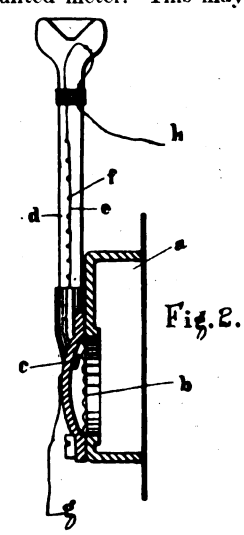

Fig. 2.

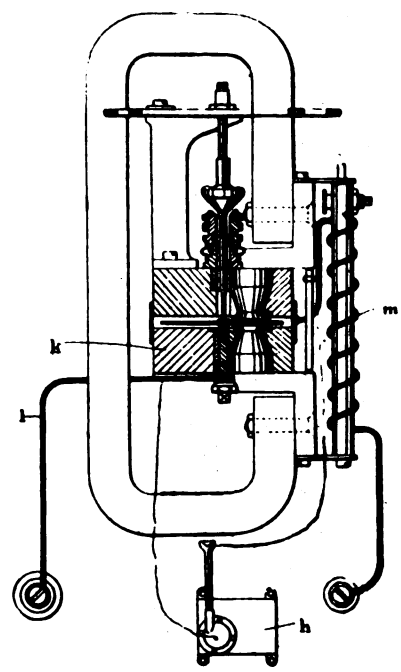

Fig. 3.

be effected by placing the mercury in a U-shaped tube one limb of which is connected through a column of air with the thermometer device so that the mercury in this limb is forced downwards and increases the effective length of the resistance wires. In order to ensure perfect contact the wire may be coated with platinum and then with palladium, and in this case, in order to prevent the mercury from draining down the wires and leaving them dry the palladium may be applied in the form of isolated rings or patches which will remain saturated with mercury. For the purpose of the resistance itself iron wire plated with copper may be used, the wire being amalgamated with mercury where it is desired to make the contacts with the mercury column.

Insulating Electric Conductors.

23007.—1908. P. MacGahan, Pittsburgh. This is an improved process of insulating wires and other electric conductors. In the diagram an ingot 1 of copper is cast into a coating 2 of aluminium and the mass is then re-heated and passed through rolls 3 until its size is materially reduced, after which it is drawn through dies 4 to the desired size and shape of conductor. During this part of the process the aluminium coating is reduced together with the copper core and forms a very thin coating for the completed conductor. From the dies, the conductor passes over sheaves

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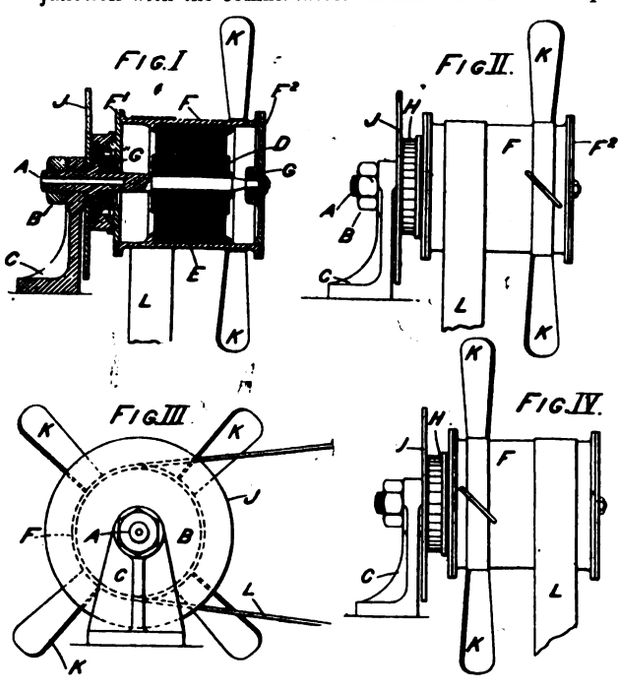
5 into a bath 6 which is contained in a tank 7 and, from the bath, it passes over sheaves 8 and 9 and through a cathode cell 10 on to a gathering reel 11. The cell contains a plate 12 of conducting material connected to the positive terminal 13 of a direct current generator 14, the opposite terminal of this generator being connected to the conducting walls 15 of the tank. The cell 10 thus forms the means for connecting the conductor to be insulated to the positive pole of the generator 14. A thin insulating film is formed on the bare conductor as it passes through the bath 6 by reason of the electrolytic action produced by the electric current which flows through a circuit that may be traced as follows:—From the generator 14, through a conductor 16 to the plate 12, through the conductor which is passing through the bath 10, the bath 6, lining 15 and conductor 17 to the opposite terminal of the generator 14. The bath 6 may contain a solution of ammonium borate or other liquid which is capable of producing an electrolytic valve action. When the process is complete, the conductor will be coated with very thin films of insulating aluminium oxide which occupy an inappreciable amount of space.

Electric Current Generators.

21813.—1908. W. A. TRIER, Camberwell. Trouble has been experienced in fitting generators to automobile vehicles owing to the limited space available and the difficulty of placing the generator so that it can be conveniently driven from some rotating part of the engine. The primary object of the present invention is to obviate these disadvantages by the construction and arrangement of a generator occupying little space and capable of being driven in a simple and practical manner. Fig. 1 is a central vertical section through one construction of generator. Fig. 2 is a side elevation. Fig. 3 an end elevation and Fig. 4 is a view similar to Fig. 2 but showing the fan and driving belt in different positions. A is a fixed spindle secured by a nut B to a bracket C. Upon this spindle is a field magnet D. The armature plates E are held within a casing F having end plates supported by ball-bearings G so that the whole casing and armature is rotatable about the fixed spindle A. To the end plate F^1 adjacent to the bracket C is fixed a commutator H and a plate J mounted upon the fixed spindle may serve as a support for brushes working in conjunction with the commutator. A fan K is mounted upon



the casing F by means of a clamping ring which allows the fan to be adjusted relatively to the casing. The casing F serves as a pulley to which rotary motion can be imparted from some rotating portion of the engine through a belt L. As the casing is of considerable breadth and the belt may pass round any part of it considerable latitude is allowed in the relative positions of the generator and the particular part of the engine from which it is driven. Obviously the fan need not be mounted upon the outer end of the casing as shown in Fig. 1, 2, and 3, but may occupy a position near the commutator end as indicated in Fig. 4. Again, although it is convenient to mount the fan upon the casing F it may form part of the end plate. The spindle A may be fixed in an eccentric mounting in the bracket C so that the tension of the driving belt may be adjusted. The construction illustrated is particularly convenient when the generator is mounted in the space behind the radiator in a motor car usually occupied by the cooling fan. In many cases the generator can be fitted to a car and can be driven from the same pulley from which the fan was originally driven.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last price. £
Alliance Electrical Co., 5 p.c. Cum. Pref., Nos. 1-70,000	1 ..	¼-⅜
—— Ord., 1,125,000	1 ..	¼-⅜
Aron Electr'ty Meter, 6 p.c. Cum. Pref. Sh's, 1-125,000	1 ..	¼-⅜
—— Ordinary, Nos. 1-125,000	1 ..	¼-⅜
British Aluminium Co., Ordinary, 1-40,000	5 ..	2-2¼
—— 7 p.c. Cum. Pref., 1-40,000	5 ..	1¼-1⅝
—— "A" 6 p.c. Cum. Pref., 1-20,000	5 ..	3⅝-3¾
—— 4 p.c. Funding Certificates, 1-20,000	5 ..	2¼-3¼
—— 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	73-78
—— 5½ p.c. Loch Leven Deb. (Reg.), Red., 1-3,000	100 ..	95-98
British Insulated and Helsby Cables, Ord. 1-100,000	5 ..	7¼-7¾
—— 6 p.c. Cum. Pref., 1-100,000	5 ..	6¼-6¾
—— 4½ p.c. Mortgage Debentures	100 ..	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	89-94
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 275,001-475,000	3 ..	3/16-7/16
—— p.c. Mortgage Debenture Stock	100 ..	38-42
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	0-¼
—— Non. Cum., 6 p.c., Pref.	2 ..	0-¼
—— 4 p.c. 1st Debenture Stock	100 ..	41-46 xd
—— 4½ p.c. 2nd Debenture Stock	100 ..	27-31
Callender's Cable, Debentures	100 ..	104½-106½
—— Ordinary	5 ..	10¼-10⅞
—— 5 p.c. Pref.	5 ..	5¼-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	¼-⅜
Crompton and Co., Nos. 1-85,000	3 ..	¾-1⅛
—— 5 p.c. 1st Mort. Reg. Debs., Nos. 1-900 of £100, and 901-11,100 of £50, Red.	— ..	90-93
Dick, Kerr, and Co., Ordinary, 1,260,000	1 ..	1¼-1 5/16
—— 6 p.c. Cum. Pref., 1-305,000	1 ..	1¼-1⅛
—— 4½p.c. Debenture Stock.	100 ..	100-103
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¼-⅜
—— "A" Shares, 01-017,139	5 ..	1-1⅛
—— 4 p.c. Deb. Stock, Red.	100 ..	84-87
—— 5 p.c. Debentures	100 ..	68-73
Electric Construction, Nos. 1 to 112,100	2 ..	7/16-½
—— 7 p.c. Cumulative Pref.	2 ..	1 3/16-1 7/16
—— 4 p.c. Perp. 1st Mort. Deb.	100 ..	65-69
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	71-77
General Electric Company (1900) 5 p.c. Cum. Pref.	10 ..	7¾-8¼
—— 4 p.c. 1st M. S. Deb. Stock	100 ..	85-88
W. T. Henley's Telegraph Works, Ordinary	5 ..	12¼-13¼
—— 4½ p.c. Preference	5 ..	5-5⅛
—— 4½ p.c. Debentures	100 ..	105½-107½
India Rubber, Gutta Percha, and Telegraph Works	10 ..	14¼-15¼
—— 4 p.c. Debentures	100 ..	100-102
National Electric Construction Co., 1-170,000	1 ..	⅜-½
Telegraph Construction and Maintenance	1[illegible] ..	34¼-36
—— 4 p.c. Bonds	100 ..	100-102
White, J. G., and Co., 6 p.c. Cum. Pref., 1-15,000	10 ..	9¼-10¼

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4¼-5¼
Bournemouth and Poole, Ordinary	10 ..	9½-9¾
—— 4½ p.c. Cum. Pref., 7,501-15,000	10 ..	9¼-10
—— 6 p.c. Cum. Second Pref., 15,001-22,500	10 ..	10-10¼
—— 4½ p.c. Debenture Stock, Red.	100 ..	99-103 xd
Bromley (Kent) Electric Light and Power Co.	5 ..	4¼-4⅝
—— 4½ p.c. 1st Debenture Stock, Red.	100 ..	93-96
Brompton and Kensington, Ordinary	5 ..	7¼-8
—— 7 p.c. Preference	5 ..	7¼
Calcutta Electric Supply Corp., Ord., Nos. 1-100,000	5 ..	6-6¼
Cambridge Electric Supply Company, £10 Ord.	8 ..	12¼-13¼
Canadian General Electric Co., Common Shares	$100 ..	122-127
—— 7 p.c. Cum. Pref. Stock	$100 ..	118¼-123¼
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100 ..	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5 ..	4-4¼
—— 4½ p.c. Cum.. Pref., 1-80,000	5 ..	4⅜-4⅞
—— 4 p.c. Debenture Stock, Red.	100 ..	96-99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5 ..	3⅞-4⅛
Chelsea Electricity Supply	5 ..	3⅞-4¼
—— 4½ p.c. Debentures	100 ..	100-103 xd
City of London, Ordinary	10 ..	10¼-10⅝
—— 6 p.c. Cumulative Pref.	10 ..	11⅛-12⅛
—— 5 p.c. Debenture Stock	100 ..	121-124
—— 4½ p.c. 2nd Deb. Stk., Red.	100 ..	100-103
Cordoba Light and Power Co., 1st Mt. Stl. 5 p.c. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	2¾-3⅛
—— 5 p.c. Preference, 1-50,000	5 ..	3-3⅛
County of London Elec. Supply, Ordinary	10 ..	7⅜-8⅛
—— 6 p.c. Cum. Pref.	10 ..	10¼-11
—— 4½ p.c. Debentures Prov. Certs. Al pd., Rd.	100 ..	104-107
—— 4½ p.c. 2nd Debentures Prov. Certs.	100 ..	100-103
Edmundson's Electricity Corporation, Ord., 1-80,000	5 ..	¼-5/16
—— 6 p.c. Cum. Pref.	5 ..	⅜-½
—— 4½ p.c. First Mort. Deb.	100 ..	58-61
Electrical Development Co. of Ontario, 5 p.c. 1st Mort. 30-year Gold Bonds, 10,751-15,750	— ..	86-88
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100 ..	91-94
Folkestone Electric Supply, Ord., Nos. 1-10,000	5 ..	4¼-5¼
—— 5 p.c. Cum. Pref., Nos. 1-10,000	5 ..	5-5¼
—— 4½ p.c. First Deb. Stock, Red.	100 ..	97-100
Hove Electric Lighting, Ord., 1-13,000	5 ..	7¼-7⅛
Indian Electric Supply and Traction Co., 6 p.c. Construction Deb. Stock, Red.	5 ..	1¼-2
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100 ..	74-79
Kalgoorlie Electric Power and Lighting, 6 p.c. Cum. Pref., 1-150,000	1 ..	⅜-27/32
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	6¼-6¾
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100 ..	95-98

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Name.	Amount paid. £	Last price. £
London Electric Ordinary	3 ..	1⅞-2⅛
—— 6 p.c. Pref.	5 ..	5-5⅛
—— 4 p.c. st Mortgage Debenture Stock, Red.	100 ..	93-97
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100 ..	76-80
Metropolitan Ordinary, 100,001-300,000	5 ..	4⅛-4⅜
—— 4½ p.c. First Mortgage Debenture Stock	100 ..	105-108
—— 4½ p.c. Cum. Pref.	5 ..	4⅛-5
—— 3½ p.c. Mortgage Debenture, Red.	100 ..	83½-84
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,000 ($500) M 1-4,400 ($1,000)	— ..	83-85 p.c. 75
($500), 4,001-14,000 ($1,000)	— ..	88-89⅛
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	94-97
Newcastle-upon-Tyne Electric Supply, Ord., 1-87,500	5 ..	4⅛-4⅜
—— do. 87,501-137,500 (issued at £1 prem.). All paid (Prov. Certs.)	5 ..	4⅛-5⅛
—— do., 5 p.c. Pref., 1-87,500 (Prov. Certs.)	2 ..	4⅛-5
—— 5 p.c. Pref., 87,501-137,500 (Prov. Certs.)	4 ..	4⅛-5⅛
Notting Hill Electric Lighting	10 ..	11-12
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6-6½
—— 4 p.c. Debenture Stock	100 ..	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1 ..	1 5 16-1 7/16
—— 6 p.c. Non-Cum. Pref., 1-100,000	1 ..	11/32-1 3/32
—— 5 p.c. Debenture Stock, Red.	100 ..	102-103½
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5 ..	5⅛-5⅜
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5 ..	5⅛-6
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100 ..	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	.. —	105-106
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	9/16-13/16
South London, Ordinary	4 ..	2⅛-3
South Metropolitan Electric Light and Power, Ord.	1 ..	5/16-9/16
—— 7 p.c. Cum. Pref.	1 ..	1⅛-1⅛
—— 4½ p.c. 1st Mort. Deb.	100 ..	102-105
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	8½-9
—— 7 p.c. Pref.	5 ..	7-7⅛
—— 3½ p.c. Deb.	100 ..	84-88
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	½-1
—— 5 p.c. Cumulative Preference, 50,001-80,000	5 ..	1½-2
—— 4½ p.c. First Mort. Debenture Stock, Red.	100 ..	77-81
Westminster, Ordinary	5 ..	8½-9 xd
—— 4½ p.c. Cum. Pref., 110,101-138,251	5 ..	5-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 10 p.c. Non-Cum. 2nd Pref., 260,008-280,007	5 ..	4⅛-4⅜
—— Permanent 6 p.c. Debenture Stock, 1888	100 ..	91-92
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	102-105
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	⅛-¼
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1 ..	9/16-11/16
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100 ..	88-91
Blackpool and Fleetwood Tramroad	10 ..	13⅛-13⅜
Bombay Elec. Supply and Trams. Co., 6 p.c. Cum. Pref.	10 ..	9⅛-9⅜
—— 4½ p.c. Deb. Stock, Red.	100 ..	93½-95½
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	6⅜-7
—— 5 p.c. Cum. Pref., Nos. 1-75,000	5 ..	5-5⅛
—— 4½ p.c. Deb. Stk., Red., Prov. Certs., all pd.	100 ..	100-103
British Columbia Electric Railway Co., Ord. Def.	100 ..	148-152
—— Ord. Pref.	100 ..	123-127
—— 5 p.c. Cum. Perpetual Pref. Stock	100 ..	109-112
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	102-104
—— 4½ p.c. Vancouver Power Deb.	100 ..	102-105
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10 ..	9/16-13/16
—— 6 p.c. Cm. Pf., 30,001-60,000	10 ..	
—— 5 p.c. Perpetual Debenture Stock	100 ..	85-88
—— 4½ p.c. 2nd Deb. Stock	100 ..	63-67
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	81-86
Buenos Ayres Gd. Nat. Trams. Co., 5½ p.c. Pref. Deb. Bonds, Red., 1-1,500	100 ..	102-107
—— 6 p.c. Deb. Bonds, Red., 1-2,275	100 ..	103-106
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	97-99
Calcutta Tramways, Ord., No. 1 137,610	5 ..	4 9 16-4 13 16
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5 ..	4⅛-5
—— 4½ p.c. 1st Deb. Stock, Red.	100 ..	99½
Cape Electric Tramways, Nos. 1-491,222	1 ..	¼-⅜
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5 ..	4⅞-5⅛
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	97-101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5 ..	5 11/16-5 13/16
—— 4 p.c. Deb. Stock, Red. (1985)	100 ..	98-101 xd
Colombo Electric Tramways and Lighting, 5 p.c. 1st Mortgage Debenture Stock, Red.	100 ..	98-101
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 p.c. Cum. Pref.	10 ..	12⅞-13⅜
—— 4 p.c. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12⅜-13⅜
—— 6 p.c. Pref., Nos. within 1-60,000	10 ..	12⅛-13⅛
—— 3½ p.c. Mort. Debs., 1-3,000 Red.	100 ..	90-95
Hastings & Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	76-81
Havana Electric Railway Consolidated Mort. 5 p.c. 50-year Coupon Bonds of 1952, 1-6,957	$1,000 ..	91-94
Imperial Tramways, Ordinary	all ..	18-19
—— 6 p.c. Cum. Pref.	all ..	14-14½
—— 4½ p.c. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 p.c. Cum. Pref., Nos. 30,001-60,000	5 ..	⅞-1⅛ xd
—— 4 p.c. 1st Mt. Db. Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/32-3/32
—— 5 p.c. " A " Deb. Stock	100 ..	91-94
—— 6 p.c. " B " Deb. Stock	100 ..	66-68⅛
Kidderminster & District Lighting & Traction, Pref.	5	9 15/16-10 3/16
Lancashire United Tramways, Limited, 5 p c Prior Lien Deb Stock, Red	100 ..	88½-90⅛
—— £296,500 2nd Mort Deb Stock	— ..	—
—— £83,330 Deferred Deb Stock (all fully paid)	— ..	—
Lisbon Elec Trams, Limited, Ord, Nos 1-594,188	1 ..	29/32-1 1/32
—— 6 p.c. Cum Pref, Nos. 1-425,553	1 ..	15/16-1 3/16
—— 5 p.c. Mort. Deb., 1-5,000, Red.	100 ..	98-102
London United Trys (1901) 5 p.c. Cum. Pref.	10 ..	2⅛-2⅜
—— 4 p.c. 1st Mt. Db. Stock, Red.	100 ..	67-70
Madras Elec. Trams. (1904) 5 p.c. Deb. Stk., Red.	100 ..	93-96
Manila Elec. R.R. & Ltg. Corp., 5 p.c. 1st Lien & Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000 .	95-97
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5 ..	4⅛-5
—— 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	86-91
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	1/32-5/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1 ..	11/16-13/16
—— 4½ p.c. Deb. Stock, Red.	100 ..	95-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 p.c. Gold Bonds	.. —	96-97⅛
Milwaukee Electric Rail and Light, 5 p.c. 30-yr. Con. Mort. Bonds (1926) 1-5,500 and 7,001-8,000.	$1,000 ..	103-105
Montreal Street Rail., 4½ p.c. Sterling Deb., 601-2,000 (1922)	100 ..	102-104
New General Traction, 6 p.c. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	⅛-⅜
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100 ..	100½-103½
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	⅛-⅜
—— 5 p.c. Cum. Pref., 300,001-545,000	1 ..	⅛-⅜
—— 4½ p.c. Debenture Stock	100 ..	86-89
Provincial Tramways Co., Ordinary, 1-24,912	10 ..	4-4⅛
—— 6 p.c. Cum. Pref., 1-10,000	10 ..	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5 ..	5⅜-5⅞
—— 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	99-101
San Paulo Tramway, Light, and Power Co.	$100 ..	146-146⅛
—— 5 p.c. 1st Mort Deb, Red. (1929) 1-12,000	$500 ..	101-103
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	⅛-⅜
—— 4 p.c. Deb. Stock, Red. (1940)	100 ..	70-74
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red., 1-1,600	100 ..	81-85
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5 ..	⅛-¼
—— 6 p.c. Cum. Pref., 1-46,261	5 ..	1⅛-2⅛
—— 4½ p.c. 1st Deb. Stock, Red.	100 ..	81-85

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100 ..	62-64
—— 4 p.c. Pref.	100 ..	8 -86
—— " " deferred	100 ..	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	101-103
City and South London, Consolidated Ordinary	100 ..	31-32
—— 4 p.c. Debenture Stock	100 ..	100-102
—— 5 p.c. Pref. Stock '91	100 ..	108-110
—— " " " '96	100 ..	10 -107
—— " " " '01	100 ..	100-103
—— " " " '03	100 ..	93-96
Liverpool Overhead, 5 p.c. Pref.	10 ..	4⅛-5
—— Ordinary, 1-50,000	10 ..	⅜-⅝
—— 4 p.c. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 p.c. 4½ p.c. Bds.	— ..	89

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price £
Amazon Telegraph Co., 1-25,000	10 ..	2⅞-3⅛
—— 5 p.c. Debs., Red., within 1-1,069	100 ..	93-96
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000 ..	96-144⅛
Anglo-American Telegraph Co., Ordinary	100 ..	60½-62½
—— 6 p.c. Preferred Ordinary	100 ..	103½-104½
—— Deferred Ordinary	100 ..	20½-21⅛
Anglo-Portuguese Telephone Co., 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	103½-105½
Chili Telephone Co., 1-44,000	5 ..	8-8⅛
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100 ..	90-92
Cuba Submarine Telegraph Co., Ordinary, 1 16,000	10 ..	8⅛-9
—— 10 p.c. Preference, 1-6,000	10 ..	17-18
Direct Spanish Telegraph Co., Ordinary	5 ..	3-3⅛
—— 10 p.c. Cum. Preference	5 ..	8⅛-8⅜
—— 4½ p.c. Debs., 1-600	50 ..	99-101
Direct United States Cable Co.	20 ..	12⅛-13⅛
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100 ..	99-101
Eastern and South African, 4 p.c. Mort. Debs., within 1-3,000 (1909)	100 ..	100-100⅛
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	25 ..	103½-105½
Eastern Extension, Australasia and China, 1-300,000	10 ..	11⅛-11⅜
—— 4 p.c. Mort. Deb. Stock, Perp.	100 ..	102-104
Eastern Telegraph Co., Ordinary Stock	100 ..	129-132
—— 3½ p.c. Preference Stock	100 ..	84½-85⅞
—— 4 p.c. Mortgage Debenture Stock	100 ..	104⅛-106⅛
Great Northern Telegraph Co. (of Copenhagen)	10 ..	26
Halifax and Bermudas Cable Co., 4½ p.c. 1st Mort. Debs., within 1-1,200, Red.	100 ..	99-101
Indo-European Telegraph Co.	25 ..	51⅛
Marconi's Wireless Telegraph Co., Nos. 256,128-384,190.	1 ..	11/16-13/16
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	13/16-15/16
—— 5 p.c. Preference, 1-86,492	1 ..	⅜-½
National Telephone, Preferred	100 ..	106⅜
—— Deferred Stock	100 ..	123⅛
—— 6 p.c. Cum. First Pref.	10 ..	10⅛-10⅜
—— 6 p.c. Cum. Second Pref.	10 ..	10⅛-10⅞
—— 5 p.c. Non. Cum. Third Pref.	5 ..	5 7/16-5 11 16
—— 3½ p.c. Deb. Stock, Red.	100 ..	98-100
—— 4 p.c. Deb. Stock, Red.	100 ..	100-102
Oriental Telephone and Electric Company	1 ..	1 5/16-1 7/16
—— 6 p.c. Cum. Pref.	1 ..	1 1/16-1 3/16
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100 ..	99½-101⅛
United River Plate Tele. Co., Ordinary, 1-100,000	— ..	7⅛
—— 5 p.c. Cum. Pref., 1-40,000	5 ..	5⅛-5⅜
—— 4½ p.c. Debenture Stock, Red.	100 ..	103½-105½
Telephone Co. of Egypt, 4½ p.c. Deb. Stock, Red.	100 ..	100-102
West African Telegraph Co.	10 ..	12⅞-13⅛
West Coast of America, 1-30,000 and 53,001-53,008	2½ ..	1⅛-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	99-101
West India and Panama Telegraph Co., Ordinary	10 ..	4
—— 6 p.c. Cum. 1st Preference	10 ..	8-8⅛
—— 6 p.c. Cum. 2nd Preference	10 ..	8 9
—— 5 p.c. Debs., Red., 1-800	100 ..	101-103
Western Telegraph Co., 1-207,935	10 ..	13 7 16-9 32
—— 4 p.c. Debenture Stock, Red.	100 ..	103⅛

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.						
	Ending	1909.	1908.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.
		£	£	£	£				£					
Aberdeen Corporation	Sept. 1	1,611	1,555	+ 56	— 600	27¼	27¼	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,946
Ayr Corporation	Aug. 21	506	487	+ 18	—	8	8	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	„ 7	2,770	2,650	+ 120	—	4·25	—	—	—	—	—	—	—	—
Birkenhead Corporation	„ 1	1,073	1,108	— 35	— 492	13·52	13·52	—	—	—	—	—	—	—
Birmingham Corporation	July 31	6,446	6,326	+ 120	—	56·792	—	—	—	—	—	—	—	—
Blackburn Corporation	Sept. 1	1,061	1,122	— 61	— 988	24·5	28·3	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,329	— 24	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	„ 1	2,210	2,500	— 290	— 990	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29¼	29¼	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912
Bradford Corporation	Aug. 28	4,762	4,586	+ 176	+ 2,114	98	98	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378
Brighton Corporation	Sept. 6	1,218	1,036	+ 182	+ 1,119	9·5	—	—	—	—	—	—	—	—
Bristol Tramway Company	„ 3	5,970	5,061	+ 909	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—
Burnley Corporation	„ 4	1,252	1,226	+ 26	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971
Burton Corporation	„ 5	265	287	— 22	—	10	10	„ 31	14,018	3,221,595	430,913	1·04	8·30	1,460
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—
Central London Railway	Aug. 21	4,473	6,528	— 2,055	— 14,059	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404
Charing X, Euston, & Hamp. Ry.	„ 7	3,695	3,515	+ 180	—	7·75	—	—	—	—	—	—	—	—
City and South London Railway	Sept. 5	2,970	3,102	— 132	+ 1,170	7·26	7·26	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 19	— 811	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477
Cork E. T. and L. Company	Sept. 2	504	485	+ 19	—	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—
Croydon Corporation	Aug. 20	1,693	—	+ 254	+ 798	11¼	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703
Darwen Corporation	„ 13	305	282	+ 23	— 202	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922
Dover Corporation	July 31	258	336	— 78	— 478	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—
Dublin and Lucan Electric Ry.	Sept. 3	166	151	+ 15	—	7	7	—	—	—	—	—	—	—
Dublin U.T.	„ 3	5,822	5,836	— 14	+ 1,234	54¼	54¼	—	—	—	—	—	—	—
Dundee City Tramways	„ 1	1,368	1,224	+ 144	— 422	—	20½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,871
East Ham Corporation	„ 4	977	860	+ 117	+ 3,210	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—
Glasgow Corporation	July 17	15,961	17,286	— 325	— 2,745	185½	179	May 31	907,494	226,048,290	20,766,722	·96	10·49	5,080
Gloucester Corporation	Sept. 1	310	287	+ 23	+ 559	15	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Aug. 7	4,130	4,480	— 50	—	9·25	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528
Huddersfield Corporation	„ 21	1,741	1,645	+ 96	+ 771	28½	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421
Hull Corporation	Sept. 4	2,685	2,429	+ 255	+ 1,689	29	26	„ 31	128,722	30,964,254	3,022,814	1·	10·22	—
Ilford Corporation	July 31	487	498	— 11	+ 687	10	10¼	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066
Ilkeston Corporation	Sept. 1	156	162	— 6	—	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803
Kirkcaldy Corporation	„ 1	279	271	+ 8	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856
Lancashire United Tramways	„ 1	1,319	1,350	— 31	— 565	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—
Leeds Corporation	Aug. 21	7,178	6,672	+ 506	+ 2,024	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527
Leicester Corporation	„ 21	2,288	2,183	+ 105	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	July 24	11,088	11,403	— 315	— 3,017	104	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508
Liverpool Overhead Railway	Aug. 1	1,452	1,481	— 29	— 72	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—
London County Council	„ 21	37,122	35,359	+ 1,763	+ 26,198	124	123½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—
Lowestoft Corporation	„ 17	216	258	— 42	— 743	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279
Maidstone Corporation	Aug. 28	206	190	+ 16	—	5½	—	—	—	—	—	—	—	—
Manchester Corporation	July 31	14,874	16,424	— 1,550	— 2477	181	181	—	—	—	—	—	—	—
Metropolitan District Railway	Sept. 4	9,069	9,045	+ 24	—	24	24	—	—	—	—	—	—	—
Metropolitan Railway	Aug. 22	13,951	13,839	+ 112	+ 1,658	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—
Nelson Corporation	Sept. 4	136	130	+ 6	— 85	2½	2½	Mar. 31	7,362	2,060,712	204,7·0	·85	8·63	1,907
Newcastle-on-Tyne Corporation	July 31	3,860	3,850	+ 10	— 1,416	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504
Newport (Mon.) Corporation	„ 31	672	713	— 41	— 382	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—
Reading Corporation	Sept. 2	644	651	— 7	— 103	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Aug. 2	4,551	5,379	— 825	— 3,017	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	July 18	5,718	5,528	+ 190	— 1,112	68½	66½	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225
Southampton Corporation	Sept. 1	1,223	1,151	+ 72	— 421	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—
Southend-on-Sea Corporation	Aug. 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—
Swindon Corporation	Sept. 1	154	157	— 3	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 17	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—
Wallasey U.D.C.	Sept. 4	978	939	+ 39	+ 523	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Aug. 12	2,449	2,175	+ 274	+ 2,636	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417
Wolverhampton Corporation	Sept. 1	771	815	— 44	— 950	20	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190

a Train miles. *b* Half-year's figures.

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NOTES.

ELECTRICAL BREAKDOWNS.

Mr. Michael Langridge's report on the causes of breakdown in electrical machinery occurring during the past twelve months is decidedly calculated to further the suggested maintenance contract scheme. He attributes about 50 per cent. of breakdowns to age and deterioration of machinery, and dirt and neglect. As much as 25 per cent. was caused either by faulty design or bad workmanship. There was little overloading, and pure accidents accounted for under 10 per cent. of the reported cases. Dealing with motors, it would appear that the alternating current has a slight advantage over direct current, for although the former shows weakness as regards the stationary coils, this is counterbalanced by the advantage by the weakness of the commutator used on direct current motors. The high percentage attributed to breakdowns from "age and deterioration," and "dirt and neglect," would seem to show that supervision is urgently needed. Certainly, in the case of smaller motors, the "engineers in charge" are rarely men who have any knowledge of electricity. Under maintenance contracts, of course, defects would be seen to at once, and both the supply stations and the consumers would feel the benefit. There is much to be said in favour of such a policy, which would do wonders in popularising the use of electricity for domestic purposes and in small industries.

WELSH HYDRO-ELECTRIC SCHEMES.

In our leader columns we deal with a great project for the supply of electricity to Paris from the far distant Rhone. In view of what we recently had to say about small stream power, it is instructive to give a few particulars of the Newcastle Emlyn scheme. This flourishing little Cardiganshire borough is on the banks of the river Teifi, a by no means formidable stream, yet it has been found sufficient to work turbines which will transmit the power hitherto running to waste to the dynamos, which will generate electricity sufficient to light all the streets and public buildings and to provide the inhabitants with electricity for light and power. It is a very neat little scheme, and one which might serve as a model to many other places similarly situated.

ELECTRIFICATION OF THE FINNISH RAILWAYS.

In Finland, where less than 7 per cent. of the 3,000 miles of railways is owned and run by companies, the problem of electrification is being closely studied. While a future general working by electricity is looked forward to, the immediate project only provides for the conversion of the line between St. Petersburg and Helsinfors, as this goes through the most thickly populated part of the country, and carries the greatest passenger and goods traffic. Then there would follow a branch between Viborg and Autica. The total distance thus allowed for is about 300 miles. The power would be derived from the falls of Wallinkoski, on the river Wuoksen, the outlet of the Saima lake. This gives a fairly constant flow of 410 cubic metres per second, with a fall of 10½ metres. It is proposed to use single-phase transmission at 40,000 volts with a periodicity of 25, the motors being single-phase with a voltage of 12,000. There will be 14 sub-stations, each with three or four transformers, and a maximum of 1,500 kilovolt-amperes per transformer. After allowing for all charges it is expected that a saving of considerably over £50,000 a year would be effected by this change.

ELECTRICITY IN THE HOSPITAL.

Not unnaturally, the majority of medical men in the United Kingdom are turning their attention to St. Bartholomew's Hospital, for the electrical department there has recently been enriched by the introduction of a Von Lepel generator. It is the first, so far, put into use over here, and is intended to cure rheumatoid arthritis and other diseases of the articulations. By means of a transformer a current of low frequency is stepped up to a sinucoidal current of high frequency. The electrodes consist of copper discs, which are brought into contact with the bare skin at the desired points. The current is controlled by means of a pedal arrangement, the operator thus having his hands free, and is able to watch the patient and the ammeter. Under the control of Dr. Lewis Jones, the Von Lepel instrument is already giving promise of success in rheumatoid cases, and is being tried in the treatment of paralysis. The instrument and treatment are too new for one to venture the prophecy that these appliances will become part of the obligatory equipment of every hospital and surgery, but, if Continental experience is confirmed over here, this will only be a question of time. Once more the electrician will have conferred an immense boon on humanity.

ANOTHER ELECTRICAL EXHIBITION.

The Boroughs of Shoreditch, Stepney, and Hackney are combining in the organisation of a Municipal Electricity Exhibition at the Pitfield-street Baths, Shoreditch. On a previous undertaking of this kind, over 24,000 people visited the show in twelve days. It is hoped to do better on this occasion. Shoreditch does very well with its electricity department, which not only supplies light to a goodly number of its ratepayers, but also power for numerous motors run in both big and small workshops. Hackney is also well satisfied with its electricity works, where part of the steam is raised in boilers placed over the refuse destructor furnaces.

HYDRO-ELECTRICITY FOR THE COLONIES.

The brief details of a successful hyrdo-electrical scheme carried out by Mr. Chalmers in Nyassa-land, should be carefully studied by our colonial readers, for it affords a practical example of what may be done under difficult circumstances even in a sparsely inhabited country. We often hear of hydro-electrical schemes in connection with mining or other considerable industrial undertakings, but it is far more rare to find a well thought-out scheme such as this, to supply the domestic requirements of a "savage" land. What was applicable to this case in Nyassa-land would be equally so in many other out-of-the-way places, bringing immediate comfort and hastening prosperity.

STORAGE BATTERIES FOR CRANE WORK.

Although in simplicity of construction there is no comparison between the hydraulic accumulator and the storage battery, the latter more than holds its own in crane work. Indeed, it is likely that the principal business for storage battery makers in the near future will be supplying accumulators for industrial operations where hitherto the hydraulic accumulator has had the field to itself. A reversible booster with a storage battery was installed by Johnson and Phillips for crane work on one of the London docks about 12 years ago and since then the idea has been copied wholesale. At Southampton, for example, there is an installation equipped with a Lancashire Dynamo Co's booster and a large D.P. storage battery. The cranes

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have replaced some hydraulic cranes and they have a capacity of 1½ tons and are capable of loading and unloading at an average rate of one ton per minute. When the cranes are working simultaneously the average current is 250 amperes or 500 volts, but there are times at starting the grabs when as much as 800 amperes are required. The generating plant consists of a gas producer engine and dynamo capable of giving 190 amperes at 520 volts, with a 15 per cent. overload. The D.P. battery will give 500 amperes for one hour or 1,000 amperes for short periods and in conjunction with the reversible booster its effect is to keep the dynamo load within 15 amperes of the mean, whereas the load on the cranes varies from zero to 800 amperes. One advantage which the electric accumulator has over the hydraulic is that its capacity is much greater; the above mentioned battery will keep the cranes going for 3 hours.

THE SHELVING OF A BIG IRRIGATION AND ELECTRIC POWER SCHEME.

Victorian papers recently to hand state that the Trowood dam scheme for irrigation and electric power has been shelved. This scheme, first proposed by Mr. Coane, of Melbourne, and Mr. E. Kilburn Scott, late of the University of Sydney, was one of the biggest of its kind. A dam, 180 ft. high and about one-third of a mile long, would have impounded more water than the Assouan dam in Egypt, and the water would not only have irrigated a large tract of country, now feeding about a sheep to the acre, but would have also developed over 10,000 h.p. The sale of current would therefore have gone a good way towards covering the interest charge on the hydraulic works, thus cheapening the cost of water to the irrigators. As Trowood is only 60 miles from Melbourne and Ballarat, there would have been no trouble in disposing of the power. It is too good a scheme to be pigeon-holed for ever. Some day, when the people of Australia really awake to the possibilities of their country it will be carried out. Trawood, like many other suggestions, has been made a counter in petty political strife; seven Parliaments of paid gas bags misrule the destinies of four millions of people. Australia is a big country and requires men with big ideas and a broad outlook to govern it; but this is not the type that cares to enter its petty self-centred Parliaments. The result is that the country is governed by the Coolie class, as a shrewd Japanese observer has stated.

OUTDOOR SUB-STATIONS.

Among the more remarkable developments of long distance transmission of power, the outdoor sub-station may be mentioned. On the Niagara Lockport and Ontario Power Co's system there are no less than six 60,000 volt outdoor transformer stations, and since October, last year, when they were set to work, they have not given any trouble. By doing away with a building there is considerable saving, because the partition cells and conduits disappeared along with the walls and roof, windows, doors, etc. One wonders what the Board of Trade officials would do if outdoor 60,000 volt sub-stations were proposed in Enlgand. Judging by the difficulty in getting permission for bare overhead mains at 10,000 volts, they would be horrified. In America and Canada no restrictions are placed on the engineer and so problems are tackled in most original ways and there is great progress. It is probable that the development of apparatus for outdoor sub-stations will have the effect of very considerably simplifying apparatus for indoor stations and making the walls and roof what they ought to be, namely, a mere shell.

COST OF SUB-STATION.

An indoor sub-station for 40,000 volts and over is an absurdity, because not only is the cost of the building excessive but there is also great expense in making contact apparatus to go within the four walls of the building. Directly the apparatus is placed outside all this trouble disappears. One of the difficulties power transmission companies are up against is that they have to keep tapping off comparatively small blocks of power, and it costs practically as much to build and equip an indoor sub-station for 100 k.w. at 40,000, as it does for 1,000 k.w. at the same pressure. It is the 40,000 volts that has to be taken care of all the time.

NOVEL FORM OF MAINTENANCE CONTRACT.

The Haslemere and Hindhead Electric Lighting Co. has put forward a novel form of maintenance contract as a condition of their extending operations at Haslemere. The proposition is that a charge of 2s. 6d. per quarter per lamp should be made, and that every house connected should have a minimum of four lamps. Moreover, the tenants or owners would have to agree to pay for a period of three years, whether the premises were occupied or not. On the face of it, this long term hardly seems a proposal that is likely to popularise electricity in the neighbourhood, but the principle involved is a sound one, even though it be a return to old methods.

RADIO-TELEGRAPHIC DEMONSTRATION AT CULLERCOATS.

[From our Correspondent.]

On Saturday and Monday, the 11th and 13th inst., an interesting demonstration of Dr. Valdemar Poulsen's radio-telegraphic apparatus was held at the Cullercoats Radio Telegraph Station, Whitley Bay, near Newcastle-on-Tyne, in order to illustrate the special advantages of the Poulsen system in regard to automatic high speed wireless transmission. This was attended by a considerable number of gentlemen representing the various interests connected with telegraphic work, including Major S. C. Long, of the Signalling Corps; Mr. H. A. Kirk, representing the India Office; Mr. Arthur Silvertop, representing the Admiralty; Lieut. Arthur Rice, R.N., of H.M.S. "Vernon"; Mr. Preece, of Messrs. Preece & Cardew, representing the High Commissioner of New Zealand; Mr. F. Ryan, representing the Eastern Telegraph Co.; Mr. John Mitchell, representing Sir Somerset French, the Agent-General for the Cape of Good Hope; Captain Ellershaw, of the Aldershot School of Signalling; Lieut. F. G. Loring, R.N., representing the General Post Office; Mr. G. E. Taylor, representing the Engineer-in-Chief's Department of the General Post Office; and representatives of the Orient and other lines of steamships. From this it will be seen that the audience attending the demonstrations was of the highest importance, and the apparatus is well worth all their attention.

It will be remembered by our readers that in May of this year Mr. Aage S. M. Sorensen, who is the Engineer-in-Charge of the Radio Telegraphic Station at Cullercoats, read an informal paper before the Newcastle Section of the Institution of Electrical Engineers, in which the Station was generally described, and it will not be of advantage to duplicate this general description. At the end of his remarks, however, he referred to some very interesting experiments with telegraphic printing, by means of which messages had been transmitted between Lyngby and Esbjerg, in Denmark, at speeds up to 300 words per minute; while Cullercoats had been in communication with Lyngby up to the rate of 100 words per minute. This announcement created great attention at the time of the meeting, and the present demonstration is the confirmation of this statement.

Mr. Poulsen was well aware of the fact that one of the greatest obstacles to the commercial adoption of wireless telegraphy was the fact that even a good operator could not transmit more than about 30 words per minute, unless he was assisted by some means analogous to the high speed printing machine in use in connection with copper conducted telegraphic messages, and the present invention is the means of overcoming this difficulty. It consists essentially of a receiver, which in the present experiment was located at Cullercoats, and a transmitter, of which there is only one at present in existence, located at Lyngby. Photographs of this transmitter were on view at the demonstration, but the apparatus is not at the moment available for complete technical description. In the meantime, however, it may be indicated that it consists of a series of rotating commutators, three in number, one of which has a comparatively large number of alternate conducting and insulating segments, and which is reserved for the dots in the Morse Code, while the other two discs have longer spacings of commutator segments, and are kept for the dashes. Mounted on the same axis as these commutators is the tape moving

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device, consisting of a species of sprocket wheel, which engages with a central line of punch holes in the tape, moving it along at a regular rate. On either side of these punch holes, however, are other holes punched by hand in the tape corresponding to dots on the one side and dashes on the other. The tape gear wheel has certain light radial pins, which tend to fly out except when they are retained in position by the tape. Where, however, a hole occurs they are allowed to spring outwards. As these pins are mechanically connected to larger pins on a further attachment to the spindle, these larger pins also fly out when permitted to do so by the tape.

Adjacent to these last-named set of pins are spring contacts, by means of which circuit is closed when the springs are struck by the projecting pins. These contacts are, however, in series with another set of brushes which press on the segments of the first three wheels mentioned, so that all actual making and breaking of the current is carried on on these larger segments, while the tape controls the whole apparatus by means of the lightest possible form of mechanical construction. By this means the effect of inertia is brought to its lowest limit. There are 72 pins, each representing a dot and a space. As in our telegraphic code, one word has an average of five letters, it is possible to transmit three words for one turn of the transmitting combination, and the speed of the machine (which is driven by an electric motor) can be varied between the limits of ordinary hand speed and a transmission of 200 or more words per minute.

By means of this apparatus messages, which have been previously punched on the tape, were transmitted in the demonstration from Lyngby to Cullercoats; the highest speed obtained being about 140 words per minute. Everyone was pleased with the clearness of record obtained when a speed of 92 words per minute was being maintained. The apparatus at Cullercoats receiving the signal consists of an Einshowen galvanometer, which is an arrangement of the galvanometer principle, whereby a very fine platinum wire of 400 ohms resistance is placed in a strong magnetic field and is deflected by the passages of minute impulses of current obtained from the detector. The wire is moved in front of a slot, and this slot is photographed through a microscope together with the moving shadow of the wire on a strip of sensitive paper. The light source which was used in the experiments was that of an ordinary Nernst projector lamp. The photographic tape was automatically developed and fixed; records being obtained, which were easy to read, practically immediately after the message had been received by the detector. It takes on an average 2½ metres of tape per 100 words, and the spool carrier of the instrument carries 70 metres of prepared tape.

The practical limit of speed of reception has not yet been obtained, as in Denmark 300 words per minute have been transmitted over 200 miles, while between Cullercoats and Copenhagen the rate has reached 125 to 150 words.

Incidentally, the demonstration showed the great selectivity of the Poulsen system, and during the whole of the experiments no trouble occurred through outside disturbances, as these appear to be reduced to a minimum. It is possible by means of the Poulsen system of working with an arc in an atmosphere of hydrogen to tune the receiving and sending apparatus to within a fractional percentage. Another point which was evidenced was the great speed of signalling which it was possible to obtain, and nothing more need be said upon the subject than a reference to the speeds mentioned above. A fourth point, however, which is worth bearing in mind is the slight expenditure of energy and the greater facilities so far as insulation is concerned, owing to the comparatively low electric tension employed, together with the very high frequency of the impulses. This makes the handling of the apparatus comparatively safe, while the small energy expended means economy in power and in space, which is a very important factor in ship installations. It should be remembered that the Cullercoats installation is chiefly employed in signalling to ships, and in this connection it has been found possible to signal to a boat on one of the American lines over a distance of 2,400 kilos., with an expenditure of only 6 kw. in the ship station.

We hope next week to be able to furnish photographs and one or two further particulars concerning this most interesting demonstration.

THE THURY D.C. SYSTEM AND ITS DEVELOPMENTS.

The well-known "Series" direct current transmission line from Moutiers to Lyons, which has been in operation since 1905, has proved such a remarkable success that very important developments are to be carried out on the same lines.

The generating station itself is situated near to Moutiers (Savoy), and takes its power from the River Isere. The generating plant being high tension direct current machines and high tension alternators. The total h.p. of d.c. high tension plant at present is 6,400, and is transmitted at a pressure of 57,600 volts to Lyons, a distance of 180 k.m. by means of 2 conductors of 9 m.m. diameter. Parallel to the continuous current line is a three-phase line going to the same point. At Lyons, the d.c. energy is utilised in a number of motor generators. The series system has not only demonstrated its elasticity, but has proved to be so reliable and easy to operate that the companies have decided to immediately carry out extensions on a large scale.

A generating station is to be erected at La Bridoire (Savoy) in which three generating high tension d.c. units will be installed, each of 2,000 h.p. at 428 r.p.m. They will operate at a current density of 150 amps., a pressure of 8,000–9,125 volts. A second generating station on the Roziers at Bogel (Savoy) will consist of:—2 generating groups, each consisting of 2 double machines driven by the same turbine and capable of giving an output of 3,500–4,000 h.p. at 428 r.p.m., and delivering current at a density of 150 amps., and a pressure of 16,000–18,250 volts. A corresponding amount of d.c. motor-generator plant will be placed in the Vaulx-en-Velin sub-station.

The total capacity of the direct current high tension generating plant, when the extensions are complete will be 15,000 k.w., and the three generating stations connected in series will deliver 150 amps. at 100,000 volts.

This will be a notable development, as for the first time in Europe an operating voltage of 100,000 volts will be reached, and it is claimed that this pressure is not the limit which can be achieved on this system.

METROPOLITAN RAILWAY COLLISION.

MISTAKE IN THE SIGNAL.

Lieut.-Col. E. Druitt has reported to the Board of Trade the result of his enquiry into the causes of the collision which occurred on the 5th ult. between two passenger trains at Moorgate-street, on the Metropolitan Railway. Three passengers were slightly injured in the collision, but the damage to rolling stock was slight, and there was no injury to the permanent way. The 5.44 p.m. train *ex* Neasden was standing at the up platform at 6.16 p.m. on the day in question, when the 5.47 p.m. train *ex* Hammersmith ran into it from the rear. "There is no doubt from the evidence," says the Inspector, "but that the up home signal was 'off' for the second train, though it should have been 'on,' as the first of the two trains was still in the section just ahead." The system of signalling in use is known as the Johnson All-Electric Automatic and Semi-Automatic Power Signalling System. It was installed by the McKenzie, Holland & Westinghouse Power Signal Co., Ltd., and it is still in their hands for maintenance. It was brought into use at Moorgate-street on July 4 last, though it has been in operation at Praed-street Junction since July 26, 1908. The home signals at Moorgate-street are of the semaphore type, being in an open cutting, and operated by Johnson's Patent Oil machines, and are semi-automatic. At the time of the collision the levers in Moorgate-street signal-box were pulled over, and the signals were working automatically. There is an illuminated diagram in the cabin, but it is not part of the duty of the man in the signal-box to watch it, though it shows the condition of the track circuits approaching the station. After the collision, the oil machine which worked the signal rod was examined by Mr. H. G. Brown, the chief engineer of the Power Co., who is of opinion that the probable cause of the signal remaining in the clear position was an accumulation of sediment in the oil which caused the release valve to stick, and so prevented the signal going to danger when the magnet controlling the release valve was de-energised by the track circuit being interrupted by the presence of the first train in this section. Mr. Brown states that this release valve is to be re-designed, and all the signals actuated in a similar manner, 18 or 19 in number, will have new valves fitted to the oil machine. In the meanwhile, the company state that all these signals are being watched to see that they go to danger after the passage of a train, and they will be watched until the contemplated alteration in the pattern of valve has been effected, and found by practical working to be satisfactory.

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INTEGRATING WATTMETERS ON CARS.*

By THOMAS W. HINKLE, Electric Service Supplies Co., U.S.A.

Electric railway companies are spending large sums of money in building modern power plants and equipping them with efficient machinery, but after the power goes out to the line no record is kept of it, and the motorman uses it either wastefully or economically, depending upon his intelligence and care. There is a great difference in motormen in the use of power, and it is my belief that if wattmeters were installed they would pay for themselves in a short while. Where integrating meters have been installed on various cars some very valuable information as to the relative efficiency of different men in handling the cars have been obtained.

With wattmeters installed on every car on a particular line or system, the total kilowatt-hours used would thus check against the station output, the difference between the totals being in transmission loss, leakage, etc. This is analogous to the comparison obtained between the total readings of the consumers' meters in electric lighting service with the station output meters, and it has been found in such service that this comparison often affords the most accurate, and really the only, method of picking out and hunting down undue losses in transmission, etc. Even with a few meters, shifted at intervals of a week or so from one car to another of a line, a series of readings could be obtained during the course of a few months, which would give a fairly good check of total car consumption against station output. This method might be practically as satisfactory, and considerably less expensive, to a railway company desiring to investigate the matter, as installing meters on all cars.

Under the present methods of inspection of equipment, motor troubles, bad brake adjustment, condition of bearings, gears and pinions, etc., are quite readily found if the road employs careful inspectors. All of these troubles, and many others which are hard for inspectors to locate, will cause undue friction and necessarily cause the car to consume too much current, but by the use of wattmeters any excessive current consumption will readily be found. That car can then be taken to the barn and the trouble eliminated, whereas without the meters the car would run indefinitely before the trouble was found.

Another use of wattmeters is in checking the relative efficiency of different equipment operating on the same line under the same condition, and comparing energy consumption on different lines of the same system.

There are also now on the market integrating ampere-hour meters, which show ampere-hours of current consumption in any circuit, entirely irrespective of voltage, differing in this respect from integrating wattmeters.

Some interesting tests have been made within the past year by different operating companies on transmission and line efficiency by using both ampere-hour and watt-hour meters on cars Such a combination is, of course, only recommended for special tests, as it would be unnecessary and undesirable to install ampere-hour meters on cars as a general thing. The special test referred to is based on the idea that if the ampere-hour consumption of a particular car on a certain line, or section of line, is multiplied by the average station voltage during the period of a test the watt-hours thus obtained will be the station output required for that particular car, operating over the section of line during which readings have been taken. If, in the same car, a suitable integrating wattmeter is installed, its readings will show the true watt-hours consumption of the car, and the difference between the volt-ampere-hour reading and the watt-hour reading on the car will be the loss in transmission from the station for that particular car and section of the line. By taking a series of such observations with two or three different cars on various sections of line at different conditions of traffic, it has been found possible to obtain valuable data as to conditions of transmission line efficiency, of sub-stations, feeders, etc., for different lines and sections of lines.

*Abstract of Paper presented at meeting of Central Electric Railway Association, Detroit.

Until about three years ago there was no integrating wattmeter suitable for this purpose—that is, which would withstand the severe conditions under which a meter on a car has to operate. Later, special wattmeters were brought out for this work, but owing to certain inherent and unavoidable features of their construction, their use was principally confined to special test cars, or on cars where precautions were taken to eliminate as far as possible the effect of vibration and jar on the meter. On account of the special care required in the use of the meters and their expense, their application in electric railway work was very limited until during the last few years, when meters have been brought out which are so constructed as to withstand without any injury whatever the most severe conditions of street railway operation.

The mercury type meter has proved the most successful and accurate, I believe, for this class of work.

In general, a mercury meter consists essentially of a cylinder or disc-like motor element partly or entirely submerged in mercury, so that current can be led in and out from this element by the mercury through fixed metallic contacts set in the walls of the chamber containing the mercury and disc. The reaction of current passing radially or diametrically across the armature—that is, the metallic rotating element—with a magnetic field properly set with respect to the armature, will cause rotation, and this rotation will be proportional to the amount of current passing through the armature.

When operated on direct current, the main current passing to the load, or a proportional part of it, passes directly through the armature or the motor element. The poles of the field magnet are located in close proximity to the armature disc, and the field set up in this magnet by the shunt coil is proportional to the voltage of the circuit. The current passing through the armature, therefore, is acted upon by this field. As the current through the armature is the load current, or a fractional part of it, the torque or rotative effect produced upon this current by the field is proportional to the power or watts, and the rate of rotation of the armature becomes a measure of the power passing through the metering device at any instant. In fact, this meter is nothing more or less than a *small and delicate* direct current motor, having an armature equivalent to a single turn—that is, the current passes once across the disc—and having a field with two air-gaps, similar to an ordinary bipolar motor. The mercury at the edges of the armature carrying current to and from the contact, corresponds in a sense to a commutator of the usual motor.

The armature, or rotating element, is made with a central dome or float, so that the total displacement when immersed in mercury is sufficient to buoy up the entire rotating system, including a damping disc outside of the mercury chamber, so that the difference between the true weight of the rotating system and this buoyancy effect is only about 1-10 ounce. This, then, is the effective weight or pressure upward against the top bearing jewel. This weight or pressure upon the jewel is less than one-fifth that in any other type of meter, and as the armature is completely immersed in mercury, any jar, vibration or shock upon the meter is absorbed by the mercury, so that there can be no sudden motion of the armature vertically. Therefore, the pounding and jarring of a car cannot injure the jewel in this meter, thereby impairing its accuracy.

Another good point in favour of meters of this type is that lightning has less effect on it, as the enormous choking effect of the shunt coil on its iron core protects the meter against any alternating or oscillating discharge like lightning.

Another very important and convenient feature of this type of meter is the fact that it can be operated by a shunt, allowing only a portion of the load current to pass through the meter. This enables the meters to be made smaller and more compact, and they can be located at any convenient, out-of-the-way place on a car, and connected to the shunt by small leads. Since the introduction of meters of this type their use has become quite general by a number of large operating companies in the cities and by a few of the large interurban companies, but as yet the majority of railways have not realised the valuable information which can be obtained by a proper and intelligent use of integrating wattmeters on cars.

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THE ELECTRICAL PYROMETER.

By FRANCIS H. DAVIES, A.M.I.E.E.

Prior to the introduction of the electrical pyrometer, the accurate measurement of high temperatures presented numerous difficulties. Generally speaking, it was necessary to be satisfied with very approximate results, obtained with apparatus which although often ingenious, was comparatively clumsy and uncertain in its action. To appreciate what electricity has done for thermometry, it is only necessary to review some of the early methods of high temperature measurement such as those employed in the Daniel Pyrometer, the Siemens Water Pyrometer, and the more familiar Thalpotasimeter. The first of these depended on the expansion of a rod of platinum or soft iron, enclosed in a blacklead case and fitted with a porcelain index. The whole apparatus was placed in the furnace, and the expansion of the rod, which was relatively greater than that of the black lead, resulted in the index being pushed forward in proportion to the temperature of the furnace. When removed, the position of the index afforded an approximate idea of the greatest temperature to which the pyrometer had been subjected. The Siemens Water Pyrometer, which must not be confused with the electrical instrument to be mentioned later, was more accurate than

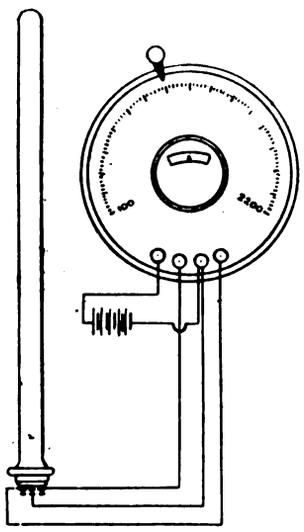

FIG 1.

the Daniel; it, however, possessed several obvious disadvantages. With this instrument the temperature of a furnace is ascertained in the following manner: A copper, iron or platinum cylinder is placed in the furnace and left there from two to ten minutes in order that it may attain the full temperature. It is then taken out and dropped into the pyrometer, which contains in a carefully lagged vessel one pint of water. A thermometer is fixed in this vessel, and the heat given out by the cylinder is recorded upon it, serving as a basis for determining the temperature of the furnace. The Thalpotasimeter is a more practical piece of apparatus, but it possesses the disadvantage, when compared with modern instruments, of having to be fixed, dial and all, to the pipe or furnace of which the temperature is required. It is obvious that such an arrangement is in many cases by no means so convenient as one which allows the recording part of the instrument to be placed in a position better suited for observation. The construction of the Thalpotasimeter is very simple. It consists of an ordinary Bourdon pressure gauge attached to a hollow metal stem, which latter projects into the furnace or pipe through a gland. The stem is filled with mercury, water or ether, according to whether the temperature it is required to measure is high, medium or low. In the respective cases the temperature ranges are: mercury, up to 1,400°F; water, from 212° to 680°F; ether, from 100° to 220°F. Its action depends upon the fact that at certain temperatures the substance with which the stem is filled is converted into a gas, the pressure of which corresponds to the temperature it is exposed to. The pressure is, of course, recorded by the gauge which is calibrated direct in degrees Fahrenheit or Centigrade, as the case may be.

The foregoing cursory *resumé* of early practice will suffice to show the difficulties under which high temperature measurement was carried out until a very few years back. Accuracy as it is known to-day was not looked for, and efficiency and good work were left to a great degree to chance or rule of thumb. It is, perhaps, not generally appreciated that in many chemical and allied processes employing intense heat it is not only convenient but, in the light of modern practice, essential, to know very closely the temperature at which work is being carried out. For instance, 5 or 6% will make all the difference in the

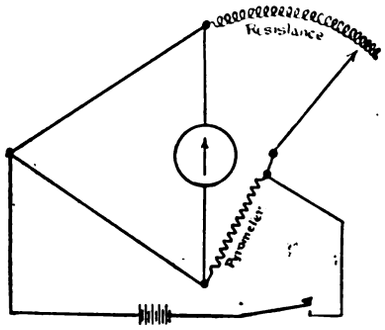

FIG. 2.

hardening of high speed tool steel, and there are numerous other cases in which accuracy down to 1% is desirable in the interests of cheap production.

The electrical pyrometers now on the market may be divided into three classes, resistance, thermo-electric, and radiation types.

Resistance Pyrometers.—No better example of these can be chosen than the instrument manufactured by Messrs. Siemens Bros. & Co. It is accurate to within a fraction of 1%, and simple in its operation, which is dependent upon the effect of temperature on the resistance of a platinum wire spiral. In one form the variation of resistance is measured by means of a special wheatstone bridge calibrated in degrees Fahrenheit. Fig. 1 is a diagram of this apparatus, and Fig. 2 shows the electrical connections. The platinum wire is wound upon a cylinder of refractory material and placed in a long closed tube, which is subjected to the heat it is required to measure. Round the edge of the circular dial is arranged a helical coil of wire, over which runs a contact arm fitted with a pointer reading on the scale. As shown, the galvanometer is in the centre, and when the contact arm is in such a position that upon pressing the key no deflection is obtained, the temperature is as indicated by the pointer. Pyrometers of this class possess the advantage of great accuracy and a wide range; they are, however, expensive, and are not generally employed for work of a rough nature.

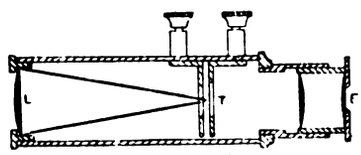

FIG. 3.

Thermo-electric Pyrometers.—These instruments are not so sensitive as those of the resistance type, and, generally speaking, require more frequent calibration. Their special field lies in practical engineering work, such as power stations, where they are employed for ascertaining flue and steam temperatures, kilns, hardening and annealing furnaces and the like. An excellent example is the direct reading thermo-electric pyrometer, made by Messrs. Crompton. It is essentially a simple piece of apparatus, consisting only of a thermo-electric couple, an indicating instrument which is an ammeter calibrated to read in temperature, and a pair of wires connecting the two. According to the temperature at which the pyrometer is to be used, the couple is composed either of nickel and steel or constantan and copper. The former is employed where it is necessary to go as high as 1,100°C, the latter where 500°C is about the maximum. In the high temperature instrument the steel tube forms one half of the couple, the other half being supplied by a nickel rod passing clear down the centre of the tube and welded to it at the extreme end, which, of course, is the point at which the temperature is measured. From the terminals at the end of the

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pyrometer, wires of nickel and steel are connected to their respective similar elements and run to the indicating instrument, which thus forms the cold junction of the circuit. These wires may be of any reasonable length, but if too long, as supplied, should not be cut, as the resistance of the circuit would thereby be altered and the accuracy of the indications impaired. It is obviously best to employ wires of a similar material to the couple, as by this means there is no risk of a disturbing influence due to a second thermo-electric couple in the circuit. An interesting point about the Crompton pyrometer is the scaling of the indicating instrument, which is so arranged that error due to atmospheric temperature variations is eliminated. The current generated by a thermo-electric couple depends greatly upon the difference in temperature of the hot and the cold junctions. If, as in this case, the temperature of the cold junction is apt to vary over a comparatively wide range, the indications with equal furnace heat would not always be the same, and the instrument would be useless for anything approaching accurate work. The difficulty is met in a very simple and effective manner. On the face of the instrument is a small thermometer which shows what is practically the temperature of the cold junction. The indicator is scaled in several arcs, each of which corresponds to a certain point on the thermometer, and in reading, the scale indicated by the latter is used. Between the atmospheric temperatures of 10° and 30°C there is a difference of over 100°C in the indications of the instrument, which proves the necessity of several scales. In installing this apparatus, care must be taken not to fix the instrument in too close proximity to iron, such as a girder or pillar, as this will affect the accuracy of its readings. Also, for obvious reasons, as cool a place as possible should be chosen.

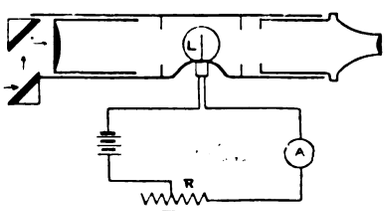

FIG. 4.

Radiation Pyrometers.—As its name implies, the radiation pyrometer measures the temperature of a furnace or its contents by means of the light radiated. A well-known example is that due to Fery, which is illustrated in diagram in Fig. 3. By means of the fluorite lens L the image of the radiant object is formed on the receiving surface T, the temperature of which is ascertained by a thermo-electric couple and suitable galvonometer. After being calibrated, this gives a direct indication of the heat of the radiating object. To allow of proper focussing, the instrument is made in telescopic form and equipped with an eye piece E, as shown. Provided that the body observed is not too small, the Fery pyrometer is accurate within 1%. The type described is not suitable for temperatures below 900°C., owing to lack of sensitiveness, but an improved instrument is made by means of which it is possible to get down to 600°C. Fig. 4 is a diagram of the Holborn & Kurlbaum optical pyrometer, which although of the radiation type, achieves its end by different means. The instrument takes the form of a telescope, and receives the image of the radiant body in its focal plane. As shown, in the centre is fixed a small incandescent lamp L, the brightness of which is controlled by the rheostat R, while the current taken is recorded on the ammeter A. In operation, the luminosity of the lamp is varied until the filament is indistinguishable from the image as seen through the eye piece. At this point the ammeter is observed, and from the reading obtained the temperature of the radiating object is calculated. Necessarily, this instrument requires very careful standardisation, and to achieve accurate results some considerable experience in its use. The advantage of all radiation pyrometers is that in no part do they come in contact with the temperature they measure. For classes of work employing excessive heat they are for the most part accurate, and, for obvious reasons, more suitable than instruments of which the essential part is exposed to very high temperatures.

ELECTRIC REDUCTION OF IRON ORE.*

By JOSEPH W. RICHARDS.

In order that one may understand thoroughly the problems arising in the reduction of iron ore by carbon in an electrically heated furnace, he should first of all have a clear idea of how this reduction proceeds in an ordinary non-electrical blast furnace.

The iron ore contains iron oxide, with silica and clay as usual impurities, and more or less moisture; its phosphorous content may be low or high, but its sulphur content must be low, not over 0·5%. If the ore carries over 1% of sulphur it is given a preliminary roasting. In the furnace, perhaps 99% of the iron oxide is reduced to metallic iron, 10 to 20% of the silica is reduced by carbon to silicon, which combines with the iron, all of the phosphorous is reduced into pig iron, and a varying proportion of sulphur, this proportion being smaller the more basic the slag is made with lime and the higher the running temperature.

Flux is added to make fusible slag by combining with the unreduced silica and the clay in the ore. Limestone, unburnt, is the usual flux, but magnesian limestone, carrying $MgCO_3$, is quite commonly used, the magnesia increasing the fusibility of the slag if not in greater proportion to the lime than the proportions $_2CaO.MgO$. The amount of flux added is variable; it depends on how basic the slag must be made. If the fuel is coke, and, therefore, considerable sulphur comes into the furnace, the slag formed must be nearly half lime and magnesia, to make low sulphur pig iron; if the fuel is charcoal, carrying almost no sulphur, and the ores carry none, the slag may be only one-third lime and magnesia and two-thirds silica and alumina, and make best quality pig iron. Such slag costs less for flux, and is more fusible than the basic lime slags.

Fuel is needed to provide heat and reducing effect. The heating effect is almost entirely produced by the combustion of the larger part of the fixed carbon (non-volatile carbon) of the fuel to carbon monoxide (CO) before the tuyeres. This combustion fills two functions: it provides the high temperature necessary to melt down the iron and slag, and it provides large quantities of reducing gas, practically identical in composition with producer gas (30 to 35% CO, 1 to 2% H_2, rest N_2), which performs in the upper part of the furnace the larger part of the reduction.

The amount of fuel used in a blast furnace is determined by the amount which must be burned at the tuyeres to produce the necessary smelting temperature, and not by the amount necessary to perform the reduction of the metallic oxides. The amount necessary for performing the reductions taking place in the furnace is only one-third to one-half of the amount necessary to be burned to provide the smelting heat. That this statement is true of the ordinary blast furnace may be seen from the fact that if the smelting zone is increased in temperature by heating the blast, the amount of carbon used in the furnace per unit of pig iron made is at once decreased. Or, if the heat available in the smelting zone is increased by drying the blast, and thus removing the strong cooling influence which the decomposition of the moisture of the blast exerts, economy of fuel at once results. In fact, any means of getting high smelting temperature without combustion of carbon before the tuyeres decreases at once the quantity of fuel necessary to use in the furnace, since the quantity used is determined by the heat requirements in the smelting zone, and not by the requirements for reduction, which are only a fraction to the former. The ash of the fuel is largely silica, with some alumina and lime, if coke, or alkalies, if it is charcoal. This requires flux to slag it, an amount which may be considerable when using poor coke high in ash. Regard for this item of cost should be had in purchasing or valuing the fuel.

The pig iron produced contains carbon between 2·5 and 4·5%, silicon in varying quantity 1 to 4%, according to the temperature and rate of running of the furnace, practically all the phosphorus of the charge, and one-tenth to one-fourth of the sulphur. Its melting point is about

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1,200°C., and it runs from the furnace ordinarily at 1,500°C. to 1,600°C., carrying out as sensible heat 250 to 300 calories.

The slag may be basic or acid, as before explained, and these varieties will average in per cents. :—

	Basic Slag. High Sulphur. Charge.	Acid Slag. Low Sulphur. Charge.
SiO_2	35	55
Al_2O_3	10	10
CaO	40	25
MgO	10	5

These slags melt at about 1,350°C. and 1,200°C. respectively, and ordinarily run away from the furnace at 1,600°C., carrying out as sensible heat 500 calories.

The reduction of silica and phosphorus oxide in the furnace is accomplished by solid carbon in the smelting zone. A small part (10 to 20%) of the iron oxide in the furnace is also similarly reduced by fixed carbon; the rest is reduced in the upper half of the furnace by the excess of carbon monoxide gas. So much of the latter gas, however, is produced before the tuyeres in generating the temperature necessary in the smelting zone, that only a fraction of it is converted into carbon dioxide, CO^2, in reducing the iron oxides of the charge. This is the chief reason for the excess of unused carbon monoxide in the gases of the blast furnace, an amount whose potential calorific value often represents one-half of the calorific power of the fuel put into the furnace. It is true that all the carbon monoxide in the gases could not be utilised, no matter how small its amount, but that is a limit set by the principle of chemical equilibrium or mass action, which ordinarily is not approached because of the excessive amount of carbon monoxide produced in the lower part of the furnace in the effort to get the requisite smelting heat and temperature. The proportions of carbon ordinarily consumed at the tuyeres are 9 atoms (108 parts) of carbon for each molecule of iron oxide (160 parts) reduced by the carbon monoxide gas. The chemical equation is: $Fe_2O_3 + 9\ CO = 2\ Fe + 3\ CO_2 + 6\ CO$. This equation shows us that only one-third of the carbon monoxide produced before the tuyeres in generating the smelting temperature is utilised in reduction, while two-thirds escape unused.

Passing to the electric principle of smelting, we have here to deal with the case of all necessary heat supplied by electrical energy, no blast blown in, and, therefore, all the solid carbon utilised for reduction (always excepting the small amount which dissolves in the pig iron) in calculating the amount of carbon necessary to thus reduce the iron oxide, we meet at the outset with this difficulty. What proportion of the carbon will form CO^2, and what proportion CO? We know that when reduction takes place at a very high temperature, CO is almost the only product; but as this passes more or less slowly through the cooler portions of unreduced charge, CO^2 is formed in increasing amounts, until at a low red heat, given sufficient time, about half the CO may be converted into CO_2. The formulæ corresponding to these two extremes are:

$Fe_2O_3 + 3\,C = Fe_2 + 3\,CO.$

$Fe_2O_3 + 2\,C = Fe_2 + CO + CO_2.$

Comparing these with the ordinary blast-furnace reaction, which requires 9 C put into the furnace for the reduction of Fe_2, we see that 3 C, or one-third as much carbon, is the greatest amount necessary in the electric furnace reduction and $_2C$, or between one-third and one-fifth as much, is the smallest amount necessary. As will be further shown, the uncertainty as to how much CO_2 can be formed in the electric furnace reduction is perhaps the chief difficulty in running the electric furnace.

Example.—Iron ore is to be reduced to pig iron in an electric furnace, and the flux and charcoal on hand for the charge analyse as follows:—

Iron Ore.	Limestone.	Charcoal.	
Fe_2O_3	90 $CaCO_3$	90 Fixed C	90
SiO_2	8 $MgCO_3$	3 Volat'e Mt'r.	6
Al_2O_3	2 SiO_2	SiO_2	2
		Al_2O_3	1
		K_2O, Na_2O.	1

Assume the pig iron made will contain 4% of carbon and 3% of silicon; that the slag may be 65% ($SiO_2 + Al_2O_3$); that the gases contain only the CO_2 from the limestone, and none from the reductions.

Required: (1) The weights of ore, limestone, and charcoal to charge per 100 of pig iron made; (2) the percentage composition of the gases; (3) the weight and percentage composition of the slag.

Solution: (1) The weight of ore needed is that necessary to supply the 93 parts (100—4—3) of iron in the pig iron. This will require 133 parts of Fe_2O_3, which will be contained in 133 ÷ 0·90 = 148 parts of ore.

The weight of charcoal needed is that necessary to furnish enough fixed carbon to reduce the iron oxide and that silica which is reduced, and to supply the carbon in the pig iron. These quantities are:—

Reduction of Fe_2O_3	93 × 36/112	= 29·9
Reduction of SiO_2	3 × 24/ 28	= 2·6
For carbon dissolved		= 4·0
Total requirement		= 36·5
Charcoal required 36·5/0·90		= 40·6

The weight of flux required is best found by calling it x, and then figuring out the slag, as follows:—

Silica in the slag will be that in the ore, flux, and fuel, minus that reduced to silicon. Therefore,

In ore	148 × 0·08	= 11·8
In flux	x × 0·02	= 0·02 x
In fuel	40·6 × 0·02	= 0·8
Reduced	3 × 60/28	= 6·4

Silica in slag = 6·2 + 0·02 x

By similar calculations we find the slag to contain, as a whole:—

Silica	6·2 + 0·02 x
Alumina	3·4
Lime	0·50 x
Magnesia	0·04 x
Alkalies	0·4
Total weight	10·2 + 0·56 x

If the slag is to be 65% of silica and alumina together, then

$$0{\cdot}65\ (10{\cdot}0 + 0{\cdot}56x) = 9{\cdot}6 + 0{\cdot}2x$$

from which $x = 9$.

The above solution is perfectly general, and applies to all kinds of ore, flux, and fuel, and the production of any desired kind of slag.

(2) The gases will contain the fixed carbon of the charcoal (except that part that goes into the pig iron) in the state of CO, the carbonic acid driven off the flux, and the volatile matter from the charcoal. The latter may be assumed as composed of equal parts by volume of hydrogen, carbon monoxide, and carbon dioxide, which would correspond to weights of those gases in the proportion of 2:28:44. The gases passing off will therefore be, in parts by weight:

CO from fixed carbon	32·5 × 28/12	= 75·8	
CO from volatile matter	2·7 × 28/74	= 1·0	76·8
CO_2 from volatile matter	2·7 × 44/74	= 1·6	
CO_2 from flux	9·0 × 0·44	= 4·0	
H_2 from volatile matter	2·7 × 2/74	= 0·1	— 0·1
Total weight of gases			82·5

Percentage composition of gases by volume:—

		Per cent.
CO	76·8 ÷ 126 = 6·10	= 92·4
CO_2	5·6 ÷ 1·98 = 2·8	= 4·2
H_2	0·1 ÷ 0·09 = 2·2	= 3·4
	6·60	100·0

The volumes 61·0, 2·8, and 2·2 represent cubic meters of these gases per 100 kgs. of pig iron made; if multiplied by 16 they give the cubic feet per 100 lbs. of pig iron.

(3) The slag will contain, substituting x × 9:—

	Per cent.
Silica	6·4 = 42·4
Alumina	3·4 = 22·5
Lime	4·5 = 29·8
Magnesia	0·4 = 2·65
Alkalies	0·4 = 2·65
	15·1 100·00

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Combined Blast and Electrical Furnace.—The electrical reduction of iron ore differs radically from blast-furnace practice in one essential particular, viz., that since no air is blown in, any excess of carbon above that consumed in reduction must remain unused, accumulate, and eventually clog the furnace. The amount to be used as a minimum cannot, moreover, be calculated until we know how much CO_2 will be formed in reduction, and that is an unknown quantity unless arrangements are made so that none can be formed. The following modifications of working an electrical pig-iron furnace are possible, with the object in view of avoiding the accumulation of excess carbon in the crucible :—

(1) A deficit of carbon may be put into the charge, thus permitting unreduced iron oxide to escape in the slag, and preventing unused carbon from accumulating. This solution leads to the disadvantages of loss of iron, heavy corrosion of lining of furnace, and heavy consumption of electrode carbon. It may have the secondary result of preventing reduction of silica or taking up of carbon by the iron, and thus furnish a metal with high melting point and approaching steel in composition. Such slag would also remove some of the phosphorus in the charge, but practically no sulphur.

(2) A charge of ore and flux without fuel may be run through the furnace whenever an accumulation of carbon occurs, as is shown by the resistance of the furnace falling off and the furnace getting cold. This was the device adopted in the experiments of the Canadian commission at Sault Ste. Marie, but while permissible in experimental work, it would not do to thus periodically derange a furnace in regular running.

CHARGE SHEET—PER 100 OF PIG IRON PRODUCED.

Charges.		Pig Iron.		Slag.		Gases.	
Ore :	(148·0)						
Fe_2O_3 ...	133·2	Fe ..	93·0			O	40·2
SiO_2....	11·8	Si ..	3·0	SiO_2 ..	5·4	O	3·4
Al_2O_3 ..	3·0			Al_2O_3..	3·0		
Limestone :	(9·0)						
CaO ...	4·5			CaO ..	4·5		
MgO ...	0·4			MgO ..	4·5		
SiO_2....	0·2			SiO_2 ..	0·2		
CO_2	4·0					Co_2....	4·0
Charcoal :	(4·06)	C	4·0				
Fx'd C..	36·5					C	32·5
CO	1·0					CO ...	1·0
CO_2	1·6					CO_2 ...	1·6
H_2	0·1					H_2	0·1
SiO_2....	0·8			SiO_2 ..	0·8		
Al_2O_3 ..	0·4			Al_2O_3..	0·4		
$(NaK)_2O$	0·4			$(NaK)_2O$	0·4		
Totals ..	197·9		100·0		15·1		82·8

(3) The fuel may be calculated only for the production of CO in the furnace, and this condition approximated by leading off the gases from the hot part of the furnace and not allowing them to cool in contact with the ore. In this way reduction by CO is avoided, and the fixed carbon in the charge may be consumed almost entirely to CO without formation of CO_2. This would bring the furnace consumption of carbon nearer to a definite amount, and by avoiding reduction except by solid carbon tend to use up all the carbon charged, the amount of which would be calculated by this manner of working (as in the numerical example worked out for illustration).

(4) The best solution of this difficulty may be to provide tuyeres by which air can be sent into the crucible of the furnace, and thus burn any accumulation of carbon. A given quantity of air will always burn a given quantity of carbon, and therefore the cure would seem to lie in having a variable supply of air, which is increased whenever the falling resistance of the furnace indicates that carbon is beginning to accumulate, and diminished to a small minimum supply, only enough to keep the tuyeres open, when the furnace is in good electrical running order. It would represent a combined electrical and blast furnace, with the blast so regulated as to overcome the chief difficulty of the purely electrical furnace—the accumulation of unused carbon in the crucible.

It may be quite possible, by some such device, as Mr. Taylor's large electrical furnace, to practically combine the blast furnace and the electrical furnace. The writer is quite confident that any practical method of introducing electrical heat into the crucible of a blast furnace will result in large economies in the furnace working. Only one-quarter of the heating power of the fuel is developed around the blast tuyeres, and yet if half of this could be replaced by electrically-generated heat, an economy of 50% could in all probability be reached upon the fuel bill. To put it into figures, it takes 1·2 tons of coke to make a ton of pig iron in the blast furnace, and about three-quarters of a ton is burnt by the blast, producing at the smelting zone about 25% of the calorific power of the coke. If electrical energy could be made to supply one-half of this, the furnace would make iron with half the previous coke supply, that is, with 0·6 ton of coke per ton of pig iron, and this with an expenditure of electrical energy equal to 12·5% of the calorific power of but 0·15 tons of coke.

The question of economy in this case will not be, then, the simple replacement of fuel heat energy by an equivalent amount of electrical heat energy, but the comparison of fuel heat energy with the cost of one-fourth its amount of electrical heat energy. This may be quite possible in many localities, and the combined furnace would work more regularly than a purely electrical furnace. The question awaits the coming of the electro-metallurgical engineer who can make practicable the requisite combination. A possible solution may be to use cheap electrical power to superheat the hot blast, and thus to make the blast itself the agent for carrying electrically developed heat into the furnace.

PETROL-ELECTRIC SYSTEMS.

Very satisfactory results are reported to have been obtained with the Hallford-Stevens petrol-electric system. The claim is that it has been applied to an omnibus which, during the last 18 months has covered a distance of 50,000 miles, at a cost of 8·52d. per mile. In this system the dynamo is coupled direct to the petrol-engine. The motors are of the four-poles, series wound, enclosed type, and the control is effected partly electrically and partly by means of the engine throttle, and with this arrangement it is found that two "speeds" suffice to give the necessary flexibility. The arrangement is said to take up its work with perfect smoothness. At starting, the brakes are first released, and the engine is accelerated by opening the throttle with the pedal, until a speed is reached at which the dynamo excites. The field switch is then gradually operated until the vehicle gains the required velocity. At stopping, the throttle pedal is released, and thus the dynamo field becomes weaker. The brake is then applied, without interrupting the main circuit. It is understood that Messrs. W. A. Stevens are also developing an electric system for omnibuses without the petrol-engine. The Franklin Institute recently published in its *Journal* a summary of the various systems that have been applied to the propulsion of automobiles, in which petrol engines and electric generators are used in combination, and it also describes the method devised by Mr. Justus B. Entz for use in Columbia cars. In this system one end of the field-rotor of the electric generator is bolted direct to the shaft of a 45 h.p. petrol engine, thus taking the place of the ordinary fly wheel, and the field-rotor is supported at the other end in a large ball-bearing. The armature shaft is extended through the field-rotor to the bevel of the rear axle gear-box, which contains the differential. In line with the field-rotor, and behind it upon the same shaft, is the armature of a motor. The field-rotor thus serves the purpose of a clutch between the engine and the driving pinion ; and the motor provides means for multiplying the driving torque beyond such differences as can be secured by varying the speeds of the engine. The controller handle has five "speeds" ahead, and two reverse "speeds," and it enables the two separate armature windings of the motor to be coupled up in various ways for alteration of speed. It is claimed that while less than 10% more weight is added to the vehicle than would be necessary to equip it with sliding gear transmission, clutch, and fly-wheel, the efficiency of transmission is 95% for high speeds, and from 85 to 92% for low speeds, and that reversing is accomplished without the use of gears.

RESULT OF TRAMWAY COMPETITION.

The electrification of the L.C.C. tramway line which connects Bloomsbury and Aldgate with Stamford-hill is nearing completion. A full service of cars is already running between Bloomsbury and Hackney Station, and as a result of the competition caused by the improved tramway service, the North London Railway have decided upon a reduction of fares on a portion of their system.

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TUNGSTEN AS "VALVE" ELECTRODE.*

By L. H. WALTER, M.A., Assoc.M.I.E.E.

The number of metals which show the effect known as "valve action" when used as electrodes in electrolytic cells has of recent years been considerably increased; and owing mainly to the thorough and systematic investigations of G. Schulze,† a somewhat better understanding as to the phenomena involved has been arrived at.

From the two first known, aluminium and magnesium, the list has been extended until it now definitely includes quite a large number of metals. If, however, these are classified as belonging either (1) to those showing the more general behaviour—which consists in the cell developing a film offering a very high resistance to a direct current passing through it in the direction in which the metal functions as anode, and a comparatively negligible resistance in the reverse direction—or (2) to those that show the less general phenomenon, in which a similar high resistance is offered, due to a film which forms under alternating current even, during the phase which is anodic so far as the valve metal is concerned, there remain but two additional metals, viz., tantalum and niobium, which, as recent work has shown, can be classed with the original two as manifesting the true rectifying effect.

Tungsten as "Valve" Anode.

The author has now found that yet another metal, hitherto untried, gives the valve effect in a very pronounced manner; in addition, this metal, tungsten, "forms" under alternating current. In this preliminary paper it is proposed to give a brief account of some experiments which have been made in consequence of this discovery, although the complete results of a further investigation which is now in progress are reserved for a later communication.

The effect was first observed when making experiments with a sealed-in tungsten lamp filament used as anode in a form of electrolytic detector with sodium chloride solution as electrolyte. In the course of this work it was noticed that on raising and still further raising the polarising potential difference, the characteristic "boiling" or hissing of the detector, due to evolution of gases, was entirely absent; and when it was found that 8 volts could be applied directly across the electrodes without the least "boiling" in the telephone, the similarity in the behaviour to that of the tantalum point-electrode suggested that there must exist, in this case also, a marked asymmetric effect.

Experiments with Direct Current.

Experiments with a somewhat larger anode, consisting of a non-sheathed length of an inch or so of the filament from a 50 c.p. osram lamp, with dilute sulphuric acid as electrolyte and applied voltages up to 45 volts, showed that the phenomenon was not merely an asymmetric effect due to the difference in the areas of the electrodes as in Holtz's‡ asymmetric cells, but was apparently a real "valve" effect.

The investigation was continued and extended to higher voltages, several other electrolytes being tried. The maximum pressure obtainable at the time being 90 volts, it was found that this voltage could be withstood by the tungsten anode in sulphuric acid of 1 : 15 concentration (15), in potassium iodide (0·2), acetic acid (0·1), potassium bichromate (1·8), sodium potassium tartrate (0·1), and borax (0·1) solutions, none very dilute. The residual current through the cell in milliamperes after 10 sec. is shown by the figures within brackets, the area of immersed anode being 0·034 square centimetre approximately.

For the purpose of these experiments it was found convenient to embed the end of the filament in a plug of Wood's fusible alloy which itself formed a stopper at the top of a perforated ebonite tube that served to protect the very delicate filament from injury.

The behaviour of tungsten in sulphuric acid of considerable strength with an applied potential difference of 90 volts is of special interest, in that, were it possible to make use of this electrolyte in rectifiers with tungsten anodes, the dimensions of the cells would be able to be much reduced as compared with those of the cells usually employed, since the conductivity of the acid is so high. For this reason, although it appears probable that, as in the case of other metals, *e.g.*, aluminium, tantalum, the critical voltage is notably higher in other, less active electrolytes, the first experiments were confined to the examination of the behaviour with sulphuric acid and with potassium bichromate. These are also good tests for the aluminium and tantalum: Schulze gives for the critical voltages of these two metals 45 and 190 volts respectively in sulphuric acid and 95 and 70 volts in potassium bichromate. A few other electrolytes of high conductivity were also tried, including hydrochloric and nitric acids.

Table I.

Milliamperes through Cell in Effective Direction.

Potential Difference across Cell (Volts).	In Sulphuric Acid.			In Potassium Dichromate.		
	Tungsten.	Tantalum.	Aluminium.	Tungsten.	Tantalum.	Aluminium.
10	<0·02	—	—	—	—	—
20	<0·02	0·10	—	—	—	0·20
30	<0·02	—	—	—	—	—
40	0·02	0·10	0·12	0·025	0·10	0·30
50	0·03	—	0·20	—	—	—
55	—	—	0·55	—	—	—
66	0·05	0·15	—	0·03	0·15	—
70	0·10	—	—	—	—	—
80	0·20	—	—	0·05	—	—
90	1·00 (jerky)	—	—	0.13	—	—
100	(sparked at 94 volts)	0·20	—	0·13	0·20	0·40
105	—	—	—	2·0 (jerky)	—	—
120	—	—	—	—	0·30	—
150	—	0·50	—	—	0·30	—
160	—	—	—	—	—	—
180	—	—	—	—	0·50	—
200	—	—	—	—	1·70	—

Tungsten Anode in

	Nitric Acid.	Hydrochloric Acid.	Potassium Sulphate	Potassium Chloride.
10	0·04	0·13	0·10	—
20	0·05	0·15	0·13	0.02
30	0·10	0·20	0·20	0·04
40	0·13	0·25	0·25	0·13
50	0·15	0·30	0·25	0·17
60	0·15	0·30	0·30	0·20
70	0·15	0·50 (jerky)	0·30	0·22
80	0·25 (jerky)	—	0·35	2·0
90	0·50 (jerky)	—	9·0	6·0 (jerky)
94	—	—	12·0	20·0 (jerky)
100	—	—	—	—

Owing to the fact that tungsten is at present only obtainable in the form of lamp filaments, the anode used is necessarily of very small dimensions and surface, and hence, with a veiw to eliminating any differences which might be due to the unequal size of the electrodes, two test cells were made up having anodes, of aluminium and tantalum respectively, of such dimensions as to offer a surface of the same order to the electrolyte, approximately 0·1, 0·15, 0·4 square centimetre in the case of tungsten, aluminium, and tantalum respectively. The lead kathodes had a surface of about 30 square centimetres, the circular containing cell measuring 3 in. high by 1½ in. diameter. With such a cell a current up to 0·5 ampere could safely be passed in the non-effective direction for short periods, the ohmic resistance being about 6 ohms. The sulphuric acid used was battery acid of density 1·200, while the potassium bichromate was approximately a 5% solution. The valve

*Original communication to the Institution of Electrical Engineers.

† *Zeitschrift Electrochemie*, vol. 14, p. 333, 1908.

‡ *Physikalische Zeitschrift*, vol. 6, p. 48C, 1905.

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electrode was simply dipped into the electrolyte from above.

While such high limiting voltages may not be reached this way as with Schultze's arrangement, the obtaining of very high critical voltages possesses only a theoretical interest, since the cell is of little practical use anywhere near the breakdown voltage.

A difficulty arises as to the representation of the results: Schultze gives curves showing the critical voltage plotted against time in minutes as abscissa. In the present case, for showing the sealing-off property of the anode, the residual current through the cell, in milliamperes after 20 sec., is plotted as ordinate against the potential difference across the cell as abscissa.

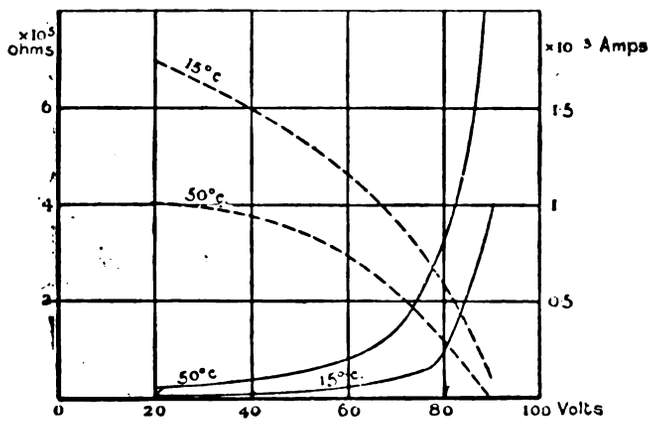

FIG. 1.

Besides the critical voltage there are two factors which determine the suitability or unsuitability of a valve electrode: the effect of higher temperatures upon the cell, and the effect of cutting off the current. As regards the former, the effect of the temperature of the electrolyte upon the leakage current in sulphuric acid is shown in Fig. 1. The full curves give the normal current at 15° and at 50°C. respectively, the dotted curves the respective resistances. These latter indicate very clearly where the critical voltage must lie (zero resistance) without it being necessary to actually break down the film. The usual behaviour, namely, that the leakage current is greater at higher temperatures, is observed, but the critical voltage is very little altered.

The effect of cutting off the current for shorter or longer periods can be seen in Fig. 2 for three different applied voltages, viz., 25, 50 and 75 volts, also in sulphuric acid. The points of the full-line curves which lie on the vertical

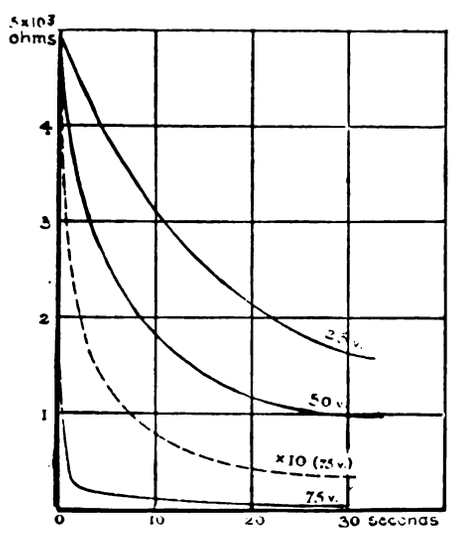

FIG. 2.

axis show the normal resistances of the cell; the other points give the resistances plotted from the currents observed on remarking the circuit after the current has been cut off for times up to half a minute.

At 25 and up to 50 volts it will be seen that the decrease of resistance of the anode film, though fairly rapid, is of a different order to that which occurs at 75 volts. It is interesting to observe that if the curve for 75 volts is reproduced with ordinates all multiplied by ten, the curve so obtained (dotted curve of Fig. 2) is very similar in shape to those for the lower voltages.

Experiments with Alternating Current.

But few experiments have as yet been made with the cell on alternating current.

The first trials with an arrangement of three cells having together four anodes, which served as a bridge, showed that using new tungsten anodes which had never previously been formed, a direct current was at once obtained on switching on the alternating supply, the applied voltage being 25 volts and the rectified current, which was passed through three accumulator cells, being 0·25 ampere. With a voltage of 25 at the direct-current (rectified) terminals and 0·043 ampere on a moving coil instrument in the same circuit the reading of a hot-wire ammeter in the alternate-current circuit was 0·13 ampere (anodic current density >4 amperes /cm.^{2}), hence the current transformation ratio as defined by Jakob,* was about 33%; this being, however, only about 1 min. after closing the circuit.

The difficulty here was that currents smaller than 0·1 ampere were not readable on the ammeter which was available. This current could be exceeded for short intervals, but owing to the small anode surface and the consequent high current density, the heating was so great that the efficiency rapidly fell off. Now that thicker filaments are promised in the near future it is hoped to obtain results for longer periods.

In conclusion it may be stated that, although the tungsten used is chemically metal, it can hardly be looked upon as being physically in the metallic (massive) state. Tungsten having been shown to behave chemically quite differently according as it is in the fused or reguline condition, or in the state of powder—notably in the greater indifference to acids shown by the fused form—it appears probable that the metal will make a more favourable showing when it is obtainable in the drawn condition, which has already been shown to be realisable, by previously alloying with nickel.

Summary of Results.

It is here shown that the metal tungsten, like aluminium and tantalum, behaves as a valve electrode in a large number of electrolytes, those which have been tried being for the most part of high conductivity and less adapted to the securing merely of high critical voltages. The critical voltages in the strong acids are as a rule higher with tungsten than with aluminium, but not so high as with tantalum.

The sensitiveness to heating is not at all pronounced. The sensitiveness to cutting off of the current appears, on the other hand, to be very great indeed. The great activity and considerable concentration of the electrolyte used must, however, be borne in mind.

The author's thanks are due to Mr. S. Skinner, M.A., for placing the laboratories of the South Western Polytechnic Institute at his disposal for the later experiments.

*Sammlung Elektrotechn. Vorträge, 9, p. 76, 1906.

UNDERGROUND WIRELESS STATION.

The latest innovation in wireless telegraphy is the construction of an underground station in Paris. It is being installed in the Champ de Mars, and will probably be open for use next month. The station will be fitted up on the latest approved lines, and comprise a machine room, a transmitting pole, and accomodation for the officials. Electricity will provide both light and energy. By the introduction of a 100 h.p. engine it is hoped that messages may be exchanged with places about 5,000 miles distant. With the use of a 10 h.p. engine the maximum of radio-telegraphy in the past has been 3,125 miles. The result of the experiment will be awaited with much interest.

TRAMS OVER BLACKFRIARS BRIDGE.

The London County Council electric trams have started running over Blackfriars Bridge. The opening ceremony brought together a distinguished company, and the first car was driven over the bridge by the Lord Mayor of London (Sir G. Wyatt Truscott). The bridge has now a width of 105 ft. between the parapets. The work of widening was completed some months in advance of the contract time. To quote Sir Melvill Beachcroft (Chairman of the London County Council), the opening of the bridge for the tramways will relieve the congestion of traffic in Blackfriars-road, and add another invaluable link between the Council's northern and southern tramways.

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NEW CATALOGUES.

Mr. James Hendry, of Bridgeton, Glasgow, has issued a new illustrated catalogue giving particulars relative to the manufacture of Hendry's Patent Laminated Leather Belting.

Messrs. W. F. Dixon & Co., Manchester, have brought out a new circular of their specialities in both Buffalo-raw-hide and water-proof paper-gears, together with a list of names and addresses of the agents they have appointed.

Copies of the Decimal Equivalents, Millimetre Equivalents, and Centigrade and Fahrenheit Comparisons appearing in Mr. S. N. Brayshaw's (Mulberry-street, Hulme, Manchester, S.W.) catalogues have been in such demand that he has had a large quantity mounted on cards, varnished and strung for hanging up. They are very neatly got up, and we understand that he will supply, free of charge, copies or sets to anyone who would find them useful for either shop, office or drawing office use.

Messrs. A. P. Lundberg & Sons have issued a new price list for switches with central "off" position, utilising the "Duplex" switch movement (for surface, flush and suspension work).

The Adnil Electric Co., Ltd. (Artillery Lane, Bishopsgate-street Without, London, E.C.) have brought out an illustrated price list of bayonet cap lampholders, Edison screw lampholders, magnetic lampholders, hand lamps, watertight fittings, etc.

The Fuller & Johnson Manufacturing Co., Farm Pump Engine Department, Madison, Wis., U.S.A., have issued an illustrated price list dealing with their diaphragm bilge pump outfits.

Messrs. Vickers, Sons & Maxim, Ltd., have issued an illustrated pamphlet, which deals with the operations connected with the use of the "Vickers" One Lock Adjustable Reamer, as adopted at their Erith Works.

The Union Electric Co., Ltd. (Park-street, Southwark, London, S.E.), are issuing a brochure illustrating a few high and low tension switchboards which have been recently constructed in their London works. These have been supplied to the order of municipal undertakings, mining companies, and various large power users. They claim that their switchboards are the desired union of "Safety for the operator and the machines controlled, simplicity in design and arrangement of connections, and reliability under severe working conditions."

A revised catalogue of the Kalkos Tinned Tube Wiring System has been brought out by the Sun Electrical Co., Ltd. (118-120, Charing Cross Road, London, W.C.). The list includes a very large number of fittings and appliances calculated to render the system, if possible, more complete and wider in its applications than in the past. In many instances considerable reductions will be noticed in the prices of both tube and fittings. Apart from low cost, ease of erection, etc., the paramount advantage claimed for the "Kalkos" Tubes is the total absence of condensation. The Tubes being non-oxydisable, wires can, if required, be withdrawn after being in position many years.

Erith's Engineering Co., Ltd. (70, Gracechurch-street, London) have brought out a pamphlet illustrating the advantages of their patent system of automatic response of both fuel and air to the varying demands on the boilers for steam. The system is applied to Erith's grateless stokers on Lancashire, water-tube and all other kinds of boilers, giving, it is claimed, identically perfect combustion with practically all fuels.

Mr. Chas. W. Richardson, Worsley-road, Patricroft, near Manchester, has issued a price list dealing with the "Richardson" Series Adaptor for placing metallic and other high efficiency lamps in series, any distance apart, in any position, on existing circuits, without re-wiring of currents, electroliers or fittings. The list also gives quotations for accessories for the series adaptor.

From Messrs. Bruce Peebles & Co., Ltd., Edinburgh, we have received a pamphlet describing the Peebles' Motor Converters (La Cour Patents), a type of machine which has come very much to the front within the last few years. The contents include a comparison of motor converters with rotaries and motor generators, as well as a list of some of the more important installations where the Peebles' motor converters are in constant use.

The Witton-Kramer Electric Tool & Hoist Co., Witton, are publishing leaflets describing their specialities, including flexible shafting, electric winches (in all sizes from 1 h.p. to 50 h.p.), etc. They are also designing a complete line of electro-lifting magnets.

Messrs. Baxendale & Co. (Electrical Department), Miller-street, Manchester, have issued a revised catalogue of electric bells, indicators, pushes, wires, batteries, speaking tubes, lightning conductors, medical batteries, etc. The list is profusely illustrated, and extends over 76 pages. Special quotations may be obtained for quantities.

Messrs. Veritys Ltd., of London, Birmingham, etc., have issued an attractive little pamphlet about the "Aston" Electric Radiators. These radiators are claimed to be the most convenient, cleanly, and healthful method of heating. Special care has been taken to ensure perfect insulation in all "Aston" radiators. A radiator of either the luminous or non-luminous type, consuming one unit, is calculated to be sufficient for a room 12 ft. sq. and usual height. Several fresh designs are given in the pamphlet, including the new pattern non-luminous radiator, as used on British battleships and cruisers.

Messrs. William Geipel & Co. have sent us a copy of their price list of Okonite and Insulating Tapes. The Okonite Tape is designed to take the place of the ordinary Para rubber strip, and is offered at a much reduced price.

BOOK REVIEWS.

"Examination Questions in Electrical Engineering, set by the City and Guilds Institute, 1900-1908." By a Certificated Teacher. Published by J. Rentell & Co., Ltd., at 1s. nett. The publication of this little book is the result of a request made to the Editor of our contemporary *Electricity* to supply copies of examination questions set by the recognised examining body on electrical engineering in this country. Answers are given to all the questions involving calculations, and a sample lot of descriptive answers are also included to show students how to set about their work in the examination room. They are, of course, more complete than any student would expect to make them, but are all the better for that, because information is given which is perhaps not so well stated in text books. The ELECTRICAL ENGINEER may be permitted to know something of the value of publishing questions and answers. Technical information given in that way is much appreciated by young electrical engineers and students, and we predict a large sale for the book.—E. K. S.

"Engineering Units of Measurement, with Symbols and Abbreviations: British and Metric Equivalents." By J. Ramsay, A.M.Inst.C.E. Published by John Smith & Son, Glasgow. (Simpkin, Marshall, Hamilton Kent & Co., Ltd.), at 1s. nett. The compiler of this pamphlet is a mechanical engineer, and so he has put it together from the point of view of what would be required by his own students. It is, however, such an excellent idea to get such information into a compact form, that it is a pity Mr. Ramsay did not collaborate with an electrical engineer so as to extend its usefulness. There is *some* information on electrical units, and the mechanical and heat units and their relations are of almost as much interest to electrical as to mechanical engineers. The edition will no doubt be quickly sold, and then the compiler and publisher might well consider the question of extending it to cover *all* the information, symbols, units, etc., likely to be useful to electrical students and engineers. —E. K. S.

"Transactions of the North-East Coast Institution of Engineers and Shipbuilders" (London and Newcastle-on-Tyne: Andrew Reid & Co., Ltd.). This part, No. 9, completes the volume. The contents include papers on "The Electrical Equipment of Cranes" (Mr. J. Brentnall Duckitt), "The Adaptation of Steam Turbines for the Propulsion of Vessels at Moderate Speeds" (Mr. Yasuzo Wadagaki).

"Rules and List of Members of the Iron and Steel Institute." Corrected to July 28. (London: Offices of the Institute. Price 1s.).

BOOKS RECEIVED.

"Continuous Current Dynamos and Motors," by W. R. Kelsey, B.Sc., A.M.I.E.E., 2nd edition (re-written). Price 7s. 6d. net. London: The Technical Publishing Co., Ltd.

"Chats on Electricity," by F. Broadbent, M.I.E.E. Price 3s. 6d. net. London: T. Warner Laurie.

PERSONAL.

Mr. William Murray, of the firm of Williamson Murray & Co. has been elected a director of the Edison & Swan United Electric Light Co., Ltd.

Mr. J. Mordey Lambe, Borough Electrical Engineer, East London (South Africa), has resigned. He was formerly Borough Electrical Engineer at Kimberley, and also in the service of the Rand Central Electric Works, Ltd.

Mr. T. Mather has been appointed Professor of Electrical Engineering at the City and Guilds Central Technical College, Exhibition-road, London, S.W., with Mr. G. W. O. Howe, Wh. Sch., M.Sc., as Assistant Professor. Mr. Howe was for several years with Messrs. Siemens Bros. & Co., and also with Messrs. Siemens & Halske, of Charlottenburg.

Mr. J. Hampden Wall, General Manager of the Port and City of Buenos Aires Tramway Co., has left for London on a business visit.

Mr. D'Abbadie D'Arrant, General Manager of the Cordoba Light and Power Co., is coming to Europe this month.

Mr. H. B. Saxby has been appointed Electrical Engineer and sent out in that capacity by the London Board of the Bombay, Baroda and Central India Railway Co. under a five years' agreement on a salary of Rs. 600—800 per mensem.

Mr. John B. McRae, consulting engineer, of Ottawa, has been engaged by the town of Renfrew, Ont., to make a report on the advisability of installing a plant for the development of the water power recently purchased by the municipality.

Mr. Bowen, Llandilo, has been appointed by the Llandilo Council to the vacant post of Electrical Engineer. He received 11 votes.

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HYDRO-ELECTRICS IN NYASSA-LAND.

One of the selected papers printed by the Institution of Civil Engineers, is an interesting account by Mr. A. S. Chalmers, Assoc.M.Inst.C.E., of a hydro-electric installation which he put up on the Shiré River in Nyassa-land. The Shiré is now only intermittently navigable, railway construction is making slow progress, and transport by native carriers is expensive. Minerals are plentiful, chiefly hæmatite and magnetite, with occasional seams of coal, but the country's development seems to lie mainly in agriculture. One or two small townships have sprung up, as Blantyre and Zomba, the engineering needs of these being supplied chiefly by a small electric-lighting plant driven by a Pelton wheel, which has not proved very reliable. At Livingstonia, at the north end of Lake Nyassa, there is a considerable white population, mostly engaged in the education and the industrial training of natives, and there has arisen a need for the employment of a considerable quantity of machinery for woodworking, printing and milling, to take the place of what, though cheap, is not very efficient native labour. Oil-engines with petroleum at 7s. per gallon were out of the question, and the installation of a steam-plant would have necessitated the introduction of an unwieldy boiler. As water-power was available, it was decided to lay down turbines, and to have them of such simple construction that skilled native labour could be requisitioned to superintend the installation when once it was erected. The main points which had to be considered were, first, that at times both lighting and power would be required simultaneously; and secondly, that the centre of distribution would be 2½ miles from the supply-station. As to the first point, storage-batteries for equalising the load were unsuitable, being too expensive, so it was decided to generate the power as required. The choice lay between a three-phase high-tension system and a continuous-current supply. The cost of overhead lines precluding the latter, the installation of three-phase units generating current at a pressure of 2,000 volts was decided upon. There was a supply of water, said to be 30 cubic ft. per sec., with an available fall of more than 100 ft. It was under these that in 1901 Mr. Chalmers undertook the design and erection of the plant. It consisted of the following: two 30 h.p. reaction turbines and generators; one high-tension motor of 25 b.h.p.; six step-down transformers with outputs ranging from 4 to 17 kilovolt-amperes; low tension motors, two of 10 h.p., one of 5 h.p., and one of 2½ h.p.; and five hundred 16 c.p. glow-lamps. The plant was of Swiss manufacture.

Erecting the plant in such a remote place proved to be more difficult than was anticipated. There were two porterages of 50 and 70 miles respectively on the route, and a timber-pile jetty 700 ft. long had to be constructed out into the lake to effect a safe landing of the machinery. The site lay 2,500 ft. above lake-level, and after several unsuccessful efforts to sledge the machinery up the hillside the attempt was abandoned, and the construction of a road 11 miles long was begun. The road occupied the greater part of two years in construction, and cost over £4,000. Directly the road was through the machinery was brought up in ox-wagons. Owing to repeated outbreaks of dysentery in the settlement from contamination of the water-supply, all work in connection with the electrical installation was stopped until a new supply could be brought from the hills. This involved the laying of 8 miles of steel pipes, from 4 in. to 1 in. in diameter. In 1904, a start was made with the electrical scheme. A dam was formed across the stream by two rows of piles 4 ft. apart and a filling of clay puddle; the face was battered with 9 in. courses of sharp gravel, sand and clay to a height of 12 ft. The water, which actually amounted to only 9 cubic ft. per sec. in the dry season, was led in a brick lade for 400 yards to a settling-pond of 10,000 cubic ft. capacity, and thence by a 14 in. pipe 490 ft. long to the turbines. The hydraulic plant consists of two 30 h.p. inward-flow reaction turbines with horizontal axes, running at a speed of 1,000 revolutions per min.

As to the electrical plant, there are two 23·5 kilowatt generators supplying current at a pressure of 2,000 volts. The generators are of the usual type with rotary magnets and direct-coupled exciters. The windings are delta-connected, as the voltage-reaction produced by uneven loading of the phases is much smaller for this than for the star connection, unless the increased expense of a fourth neutral wire is incurred. A voltage-variation of 10% up or down is obtainable through a resistance, but owing to the reliability of the governor this is very seldom altered. The installation of equal units has resulted in a considerable saving in spares, besides facilitating the running of the two machines in parallel. The switch-board consists of three panels, one for each machine, the current being combined for distribution on the third. The connections are behind the metal framework and so out of reach of the native operators. The machine-panels each carry a low-tension voltmeter connected through a three-point switch to a potential transformer. There is also an ammeter, a phase-lamp, and a three-pole high-tension switch. These are fixed on the third panel, one high-tension voltmeter with a six-point switch, three ammeters and a three-pole high tension switch.

Concerning the overhead lines, these consist of three No. 8 S.W.G. hard-drawn copper wires, which were carried on Buller steel poles 14 ft. above the ground. Horn-type arresters at both ends and middle protect the high-tension lines from lighting, and the secondary lines, where overhead, are protected by low-tension arresters of the zinc-plate spare-gap type. The scheme of distribution is arranged in sections as under:—Section 1 at a distance of 100 yards from the power-house: One 25 h.p. high-tension motor, driving a sawmill and a plastic brick-making plant. Section 2, at 1½ mile: One three-phase step-down transformer (oil-cooled) 10 k.v.a., with a star-connected secondary at 190 volts pressure, driving a 10 h.p. motor for a flour-mill and a threshing-mill. A pressure of 110 volts for lighting is obtained between a fourth neutral wire and phase 3. Section 3 at 2¼ miles: One single-phase 7 k.v.a. transformer on phase 1, for lighting only. Section 4 at 2½ miles: One 17 k.v.a. three-phase transformer, star-connected, to feed three motors at 190 volts. The motors are of 10, 5 and 2½ h.p., being used for woodworking, engineering and printing shops respectively. Section 5: One single-phase transformer of 7 k.v.a. for lighting only, on phase 2, secondary 115 volts. Section 9 at 3 miles: One single-phase transformer of 4 k.v.a. for lighting only, on phase 1, secondary 115 volts. Section 7 at 3¼ miles: One 7 k.v.a. transformer, the same as on section 5 and on phase 2. Section 8 at 3½ miles: One 7 k.v.a. transformer, the same as last, but on phase 3. The only trouble experienced with the plant was in connection with the thrust-bearings on the turbines. These had now been replaced by experimental bearings; one is a Hoffmann double-thrust ball-bearing; the other, designed by Mr. Chalmers, is a hydrostatic bearing, which automatically adjusted itself to the working-pressure. A pipe was brought to the rear of the bearing direct from the main 14 in. pipe, and the pressure of the water thus comes on to the diaphragm fixed to the shaft. If the pressure should tend to be too great for the thrust, the shaft travels endwise to a small extent and so produces a greater opening to exhaust and establishes equilibrium. This bearing, if rather cumbrous on such a small plant, should be very effective on plants working under a much higher fall. For two years the plant had been in operation on an average of 120 hours a week and without a single stoppage for repairs.

A BIG MEXICAN PROJECT.

Mr. G. L. Nies, of New York, the financial representative of the Nazas River Power Co., of Torreon, Mexico, authorises the statement that the company will spend $10,000,000 in the construction of hydro-electric plant and the building of transmission lines. Mr. J. A. Spofford, of New York, is president of the company; Mr. L. H. Hacker, vice-president and general manager, and Mr. C. A. Bobst, secretary. The plant will be located in the Fernandez cañyon, 125 km. above the city of Torreon. The Nazas River flows through this cañyon, and the initial water-power will be obtained by building a high dam across the narrow gorge. The capacity of the power plant will be 20,000 h.p. which can be increased as the demand may require. Transmission lines will run to the cities of Torreon, Gomez Palacio, Lerdo, San Pedro, Mapimi, Durango, Velardena, and elsewhere, and the power will be used in mining operations and industrial plants. The installation is to be completed by January, 1911.

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CONTENTS.

	PAGE
Notes	365
Radio-Telegraphic Demonstration at Cullercoats	366
The Thury D. C. System and its Developments	367
Metropolitan Railway Collision	367
Integrating Wattmeters on Cars	368
The Electrical Pyrometer	369
Electric Reduction of Iron Ore	370
Petrol Electric Systems	372
Tungsten as "Valve" Electrode	373
Underground Wireless Station	374
Trams over Blackfriars Bridge	374
New Catalogues	375
Book Reviews	375
Personal	375
Hydro-Electrics in Nyassa-Land	376
A Big Mexican Project	376
The Paris Scheme	377
Correspondence	378
Electricity in the Home	379
Contractors and Municipality	379
Trade with Mexico	379
Promotion of Electrical Enterprises	380
Municipal Tramways Association	380
Power Plant for Texas	380
Electric Locomotives for Canada	381
Economical Turn Down Lamps	382
Reporting by Electrophone	382
Fuses and Fuse Wire	386
Educational	387
Electrical Development in Victoria	389
Insurance of Electrical Machinery	390
St. Pancras Tramway Reconstruction	391
Normal Working of Destructor Plant	391
Technical Problems, with Solutions by Practical Men	392
Companies' Meetings	394
Companies Registered	394
Contracts Open	394
Some Contracts	395
Lighting & General Notes	395
Traction Notes	397
American Notes	398
Tyneside Notes	398
Tramway Standards as Stay Poles	399
Patents	400

THE PARIS SCHEME.

Accustomed as the French are to the utilisation of their great rivers for the generation of electricity, the proposal to supply electric power to Paris all the way from the higher reaches of the Rhone, on the Swiss frontier, is causing an unusual stir. It is a scheme well calculated to arouse the enthusiasm of Parisians who are somewhat jealous of the facilities enjoyed by several of the important and even minor provincial cities. The generation station will be situated over 250 miles away from the capital. This station will be equipped with 26 horizontal turbines, coupled, each pair generating 14,500 h.p. While the hydraulic part of the scheme has been settled, the electrical side is still under discussion. There is a strong bias in favour of the Thury direct current system, with a pressure of 200,000 volts, and cables carried mostly underground. The Thury system has certainly given excellent results in France and elsewhere on the Continent, but in this connection it would be decidedly costly. On the score of economy, as well as efficiency, the three-phase system, with a pressure of 120,000 volts, but also generating about 200,000 h.p., is now receiving more support. In this case, too, underground cables would be adopted when private land was traversed, but overhead wires will be the general rule. It is proposed to run either four or six independent lines, giving respectively 12 and 18 cables. This is with the idea of lessening the risk of breakdown. The steel towers for supporting the cables will be of considerable height and placed at about 500 ft. apart. The scheme would present many engineering difficulties, though none of them insuperable, or, indeed, more notable than those encountered on many high-pressure systems, not only in the United States, but in Italy and Switzerland; but the distance is certainly a great one for the conveyance of so large a horse-power. It is considered that Paris itself

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can take up all the power at present in contemplation, but this could be easily increased, and it is even proposed to serve other towns on the way. One possibility is that by means of transformer sub-stations power may be supplied for the electrification of existing or new vicinal narrow gauge mountain railways. This would prove an immense boon, as along the line traversed many villages, and even small towns, are practically isolated during the hard winter months. But for the moment such side issues are not being discussed with any sense of liveliness, for the Parisians are anxious to secure as much power for themselves as possible. The feeling is that such a supply would be the means of enormously cheapening the price of current, though it is difficult to give a very close estimate of the capital cost, so varied are the engineering problems that have to be faced. Cheap electricity would undoubtedly be widely appreciated by all classes in the French capital, where small workshops and home industries of all sorts are so numerous. Much of the hand and pedal labour now devolving upon seamstresses, jewellers, makers of toys, and so on, would be replaced by motors if only current was cheap enough. Although the scheme has long been under discussion, there are high hopes that the undertaking may soon be commenced.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

THE INSTITUTE OF MINING ELECTRICAL ENGINEERS.

Sir,—The speed with which the Institute of Mining Electrical Engineers has caught on "gives one to think." Amongst other things, it shows clearly that a great many members of the profession consider the Institute of Electrical Engineers does not quite fill the bill so far as their personal interests are concerned. Electrical engineering is becoming so wide that every now and then a bit will be broken off, as it were, from the parent society. The Faraday Society has for some years taken care of the electric, *chemical* and *metallurgical* branches; *traction*, also, has its own association, and now *mining* is breaking away.

All this has a weakening effect on the parent Institution, but it is inevitable, and the more so because the Institution of Electrical Engineers has shown by its masterly inactivity that it doesn't care to interfere in trade and professional matters in the way that the *Tramway Association* has done, and as the *Mining Electrical Engineers* will probably do.

The Institution of Electrical Engineers has hitherto been so anxious to be dignified and not dabble in mere trade and the filthy lucre part of the business, that it has missed chances of improving the status of the electrical engineer. This is shown by the off-hand way in which Parliament has dealt with the electric lighting Acts and the many power and tramway propositions which have come before it.

When new legislation is required in Germany, what corresponds to our Institution in that country decides definitely on a certain course. A series of resolutions are then laid before the Minister, and he brings them before Parliament as the expression of opinion of the electrical engineering profession. The engineer—and particularly the electrical engineer—ranks higher than the politician and the barrister in Germany.

The new Mining Electrical Institute will soon have something more to do than merely to read and discuss papers, because a deliberate attempt is likely to be made by the Trades Unions to reduce the use of electricity in mines. The Durham Mines Association, for example, has seriously discussed a resolution that all electrical machinery and cables should be removed from mines, and about two years ago a similar attempt was made to discredit electric power in New South Wales collieries.

The new Institute should have an important effect on the profession generally in that it will give groups of young engineers in a dozen different parts of the country a controlling interest in the profession. This responsibility will beget confidence, and a large number of what may be called the non-commissioned officers of engineering will be in training for commissional rank when the opportunity offers.

There are great possibilities before the Institute in the direction of establishing branches in other parts of the world. In metal mining especially, the electrical engineers' position will grow in importance each year as electric chemical and electric smelting processes come more into vogue. The ideal mine management of the future will be dual. There will be the mining expert who looks after the surveying, geology and chemistry, and the engineer who has charge of all the machinery, which must of necessity be largely electrical, and the electro-chemical and smelting processes, etc. In a few more years the *nominal* horse-power idiot, whose ideal of a mine pump is a "dot and carry one thing" with spear rods, will have disappeared, and he will not be regretted by

Yours, etc.,
E. Kilburn Scott.

Vale House, Burnt Ash-lane,
Bromley, Kent, Sept. 10, 1909.

ELECTRICITY IN MINES.

Sir,—I am gratified to learn that as a result of the inquiry into the accident at West Stanley, a select *committee* is to be appointed to revise the regulations pertaining to the use of electricity in mines.

As the standing Acts relating to this branch of electrical work were framed in 1903, it is of considerable importance to manufacturers and colliery owners that these rules should be revised and brought thoroughly up-to-date.

The tone of the report issued by the experts who investigated the cause of the above explosion points conclusively to electricity being the cause of the accident.

This, coupled with the proposal laid before the Durham Miners' Association, cannot fail to reflect on the manufacturers of electrical plant, and it is a regrettable fact that as yet the Home Office and the colliery owners in this country have not been of the assistance and guidance to the manufacturers that they should and could have been.

In spite of what may be said to the contrary, there are several points in the design and construction of electrical mining plant which are still in an unsatisfactory state.

Many of these defects are sufficiently well known to the majority of engineers to obviate any necessity of enumeration here.

It is the duty of the Home Office to be of assistance to the manufacturer in investigating these problems, and it would be of considerable assistance indeed if the Home Office would conduct a series of more prolonged and extensive experiments than hitherto at their test galleries at Woolwich, thereafter publishing their results for the manufacturers' guidance, or at least for consideration.

The colliery owners themselves as a body have not shown any marked desire in the past to be of assistance in the elucidation of these questions, to them of vital importance.

It would be well if the British owners would consider what has been done in Germany by colliery owners there.

The German owners in 1904 co-operated with several leading electrical firms in Germany, and without financial assistance from the Government conducted a series of valuable experiments to investigate the existing defects in electrical mining plant and to endeavour to devise methods of removing them.

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The results of these experiments, as applying to the ventilation of partially enclosed motors—to select one detail—were very valuable and of considerable assistance to the manufacturers.

It would certainly be advantageous and thoroughly in the best interests of British colliery owners to follow the example shown by our German cousins. The proposal laid before the Durham miners' Association is quite premature, and is to be regretted.

I am, dear sir,
Yours sincerely,
W. K. BURKE, S.I.Mech.E.

[This subject is dealt with in an Editorial "Note."]

ELECTRICITY IN THE HOME.

In the course of a valuable article on the benefits to be derived both by central stations and the general public from the development of electric heating devices, Mr. H. W. Hillman writes as follows in the New York *Electrical World*:—

Without considering most carefully the development and extension of electric heating devices, many may fail to realise the important relation of this particular class of development to other branches of the industry. In the erection of a new home the owner does not now consider whether it will be lighted by electricity or gas, but the question is how many of the convenient outlets and extra receptacles does he require to have a modern house. The miscellaneous electric heating devices have been so extensively introduced that there has been a marked increase in the manufacture and sale of sockets, receptacles, wire, knobs, cleats and other interior wiring devices. The manufacturer has not only gained in this respect, but the wonderful extension of the electric flat iron has been no small factor in promoting the continual demand for steam turbines and increased generator capacity. More and more the equipment of central stations will be taxed by the speedy introduction of the electric flat iron, and the electric manufacturer benefits by the sale of the apparatus. He will still further be benefited, and to a large degree, when the electric light and transmission companies take advantage of the sale of energy for many industrial purposes other than motors and lamps.

After the manufacturer, the lighting and power companies will be benefited from the development and introduction of electric heating devices. A display window and exhibition-room never cease to attract the attention of the people. There is a novelty about electric devices aside from their convenience which people enjoy, and they do not fail to show their appreciation. Therefore, the lighting and power companies are forcibly and valuably advertised in this manner. The income to the central station is gradually increasing to a substantial sum, and as every central station manager is searching for ways and means of increasing the earnings, the benefit in this respect from the heating branch of the industry is decidedly welcome.

A few years ago no engineer or central station manager anticipated that a substantial income would be secured from the introduction of flat irons, yet to-day it is an established fact that the income is substantial, and the business is permanent and profitable. Recently, through the aggressiveness and activity of the manufacturers and engineers, the electric toaster has been produced, which is so simple as to attract unusual attention. Its initial cost is low, and it is considered exceedingly durable and practically indestructible. If station managers will now stop to consider what an excellent income-earner this device promises to be, the toaster will be installed in every home where the flat iron is now used. A central station company recently claimed that 75% of its residence customers are using electric flat irons and within six months every house wired will own and use an iron. The same situation can be brought about with the toaster, and the central station will benefit thereby.

Admitting that the manufacturers and central station companies profit by the extension of electric heating devices, what about the public? Can it be shown that all three parties interested are benefited? Surely, the public has shared in the benefits to the fullest extent. It wants convenient devices for the home, and appreciates improvements which will save money. The wonderful development of the electric coffee percolator is interesting to relate. Only a few years ago it required 12 to 15 min. for the device to percolate. One of the first improvements in the design decreased the time required to about 8 to 10 min. A new idea was again presented, and 4 to 5 min. was the result of that improvement. Now coffee percolators are being produced which will percolate in 50 sec. The public always benefits when a saving in time is effected, and experience has given it confidence in electric heating devices. As a consequence, such devices will be more quickly and broadly extended than in the past.

The flat irons, toasters and percolators are emblems of engineering activity and advancement, for which much credit is due, and this credit belongs to the electric heating engineers. The public believes in convenient electric devices. In the development and extension of electric heating devices the benefits are not confined to a particular class of people. On the contrary, all classes are benefited. The servant girl who irons out on the piazza where it is cool and pleasant work appreciates the electric iron. She tells her friend, who is still using the old method, and time and experience show that servants are now demanding these benefits. The heating branch of the electrical industry is destined to grow to enormous proportions because so many of the miscellaneous devices have been made durable as well as convenient and are sold at popular prices. At no distant date electric cooking and baking outfits will be ready for greater extension and more aggressive attention by all interested.

Why should not the future look bright for electric cooking and baking? Opponents have said that electric stoves are slow and inefficient. Let them now investigate the new heating units which are so vastly superior to the past development as to call forth the heartiest congratulations among the electric heating engineers associated with the art. Electric stove lids consuming only 400 watts or 500 watts, and reaching a satisfactory heat in 17 sec., represent an advance in the art of heating that will cause the most conservative engineers to admire the progress which is really being made. Notwithstanding that the new unit is highly efficient and wonderfully rapid, it is said to be remarkably durable. The most exhaustive tests have failed to show that the unit is not durable.

A recent visit to the heating department of one of the largest manufacturers has made the writer more enthusiastic than ever on the subject of electric heating devices. Ample evidence is offered to show that the development and extension of this art has been of great benefit to the manufacturers, to the central stations and to the people in general.

CONTRACTORS AND MUNICIPALITY.

ABERDEEN CORPORATION INTERDICTED.

In the Aberdeen Sheriff Court a petition for interdict was presented at the instance of the Electrical Contractors' Association of Great Britain, against the Lord Provost, Magistrates, and Town Council of Aberdeen. Mr. Alfred E. Milne, solicitor, appeared for the pursuers.

The complaint of the pursuers is as follows: That the defenders have contravened and are contravening Section 25 of the Aberdeen Corporation Electricity Act, 1907, in respect that they have laid and are laying electric cables from the electric meters in the lodge at the City Hospital, Urquhart-road, Aberdeen, to the several buildings in connection with the hospital, all within the grounds of the hospital, and have erected, wired, and fitted, and are erecting, wiring, and fitting, electric lamps also within the grounds of the hospital.

The provisions in the Act founded on are:—

"The Corporation may provide, let for hire, and fix, set up, alter, repair, and remove, but shall not manufacture lamps, meters, electric lines, fuses, switches, fittings, lamp-holders, motors, and other apparatus, and things for lighting and motive power, and for all other purposes, for which electric energy can or may be used, or which may otherwise be necessary or proper for the supply, distribution, consumption, or use of electrical energy, and may provide all materials and do all works necessary or proper in that behalf, and may require and take such remuneration in money or such rents and charges for, and make such terms and conditions with respect to the letting, fixing, setting up, altering, repairing, or removing of such lamps, meters, electric lines, fuses, switches, fittings, lamp-holders, motors, and other apparatus and things as aforesaid.

"Provided as follows:—(a) It shall not be lawful for the Corporation to expend money (except through a contractor) upon the provision of the labour and materials required for the wiring for and fixing of electric light, fittings upon the premises of their consumers, or prospective consumers, or upon the provision of lamps, fuses, switches, fittings, lamp-holders, and other apparatus and things for light purposes, but nothing in this sub-section shall prevent the Corporation completing the service line between their supply mains and their own apparatus upon the premises of any such consumer."

Sheriff Begg ordered intimation of the petition to be made to the defenders, and notice of appearance must be lodged within five days.

TRADE WITH MEXICO.

Shippers to Mexico will be interested to learn that the disability of not being able to consign on through bill of lading to interior points in the Republic has been removed, and these documents can now be obtained from all the Steamship Companies serving Mexican ports. Information regarding this and other matters relating to Mexico will be gladly given on application to Mr. E. J. Bray, the General European Agent of the National Railways of Mexico, at Dashwood House, 9, New Broad-street, London, E.C. This office has been specially inaugurated by the Government lines to protect their interests in Europe, and with the further object of putting at the disposal of shippers and all who are interested in Mexico information concerning the country.

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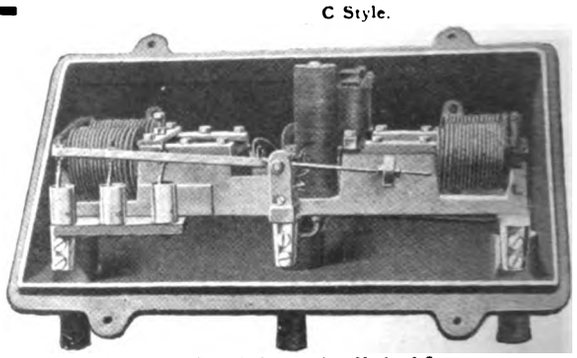

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PROMOTION OF ELECTRICAL ENTERPRISES.

The United States Consul at Brunswick (Mr. T. J. Albert) gives some interesting particulars of the German-French combination of financiers which has been formed for the purpose of promoting electrical enterprises in Turkey and the East. Certain Swiss and Belgian bankers have joined the combine. To the German group belong the Kontinentale Gesellschaft für Elektrische Unternehmungen (the Continental Company for Electrical Enterprises). This company, together with the Kommerz and Disconto Bank and the banking firm of M. M. Warburg & Co., of Hamburg, has hitherto controlled the street railway company of Constantinople. Other German companies interested are the Electrical Light and Power Plant Furnishing Co. (Elektrische Light and Kraftanlagen Akt. Ges.) and other firms standing in close relation to the Siemens-Schuckert group. The group of the General Electric Co. (Allgemeine Elektrizitäts-Gesellschaft) and the Bank for Electrical Enterprises at Zurich have also joined the combination. The French group consists of the Société Générale of Paris, the Banque de Paris et des Pays Bas, the Banque Ottomane, and the firm of A. Spitzer & Co., of Paris, also the firm of Josse Allard, of Brussels. The new combination intends, through the Swiss Kreditanstalt, to form a trust company at Zurich. As a beginning, the shares or stock of the Constantinople Tramway acquired by the combination will be deposited with the Swiss institution as a trust depository. This entire syndicate is under the leadership of the Deutsche Bank, at Berlin.

MUNICIPAL TRAMWAYS ASSOCIATION.

A variety of interesting subjects will come under discussion at the Municipal Tramways Association's annual conference, to be held in London on September 22, 23 and 24. The conference will meet in the Council Chamber at the County Hall, Spring-gardens, S.W., and, before the Presidential address by Mr. A. L. C. Fell (Chief Officer, London County Council Tramways), there will be a reception by the Chairman (Sir Melvill Beachcroft, J.P.) and members of the London County Council. Councillor A. W. Chapman (Vice-Chairman, Manchester Corporation Tramways Committee) will read a paper on "Medical Examination of Tramway Employees," and Mr. W. E. Ireland (Rolling Stock Superintendent, London County Council Tramways) will deal with "The Central Repair Depôt of the London County Council Tramways." Sir Melvill Beachcroft will entertain the company to luncheon at the Trocadero Restaurant, Shaftesbury-avenue, W., and the Association dinner is arranged to take place at the Garden Club, Imperial International Exhibition, Shepherd's Bush, the same evening. On the second day there will be a meeting of the managers' section, and at the resumption of the conference proceedings Mr. A. R. Fearnley (General Manager, Sheffield Corporation Tramways) will submit a paper on "Some Comparisons of Continental and British Methods of Operating Tramways," while Mr. R. S. Pilcher (General Manager, Aberdeen Corporation Tramways) is to discuss "Current Consumption." Luncheon will be held at the Holborn Restaurant at the invitation of the Chairman and members of the Highways Committee of the London County Council, and in the afternoon electric cars will be in waiting at Victoria Embankment (Waterloo Bridge) to convey the visitors to the Central Repair Depôt and Greenwich Generating Station. In the evening the Lord Mayor of London will hold a reception at the Mansion House. The business meeting of the Association has been arranged for the third and closing day, to be followed by an excursion to Windsor. Invitations will also be issued to the members of the Association by the Chairman and Directors of the Metropolitan Electric Tramways, Ltd., and of the Railless Electric Traction, Co., Ltd., to attend a demonstration of the Railless Electric Traction system at the Hendon Depôt of the Metropolitan Electric Tramways. The hon. sec. and treas. of the Association is Mr. A. R. Fearnley, Sheffield.

POWER PLANT FOR TEXAS.

The new power plant of the South-western Portland Cement Co., El Paso, Texas, will contain two 600 kw. Westinghouse steam turbo-alternators delivering 60-cycle, three-phase current at 440 volts, current being furnished by a 55 kw., 125-volt, engine-driven generator, and by a motor generator set comprising 55 kw. and 20 kw. direct-current generators driven by 115 h.p. induction motor. All motors were furnished complete with starting apparatus by the Westinghouse Co.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

Electric Locomotives for Canada.

The popularity of the electric railway has extended to Canada, where electrical enterprise is making encouraging progress. The accompanying illustrations show one of three locomotives of the latest pattern introduced by the British Columbia Electric Railway. These locomotives were built and supplied by the well-known firm of Dick, Kerr & Co., Ltd., the electrical equipment being manufactured at their Electrical Works at Preston, Lancashire, and the trucks and mechanical portion generally at their General Engineering Works at Kilmarnock, N.B. It is interesting to note that the locomotives are of the articulated truck four-axle type, with one motor mounted upon each axle. The maximum rated tractive effort is 16,000 lbs. drawbar pull, and the maximum instantaneous effort is 25,000 lbs. A specially interesting feature in the truck arrangement is that the body of the locomotive rests upon two four-wheeled trucks coupled together by a massive hinge having lateral flexibility, but vertical rigidity thereby enabling the rear trucks to resist any tendency to tilt under the action of the forward truck, and *vice versâ*. The centre pins and cab platform framing are not subjected to any longitudinal stress, except that due to its own enertia when starting and stopping, the whole pull of the motors being transmitted direct from the motors through the trucks. Suitable arrangements are made to allow the trucks to radiate when passing round a curve. The spring suspension is of the locomotive type, the weight being carried by semi-elliptic springs resting on the journal box saddles.

Fig. 1 gives a view of the interior of the cab. Here can be seen the two master controllers, one at each end of the cab, the contactor boxes, circuit breakers, switches, etc.

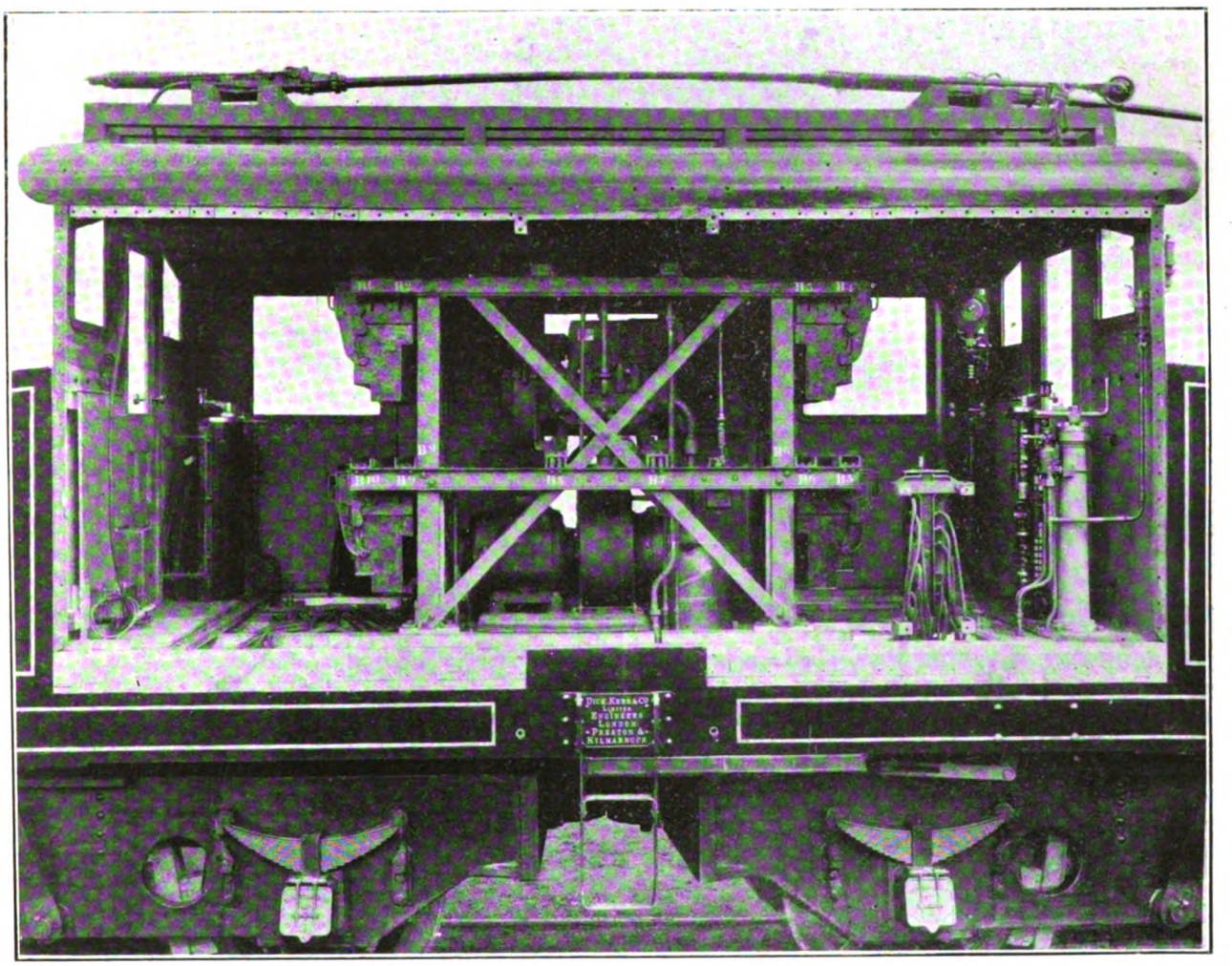

FIG. 1. 50 TON LOCOMOTIVE FOR BRITISH COLUMBIA RAILWAY CO. VIEW OF INTERIOR OF CAB.

The control equipment is of the standard Dick, Kerr multiple unit type, with series magnets operating the various contactors. The resistances are placed in the sloping ends of the super-structure. The motor equipment consists of 4 D.K. 12 A. motors. When operating on a 600-volt circuit, each motor will give a tractive effort of 4,040 lbs. on the periphery of the 42 in. wheels and a speed of 15 miles per hour at the one-hour rating. Each motor is fitted with reduction gear having a ratio of 3·64 to 1. The armature bearings of the motor are lubricated by oil rings which are specially designed to prevent flooding when running at high speeds. The axle bearings are

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lubricated by a system of wicks which are immersed in oil wells. No grease is used as an emergency lubricator. The whole of the gearing of the motors is contained in a malleable iron oil-tight gear box, which is provided with suitable stiffening ribs. It is supported by the axle bearing at one end, and by the pinion bearing and motor shell at the other end. The motors are designed and arranged for forced ventilation, the air being blown into the motor shell at the end farther from the commutator, and passing out at suitable openings provided at the commutator end. Fig. 2 shows the motor.

The air for the forced ventilation is obtained by means of a centrifugal blower, situated in the centre of the cab (see Fig. 1), and driven by a Dick, Kerr motor. The controller for operating this motor is situated near the

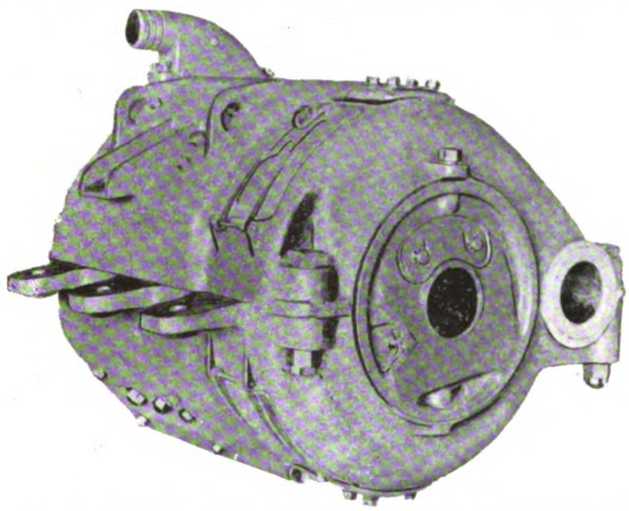

FIG. 2. 160 H.P. MOTOR FOR BRITISH COLUMBIA ELECTRICAL RAILWAY LOCOMOTIVE.

right hand master controller seen in Fig. 1. In addition to the blower for the motors, there is an electrically-driven air compressor with suitable air reservoirs for the air-brake equipment, the locomotive being fitted with combined straight and automatic air brake. The compressor for the brake equipment is mounted above the motor driven blower in the cab. Two current collectors are provided, these being of the straight under-running trolley type, the current being collected from an overhead trolley line. The trolleys are equipped with retrievers.

The appended data may also be of interest: Number of driving wheels, 8; diameter of driving wheels, 42 in.; total wheel base, 24 ft. 6 in.; wheel base of each truck, 8 ft.; length over all, 35 ft. 7 in.; length of main cab, 16 ft. 5 in.; height of cab above rail level, 14 ft. 1½ in.; width of cab, 9 ft. 8 in.; total weight of locomotive, 50 tons.

ECONOMICAL TURN DOWN LAMPS.

The Economical Turn Down Lamps now being placed on the market by Messrs. Geipel & Co. (Vulcan Works, St. Thomas-street, London, S.E.), possess advantages which strongly commend them to popular favour. The "Pull String" type they have been supplying for some time, and has been in great demand, but the "Hylo" Long Cord type is quite a new departure, and considered to have a big future. The Economical "Pull String" type has two filaments, one ordinary 8 or 16 c.p., the other a 1 c.p. filament. The switch is contained in the lamp cap for switching one or the other into circuit.

These lamps are invaluable for such places as offices, passages, bedrooms, bathrooms, hotels, hospitals, asylums, steamships and railway sleeping berths; in fact, every place where lamps may be turned down with advantage, as in the case of gas burners. This lamp, it is claimed, saves 80% of current. Messrs. Geipel & Co. supply them in all voltages from 50 to 250, and in either 8 by 1 or 16 by 1 c.p. They have a combined life of four times that of an ordinary lamp, and are used all over the United States and Canada. The 8 and 16 c.p. filament takes 4 watts per c.p., and the 1 c.p. filament takes 8 watts for the 1 c.p.

THE "HYLO" LONG CORD TYPE.

The "Hylo" Long Cord type is a new lamp which the firm are supplying. It is being sold in large numbers in the States. They are stocking these lamps with cords 3, 6, 10 and 15 ft. long. The switch has a rotary action with a flexible chain. The first pull turns the lamp on to its full power (8 or 16 c.p.), the next turn reduces it to one c.p., the third pull turns the light out. This action can then be repeated. For a window or a showroom the company are supplying a novel and attractive machine (worked by electricity) all ready to connect to the lamp socket, with hands which pull the string, changing the light from high to low and from low to high constantly. This machine is put forward as the best-known substitute for a real live demonstrator. Messrs. Geipel & Co. propose supplying one of these machines on loan for two months to all customers who order 100 or more Hylo and Economical lamps.

The Economical "Pull String" type of lamp is retailed at 2s. 6d. each, and the "Hylo" Long Cord type at 5s. 6d. each, with 3 ft. of cord, plus 2d. per foot extra for 6, 10 or 15 ft. lengths.

LIQUIDATORS AND POOLE TRACTION.

The liquidators of the Poole and District Electric Traction Co., Ltd. (in liquidation), report that the liquidation of the company was commenced in July, 1905, but owing to the delay occasioned by the litigation with the Bournemouth Corporation, full particulars of which have been from time to time given to the shareholders, the liquidators have been unable until this date to convene the final meeting. The total proceeds from the realisation of the assets amount to £137,880, and the disbursements to £136,600, which latter amount makes, with the final distribution of £3 3s. per share, a total return to the shareholders of £19 3s. in respect of each £10 share held by them. The balance, amounting to £1,280, has been retained by the Board of Trade. Of this amount, £30 is to meet outstanding dividend warrants, and £1,250 is reserved as remuneration of the liquidators, including office accommodation and services provided by the British Electric Traction Co. during the four years over which the liquidation has extended, and also a contingent claim of £158 for legal costs. Resolutions will be submitted at the meeting to authorise the payment of £1,250 to the liquidators, and to authorise the liquidators to hand the books and papers of the company to the British Electric Traction Co. to be dealt with as that company in its direction may resolve.

REPORTING BY ELECTROPHONE.

By the use of the electrophone the London *Evening News* was able to print a verbatim report of Lord Rosebery's speech on the Budget proposals the same afternoon, the sentences being in type almost as soon as they were delivered in the Glasgow City Hall. The electrophone transmitters, tiny brass fittings, were attached to the rostrum in the City Hall, and in all 2,000 miles of telephone wires were used to connect the hall with Carmelite House. The route was from the City Hall, Glasgow, to the Glasgow Post Office by underground wires, and then, by the overhead trunk system, *viâ* Carlisle railway station, Leeds Post Office, Hunslet railway station, Sheffield railway station, London-road Station, Nottingham, Luton railway station, and Finchley-road Station to the York-road Post Office. Then, by underground wires, the route was to the trunk telephone exchange in Carter-lane, and from there to Carmelite House. A staff of a dozen shorthand writers listened to the speech at the London end, each working two minutes at a time and then transcribing his notes. The arrangements were so complete that the slips of "copy" were in the printers' hands a few minutes after the words were heard in London, which was four seconds after they were uttered in Glasgow. The electrophone, as now improved by the introduction of a new transmitter, has been tested over artificial circuits representing 3,500 miles of wire, and gives a loud-sounding reproduction of the voice.

ACCIDENT TO AN ELECTRICIAN.

While engaged in connecting up the wires which carry electricity to the rows of arc lamps in Electric-avenue, Brixton, William Groves, an electrician, stepped backwards into the range of a high-tension fuse with a power of fully three thousand volts. In a moment he was gripped by the current and could not free himself. A fellow workman managed, with the aid of an indiarubber glove, to free the unfortunate man, but not before his clothing had been burnt through and his back severely injured.

SOUTH METROPOLITAN ELECTRIC.—The Debenture Stock Register and Register of Transfers of the South Metropolitan Electric Light and Power Co., Ltd., will be closed from September 17 to 30, 1909 (both days inclusive), for the preparation of warrants for interest at the rate of 4½% per annum, payable October 1 next, for the half-year ended that date.

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PATENTS.

THE PROPRIETOR of the PATENT No. 18125, of 1905, for "Improvements in Electric Motor Control Systems," is desirous of entering into arrangements by way of licence, and otherwise, on reasonable terms for the purpose of exploiting the same, and ensuring its full development and practical working in this country.

All communications should be addressed in the first instance to HASELTINE, LAKE & CO., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

THE PROPRIETOR of the PATENT No. 18408, of 1906, for "Improvements in Electric Insulators for High Tension Conductors," is desirous of entering into arrangements by way of licence, and otherwise, on reasonable terms for the purpose of exploiting the same, and ensuring its full development and practical working in this country.

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TO MAKERS OF ELECTRICAL HEATING APPLIANCES.—The PROPRIETOR of PATENT No. 14256/05 for "Electric Heating Cartridges" is desirous of having the same manufactured under licence or otherwise in this country in accordance with the terms of the Patent Act, 1907.

Communications, in the first instance, to be addressed to H. D. FITZPATRICK, 100, Wellington Street, Glasgow.

THE PROPRIETOR OF BRITISH PATENT No. 23172 of 1905, for Improvements in or relating to ELECTRO-MECHANICAL SYSTEMS FOR THE PROPULSION OF AUTOMOBILES, is desirous of entering arrangements with British Manufacturers with a view to the granting of licences under the patent so far as the application of the system to TRACTION ON RAILS is concerned.

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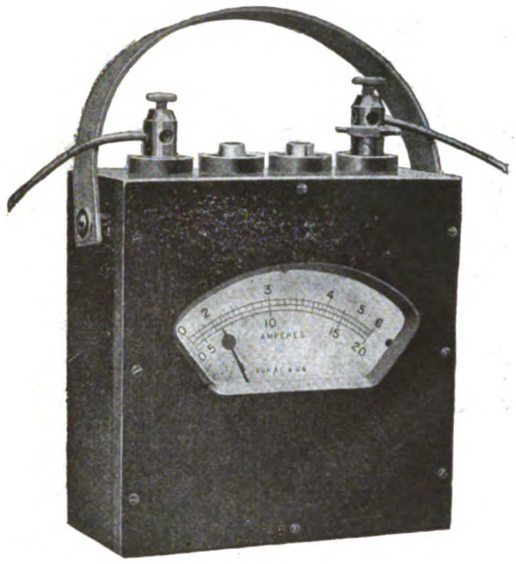

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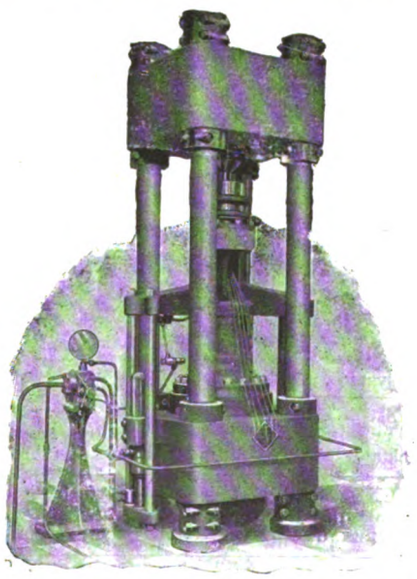

Fig. 1. Extruding Press for Manufacture of Fuse wire.

The press has been specially designed with a view to the peculiar requirements of the case. The fitting of special safety valves and facilities rendered for rapid recharging with metal alloy, from which the fuse wire is made, contribute to make it one of the most up-to-date extruding presses on the market. The molten metal is poured into the container, and maintained in that state by means of gas rings. The control is at once simple and effective, and the pump actuating the press is driven by an electric motor. Having adopted the latest and most up-to-date improvements, the Simplex Co. are enabled to supply fuse wire at strictly competitive prices, and to undertake large contracts for the supply of this material.

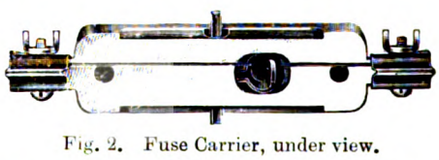

Fig. 2. Fuse Carrier, under view.

A new form of fuse carrier just introduced is the only type of indicating porcelain fuse on the market, departing only slightly from the standard design at present so popular. The fuse will fit any type of board of standard dimensions, and permits fuses being renewed by unskilled persons with the minimum amount of trouble and risk.

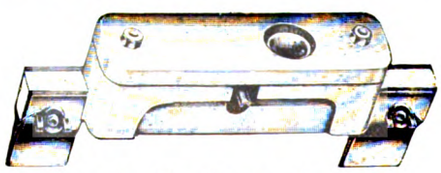

Fig. 3. Fuse Carrier, side view.

This fuse carrier is of very novel design. The indicator, which is coloured red, is shown in our illustration at the hole on the front view when fuse is blown. The fuse wire is carried at the back well out of the way, and the spring of the indicator is attached to the fuse wire by means of a hook provided. Two butterfly nuts bind down the fuse wire and render replacements an easy matter. The price is only a very slight increase on the standard form.

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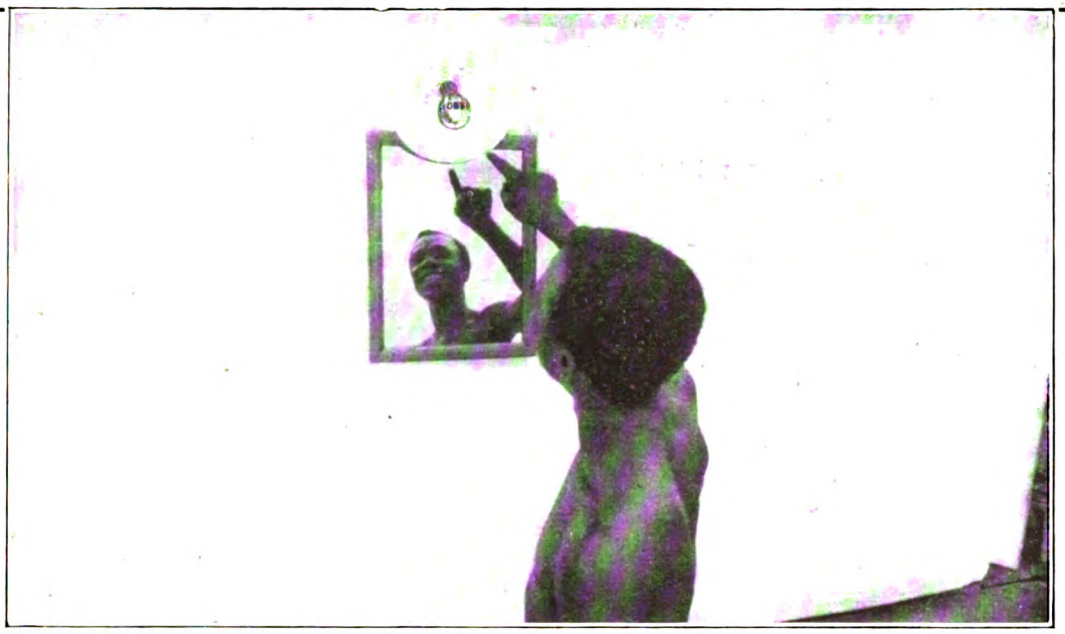

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EDUCATIONAL.

BATTERSEA POLYTECHNIC.

The electrical engineering department at the Battersea Polytechnic, London, S.W., is in charge of Mr. A. W. Ashton, M.Sc. Evening classes open on September 27 and the day classes the following day. The day and evening classes will include direct currents, alternating currents, electric traction, and electrical design. In addition there will be evening classes in telegraphy, telephony, and electric wiring.

BOROUGH POLYTECHNIC.

The Electrotechnics Department at the Borough Polytechnic Institute, Borough-road, London, S.E., opens for the session on September 27. The department will be under the direction of Dr. J. Henderson, F.R.S.E., A.M.I.E.E. The institution gives a course of instruction for students in electrical engineering, extending over four years, and, in addition, there are special courses in electric wireman's work, construction and design of electrical appliances and workshop fittings, advanced electricity, and magnetism.

DAIMLER WORKS SCHOLARSHIP.

The competition for the Daimler Works Scholarship has concluded. As a result of a written and *viva voce* examination, conducted by Dr. Hele Shaw and Professor Morgan, the following awards were made by the Directors of the Daimler Motor Co., Ltd.: Major Scholarship, value £200, viz., £100 premium and £50 per annum for two years: Harold Grinstead, B.Sc. (Hons.), Amber Field, Slinfold, Sussex, of Horsham Grammar School and London University. Minor Scholarship, value £140 approximately, viz., £100 premium and about £20 per annum wages for two years: (1) Thos. Edw. Beacham, B.Sc. (Hons.), 19, Consica-street, Highbury, London, N.; (2) Bertram Rhodes, B.Sc., Allandale, Bradgate-road, Bowden, Cheshire; (3) Frank Edw. Salter, 65, Winsham-grove, Clapham Common, West Side, London, S.W.

DURHAM UNIVERSITY.

The session at Armstrong College, Newcastle-on-Tyne (University of Durham) opens on September 27. Courses are to be held in electrical engineering.

GLASGOW.

The Glasgow and West of Scotland Technical College, Glasgow, offers systematically graded and arranged courses in the various technical subjects taught. The evening classes open on September 23, and the day classes on September 28. New and well-equipped laboratories have been provided in the motive power engineering, and electrical engineering departments. The Diploma of the College is granted in the Department for electrical engineering.

HACKNEY.

The new session at the Hackney Technical Institute, Dalston-lane, London, N.E., opens on September 20. There will be evening lecture, and laboratory courses in electrical engineering subjects, including electrical measurements, dynamos and motors, alternating currents, electrical design, etc.

STAFFORD.

The session at the Technical School, Stafford, opens on Monday next. The classes will include chemistry, electricity, mathematics, machine construction, physics, building construction, applied mechanics, and electrical engineering. As the Technical School has now so completely arranged to cater for the needs of members of Siemens' Stafford Institute, the necessity for giving lectures on General Engineering at that institution ceases. Certificates were offered to those who attended 75% of the lectures delivered in this section at the Institute last session, and the fact that close on 60 members made the requisite attendances shows that the classes were well attended. The *Electron* states that arrangements are being made whereby the scientific apparatus, etc., belonging to the Institute will be placed in glass cases in a prominent place in the Institute.

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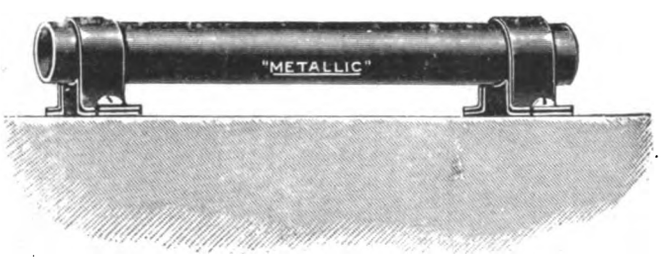

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ELECTRICAL DEVELOPMENT IN VICTORIA.*

By H. R. HARPER, City Electrical Engineer, Melbourne.

Twenty years ago electrical engineering as it is known to-day did not exist, but so rapid has been the development in the application of electricity since then, that engineers have found it necessary to specialise, and we find each member devoting his energies to one or other branches, such as designing, manufacturing, public supply, illuminating, installation contracting, traction and telephony. In this association all these are represented, with perhaps the exception of manufacturing, this branch so far having made little headway in this country. In the heavier branches of manufacturing there is little prospect of development, while the population of Australia remains at its present low figure.

In years to come, when population is attracted to our shores, heavy electrical manufacturing may become possible, but judging by the very slow manner in which the population increases, I am afraid it will not be in our time. It is a matter for congratulation that the Federal Legislature has lately appreciated these facts in regard to the production of electrical machinery in Australia, and have removed the severe restrictions in the shape of heavy import duties, which had been hampering industry until then. Our legislators have been induced to see that it is their duty in the interests of Australian mining and general manufacturing to facilitate the importation of the highly-specialised power house plant which is necessary for obtaining for the local manufacturers a cheap supply of power for their factories. The present tariff, while doing this, gives ample protection to the one or two local manufacturers of small-sized electrical plant, by imposing substantial duties on plant such as motors and accessories, which, on account of the growing quantity required, can be fairly economically manufactured in this country.

In reviewing before this association the progress that has been made in the use of electricity for all purposes, and particularly that in connection with public supply undertakings, one is almost compelled by the title of the association to restrict their remarks to the developments appertaining to Victoria, which, like several of the other States, contains a capital that, on account of its disproportionate size, dwarfs the other towns in the State with the exception of, say, Ballarat, Bendigo and Geelong, to insignificance. However, it will be interesting at the start to just glance at the development that is taking place in public supply undertakings in Victorian towns outside of Melbourne. There have been issued about 21 orders-in-council granting powers to municipalities, and in some cases to private enterprises, for the public supply of electricity. Some of the towns concerned boast of populations not greater than about 1,000 inhabitants, and on the basis of this population there are yet about 44 towns which are likely in the near future to require a supply. Of the 21 towns holding orders, Ballarat, Bendigo and Geelong are by far the most important. A system of public supply has been in operation in each of these three places for many years, covering not only lighting, but tramways in the case of the first-named two, while such are projected in the case of Geelong. Progress in the latter town has been very marked, when compared with the anticipated results when the plant was first put into operation about eight years ago. Difficulties in obtaining data from several of the towns prevent a further analysis of the progress of events outside Melbourne.

Taking all the supply undertakings in Victoria, not omitting those in the Melbourne area and including tramways, it is found that a large sum of money has been already invested in plant in connection therewith. The capital expenditure on all these undertakings approximates to about £1,600,000, which has been spent on generating and distributing plant of a capacity of about 16,000 kw., of which about 11,000 kw. is installed within the metropolitan area of Melbourne. The gross annual revenue from all these undertakings amounts to about £250,000.

Taking those undertakings within the metropolitan area of Melbourne, it is found that, excluding tramways, but including those Government buildings supplied with light by the Railway Department, there are at present connected to the distributing mains of the various undertakings no less than 255,800 16 c.p. lamps or their equivalent. The progress during the last six years has been most pronounced.

So rapidly is the demand for current for power purposes growing that it can only be a matter of time when such demand will be of greater importance than the lighting. This result will, no doubt, be assisted by the introduction of the metal filament lamp, with its low consumption of current for equivalent light.

As far as electrical tramways development in Melbourne is concerned, there is little progress to report, the only ones in operation being the St. Kilda line, worked by the Railway Department, and the Essendon line, owned by the North Melbourne Tramway and Lighting Co.

In many districts in the Melbourne area no public supply of electricity is yet available, although in some of these, statutory powers have been obtained for giving such a supply. For example, orders-in-council have been granted in the cases of Hawthorn, Williamstown, Footscray, Port Melbourne, Brighton and others, but so far no supply is available. Some of these powers have been lying dormant for many years, and it seems only fair that the bodies to whom such were granted should be forced by the Government to work their orders, or have them cancelled. In the latter case there would be, I am sure, no lack of private enterprise desirous of developing these areas. It is interesting to note that whereas the population of the Melbourne metropolitan area (that is within a radius of 10 miles) is over half a million, the population within the areas in which a supply of electricity is available amounts to only about 260,000.

In regard to the likely growth in the demand for electricity for power purposes, one has only to look at the Government Statist's annual return of factories, to come to the conclusion that Melbourne is not yet a manufacturing centre. Especially is this the case in the city area. The return for the year 1907, which is the latest published, shows that the actual horse-power used in factories during that year amounted to about 35,000, of which steam accounted for 27,000, gas and oil 4,000, and electricity 4,000. Taking the figure for steam power, and deducting those representing the electric power houses, tramways, etc., we obtain a net figure of about 20,000 h.p., which, together with that representing the gas and oil power, gives us about 24,000 h.p. remaining as a possible field for development. In passing, it may be of interest to note that of this amount of steam, gas and oil power the city area can only claim about 8,000 h.p., the balance being situated in the surrounding portion of the metropolitan area.

Mr. C. H. Merz, in his report on the "Generation of Electric Power in Victoria," recently presented to the Victorian Government, estimated the power that will be required in factories in Melbourne in 1916 at 55,000 h.p. A perusal of this report will show that this estimated amount of power is based on the Government Statist's figures for the year 1906, which give the actual power used in factories for that year at about 30,000 h.p., which, it should be noted, includes not only the power of the present power houses, but that of the motors which were at that time connected to their mains, totalling about 9,000 h.p. For the purposes of this estimate, therefore, the factory power in 1906 should be reduced from 30,000 to 21,000 h.p. Mr. Merz estimates that by 1916, in consequence of the development of industries due to a cheaper bulk supply, the increase in factory power will amount to 20,000 to 25,000 h.p. If such be realised, then the total estimated h.p. in factories in 1916 would be 46,000 h.p. instead of 55,000 h.p. To obtain this result it would be necessary to increase yearly at the rate of 2,500 h.p. for factories alone, which is a result that even under the special conditions that a special bulk supply is supposed to create, may be considered rather optimistic. It is pleasing to know, however, that such a hopeful future has been estimated for Melbourne by a man of Mr. Merz's undoubted experience.

The following table has been prepared with the object of showing the cost to various trades in the city area for a supply, under present conditions and prices:—

	Horse-power of motors installed.	Rev. per rated h.p. of motors.
Printers	307½	4- 8- 9
Newspaper Offices	368¼	3- 3-11
Clothing and Boot Mfg. ..	247¾	7-17- 2
Metal and Wood Working ..	624¾	4-12- 8
Dairy Produce Merchants ..	142¼	2-19- 5
Refrigerators, etc.	59½	7-10- 5
Elevators, hoists	510½	2-18- 6
Miscellaneous	121½	4- 2-11

The great bulk of the consumers in the various trades mentioned take their supply during the ordinary workshop hours, that is for about eight hours per day. In some cases the demand during these hours is fairly constant, or in other words, the load factor is comparatively high, and in such cases the consumers avail themselves of the option to be charged for their power at the maximum demand rate.

It will be noticed that in the case of newspaper offices, the maximum demand is heavy in proportion to the total energy taken, and the revenue per h.p. is very low. Fortunately this class of power, in the case of the morning papers, is taken at a time when the demand on the supply station is small. A still lower revenue is obtained from elevators, on account of their very intermittent demand. But for the fact that the diversity factor of such machines is high, this class of business would, comparatively speaking, be undesirable. On the other hand, refrigerator plants run for a great number of hours daily, and in consequence the rev. per h.p. is correspondingly higher. It must be noted that the figures in the table are based on the rated h.p. of the motors installed, and not on the maximum demand of the supply, which is not easily obtainable in these cases where the charge for electricity is made at the ordinary or flat rate.

The great bulk of the power at present connected to the mains of the several undertakings in the metropolitan area comprises those installations of but moderate size, in which the price of electricity is not of so important a factor as it will be in the larger

*Abstract of Presidential address delivered before the Electrical Association of Victoria.

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installations at present run by steam and other forms of power, and to these the question of cost is one of vital importance. Further, in the latter class will be included a number which, owing to the special conditions surrounding their operations, such as excellent individual load factor, are able to generate their own power, as cheaply, if not cheaper, than at which any public undertaking with its less favourable load factor and its distributing losses could supply. The present development of a power demand on the supply undertakings has been greatly instrumental in reducing the cost of production by the building up of a day load on the plant, which otherwise to a large extent would have been lying idle, and there is every reason to expect that with further development of such demand, and the installing of larger and more efficient generating units, the cost of production will still further be reduced.

So far this address has dealt mostly with the power side of the subject. To conclude with no reference to the prospects of extension in electric lighting would be impossible, in view of the great improvements that have taken place in the construction of incandescent lamps, and the consequent extended scope for extensions in this direction. For something like 25 years the carbon filament lamp has been the only incandescent electric lamp of any commercial value, and although its efficiency has been gradually improved during this period, the want of a more efficient weapon to fight the modern gas lamp was being seriously felt. During recent years several new types of incandescent lamps, such as the Nernst and the metallised carbon filament have been placed on the market, but the advent of the metal filament lamp, the tantalum and the tungsten, has placed the others absolutely in the background, and is responsible for a remarkable revolution in electric lighting.

Many tests have been carried out by the Electric Supply Department of the City Council, on tungsten lamps, which confirm what has already been said in regard to the efficiency and life of such lamps. Many of the lamps tested ran for several thousand hours, and then showed only a very small increase in the consumption per candle power. Although the price of tungsten lamps is high, there is every possibility of their being greatly reduced as the methods of production improve. Taking present prices, however, it seems that after about 120 hours burning the saving in current at present rates of supply pays for the first cost of the lamp, and during the subsequent life of the lamp the cost of burning is about one-third of that of the old carbon filament lamp, for equal candle-powers. Owing to the great brilliancy of the filaments, the installation of these lamps should be carefully thought out, with the object of preventing as far as possible the direct rays of light striking the retina of the eye. Here that new brand of engineer, the illuminating engineer, should step in, and with his superior knowledge, educate the user as to how to get the best results for the minimum expenditure of money.

There is a decided tendency on the part of consumers, and shopkeepers especially, to fix these lights at too low a level, evidently with the idea of attracting notice. This practice should be as far as possible discountenanced, and the lamps should be placed at such a height that with the aid of well-chosen and efficient reflectors, such as the holophane, uniform distribution is obtained without undue sacrifice of economy. Some form of reflector is absolutely necessary with these lamps, as owing to the disposition of the filament in the lamps, most of the light is given off horizontally, leaving only about 10% thrown down vertically. In the larger lamps fitted with spherical bulbs, it will be found desirable to frost the lower half of the lamp in order to get the best results. The manufacture of these lamps in the higher candle-powers, such as the 100, 200 and 300 c.p., will be very advantageous for the lighting of large spaces, such as public halls, and large shops. The ordinary 16 and 32 c.p. carbon lamps were failing altogether to meet the demand for such lighting, and it seemed likely at one time that the high candle-power gas lamps would take their place. All this has now been changed, and in this particular field, electric light has nothing to fear from the competition of gas. A further advantage should accrue from the use of metal lamps, in that the cost of installations per c.p. should be much less than under the old conditions.

With the same current density of sub-circuits and a similar number of sub-circuits, a far greater amount of candle-power can be installed, or expressed in another way, a less amount of wiring should suffice for a given candle-power. Further, in places of bunches of lights, involving the use of elaborate fittings, can now be installed single high candle-power lamps giving equal light, but at less installed cost. Fortunately for the supply undertakings the introduction of the metal lamp into this country has been much later than in the old countries. Following quickly on the heels of the low voltage lamp has come the high voltage lamp, and the fact that, so far, the minimum size of the latter is 50 c.p., has retarded, and, we hope, will prevent, that reduction of output and revenue that has been such a feature of many of the supply undertakings in the old country. The high voltage lamp will help the supply undertakings here to avoid the introduction to any great extent of that additional and unnecessary link, the auto-transformer. While these great improvements have been taking place in electric incandescent lighting, our gas friends have also been hard at work raising the efficiency of their lamps. It is said that imitation is the sincerest form of flattery. Well, we can congratulate ourselves on the fact that gas lighting in its recent developments has endeavoured to copy many of the features of electric lighting, not excepting even the external appearance of some of our accessories. This may be considered a strong testimony as to the convenience and other attributes of electric lighting. Nevertheless, our gas friends are keen after business, and competition between the two kinds of light is at the present time a severe one. From the efficiency of 20 candles per cubic foot of gas in their ordinary mantles, they are now producing, by aid of inverted mantles and compressed gas, lamps for which they claim an efficiency as high as 60 candles per cubic foot. This progress, but for the metal lamps, would have been a serious handicap for the electrical industry. At the present time, however, the prospects of electric lighting can be considered very satisfactory, and judging by the inquiries and interest taken in the introduction of metal lamps amongst the city consumers, there seems every likelihood of great business extensions in the very near future.

INSURANCE OF ELECTRICAL MACHINERY.

THE CAUSE OF BREAKDOWNS.

The Inspection and Insurance of Electrical Machinery Branch of the British Engine, Boiler and Electrical Insurance Co.'s (Ltd.) business again shows a satisfactory increase in the number of insurances current, also in number of breakdowns, and in the cost of repairing the damage done. The percentages of increase shown by the figures for 1908 over those for 1907, states the Chief Engineer's (Mr. M. Longridge, M.A., M.Inst.C.E., M.I.Mech.E.) Reports for 1908, are:—Insurances (dynamos), 13·8, (motors), 10·8, (starting or controllers), 14·3, (total), 11·4 breakdowns, 13·0, 8·2, 18·2 and 10·7; cost of damage, 84·8, 7·7, 4·0, and 18·3 respectively. The great increase in cost is probably temporary rather than chronic, being due to a few expensive breakdowns of a few large generators. The ratio of breakdowns among the various classes of machines were these:—Dynamos, direct current 1 in 13·7; alternating current 1 in 5·7; motors, direct current 1 in 9·2; alternating current 1 in 11·3; starters and controllers, 1 in 24.

The causes of the year's breakdowns were probably the following (the proportions being given per cent.):—Accidental—dynamos 6, motors 4, starters 8; dirt and neglect—23, 30 and 17; age and deterioration—25, 20 and 25; bad work or design—20, 11 and 9; overloading—1 and 2; unascertained—26, 34 and 39 respectively. A few of the breakdowns attributed to each of these causes are described in the Report to illustrate the kind of cases the Company has to deal with every day, frequently at the rate of one per hour.

The general impressions left upon the minds of those in charge of the electrical department are that a very large majority of the breakdowns are due to the deteriorating effect of oil, dust, and damp on the materials used for insulating. Of these oil is the most injurious and most difficult to deal with. Better arrangements are needed to prevent oil throwing. If oil once gets out of a bearing it creeps along the shaft to the back of the commutator and on to the end windings, also on to the commutator insulation and brush gear, and mixing with copper, carbon, or other dust, forms short circuits, giving rise to carbonisation and "burning out." The next most fruitful cause of damage is probably imperfect fitting, keying, and locking of spiders and core plates, commutator bushes, and even pole pieces, leading to abrasion of insulation and "earthing." Careless winding and fitting of magnet coils is also sufficiently common to be noted. Lastly, many of the users of electrical machinery do not give it the attention it requires. They fix motors in places which are difficult of access, dusty, or dirty, and leave them to work as best they may. If motor bearings were made like bicycle bearings, with balls running in vaseline, and if the armatures were regularly blown out, and the brushes attended to, the number of breakdowns would be far fewer than they are.

As many people seem to think that if a controller containing resistances in series with the armature of a motor will give certain variations of speed at full load, the same controller will give the same variations at light load, a few words on the subject of speed control may be serviceable. In 1908, the Company was asked to inspect some electric plant for a colliery proprietor, and, among other things, an 85 h.p. compound-wound motor and controller for underground haulage. The motor was to receive current at 450 volts, and was to run with the controller resistance cut out, at speeds varying from 420 revolutions per minute at full load to 450 revolutions at no load. The controller was specified to have six contact studs and resistances capable of reducing the speed from 420 revolutions per minute to 210 revolutions per minute at full load torque, and to carry the full load current for 15 minutes with the regulating switch on any contact. Both passed their tests satisfactorily at the makers' works, were certified by the Company, sent to the colliery, and erected there, but no sooner was the current switched on than the owner began to complain that the controller was irregular in its action, and at light loads would hardly reduce the speed at all, even when all the resistance was in circuit. In the course of the correspondence

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which ensued it appeared that he wanted, and had expected to get, a controller not only fulfilling the conditions described at the beginning of this paragraph, but capable of giving *any* speed, between 80 revolutions per minute and full speed, at *any* load. The Company explained that the controller specified could not possibly give the variations of speed he asked for, even if the resistance were very much increased, and a table was calculated and sent to him, to show what speed reductions could be made at various percentages of full load, with about eight times the resistance originally supplied. It was at the same time explained that unless a new controller having a greater number of contacts were provided it would not be possible to approach any nearer to his requirements. He eventually decided to have the resistances increased and to be satisfied with a specified speed control.

Although the controller with the increased resistance was able to reduce the speed from 420 revolutions per minute to 50 revolutions per minute, when taking the current required to give the full-load torque it did not effect the same reductions with smaller currents. For instance, at 58% of the full load torque, the lowest speed was 210 revolutions per minute. If the switch were moved on to the second contact to reduce the speed still further, the motor would stop altogether, unless at the same time the torque were reduced to 51·6% of the full-load torque, when a speed of 10 revolutions would be obtainable. Similarly it shows that with a current of 40 amperes, sufficient to give 25·8% of the full-load torque, the lowest possible speed was 230 revolutions per minute, but on reducing the current to 30 amperes the 80 revolutions asked for would be possible. The effect of the load upon the speeds obtainable with given resistances is explained by Ohm's law, volts = current multiplied by resistance. The speed of a shunt-wound motor, except for the effect of armature reaction, which may be neglected, depends exclusively upon the volts across the armature, while the current is determined solely by the torque required to overcome the drag of the load. Thus, so long as the torque remains constant, the volts across the armature, and consequently the speed, vary only with the resistance in the circuit, and therefore can be regulated at will by putting suitable resistances into the circuit. But as soon as the torque, and consequently the current passing, changes, Ohm's law shows that the voltage with any given resistance changes also, and that the series of speeds which were obtained by the series of resistances determined for a certain torque and current will no longer be obtained if the torque and current vary, but will be higher or lower than the required speeds as the torque is greater or less than the torque for which the resistances were calculated. Ohm's law also explains why the effect of moving the controller arm back one contact in certain cases shown by the table is to stop the motor instead of reducing its speed, for in such cases the supply voltage divided by the increased resistance = a current which is less than that which will give the torque required to turn the load. The speed of a compound-wound motor is further modified by the effect of the series windings.

The difficulty of speed regulation by resistance in series with the armature could be overcome by increasing the number of contacts, but this would mean a considerable increase in cost of the controller. The ideal controller from this point of view is no doubt one with a liquid resistance, for it will give an even graduation of speed, but the practical difficulties as regards dimensions, generation of gas, etc., in many cases counterbalance its advantages. It may also be mentioned that all forms of speed control by resistance in series with the armature are wasteful. If the speed of a motor be reduced to half its full speed in this way, the power absorbed is the same as if it were running at full speed, but the power given out is only one-half; the other half is wasted in heating the resistance coils. Control by resistance in the shunt circuit has, on the other hand, a high efficiency, and can be used with modern motors with inter-poles for a speed variation of 1 to 6. But this efficiency is only obtainable at a high first cost. For as the effect of putting resistance in series with the shunt is to increase the speed by weakening the field, the motor must be large enough to give the torque required to overcome the resistance of the full load with the weakest field. Thus, a motor with speed control by resistance in series with the shunt, capable of giving 85 h.p. at 420 revolutions per minute with all the resistance out, would have to be large enough to give 450 h.p. at 420 revolutions per minute with no resistance in series with the shunt. In other words, to get the efficiency due to shunt-speed control a 450 h.p. motor must be put down instead of an 85 h.p. There are, of course, other combinations by which wide variations of speed can be obtained, combinations of series and shunt resistances in conjunction with a single armature or with two armatures workable in series or in parallel, but none of these are of universal application. Each case must be considered on its merits, having regard to first cost, working cost, and graduation of speeds required.

CONSTRUCTION OF HYDRO-ELECTRIC PLANT.

The Susquehanna Electric Power Co. will shortly begin the construction of hydro-electric plant on the Susquehanna River. The plans include the building of a dam and power plant and pole lines for the transmission of electricity to Baltimore and other cities. The contemplated expenditure is upwards of £2,000,000 sterling.

ST. PANCRAS TRAMWAY RECONSTRUCTION.

The electrification of the tramways in the Metropolitan Boro' of St. Pancras by the London County Council has been under the consideration of the Parliamentary and General Purposes Committee of the local authority. The Borough Engineer (Mr. Wm. N. Blair) states that the road is to be widened opposite "Fairseat House" by about 23 ft., so as to allow the double tramways to be constructed. No widenings are contemplated in High-street, Highgate, and only a single line of tramway to be laid throughout a length of about 300 ft. extending from No. 25 to No. 43, High-street. The detailed plans indicate some modification of the form of the slot rails to permit the adoption of a special brake which shall be applied not only against the surface of the slot rails, but also on flanges below the surface. This, doubtless, is a special precaution having regard to the gradient of the hill. With reference to the reconstruction of the Highgate Hill tramways upon the underground conduit system of electrical traction, a letter has been received by the Parliamentary and General Purposes Committee from the County Council, stating that they propose to carry out the work similar in all general respects to that already submitted to and approved by the Board of Trade for the portions of the Council's tramways already constructed; also that application has been made to the Board for approval of these proposals.

The Committee have been informed that the only question at issue in regard to the reconstruction of this tramway is the nature of the material to be used in constructing the roadway and in connection with the levels, and these matters are now under the consideration of the engineers of the County Council, of the Borough of Hornsey and of the Borough of St. Pancras. After considering the matter, the Committee decided to recommend that, subject to the question of the paving of the roadway of Highgate Hill and the levels being agreed upon by the parties concerned, the consent of the Council be given to the reconstruction of the tramways in that thoroughfare.

Lieut.-Colonel Yorke, R.E., of the Board of Trade, has officially inspected the reconstructed tramways in Pentonville-road, Great College-street, Prince of Wales-road, Malden-road, and Southampton-road to Hampstead. On behalf of the Council it was pointed out to the Inspector that the consent of the Authority to the construction of the new lines nearer to the existing footway at the south-western corner of Prince of Wales-road and Kentish Town-road had only been given on the condition that the County Council acquired the necessary property at this point to permit of a distance of about 9½ ft. being provided between the outer rail of the tramway and the kerb.

The County Council have been in negotiation with the owners of the property, but have not yet been able to come to terms with the leaseholder, and therefore the widening has not yet been effected. The Inspector intimated that he would advise the Board of Trade to grant a license to the County Council to work these tramways, subject to the condition that they will take all necessary steps at the earliest possible date for carrying out the widening at this spot as proposed; that all cars should stop in Kentish Town-road before passing into Prince of Wales-road, and that the cars shall not pass round the corner at a speed exceeding four miles per hour.

The Committee recommend that consent be given to the County Council to proceed with the reconstruction of the tramways in Fortess-road, provided that the County Council effect the widening of the thoroughfare by Fortess-terrace. They also advise that the London County Council be again informed that with reference to the suggested widenings of Highgate-road, the Borough Council are of opinion that it is very necessary that they should be carried out in connection with the electrification of the tramways, but having regard to the fact that the widenings are only rendered necessary for tramway purposes, the local Council cannot see their way to make any contribution towards the cost.

A letter has been received from the clerk to the County Council, stating that the Council have decided to apply to Parliament next year for authority to construct a double line of tramways from Ferdinand-street along Chalk Farm-road to Child's Hill.

NORMAL WORKING OF DESTRUCTOR PLANT.

We have received from Messrs. Meldrum Bros., Ltd. (in liquidation), Timperley, near Manchester, some interesting figures relative to the normal working of destructor plant supplied by them to the Prahran Municipality, Victoria. The total weight of refuse burned for the month of July last appears at 661 tons 2 cwt. 7 lbs. The quantity used per day ranged from 15 tons 15 cwt 3 qrs. 14 lbs. to 35 tons 11 cwt. 3 qrs. 14 lbs., and the electricity generated in B.T.U. varied from 33·36 to 48·30 per ton. The units generated totalled 27,870, averaging 42·6 per ton of refuse, and 114·69 per hour (maximum 120, minimum 102·17). The revenue for the month at a half-penny per unit figures out at £58 1s. 3d.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

"If thou hast knowledge, let others light their candle at it."

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should be *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

Question No. 1,199.—On a direct-current three-wire system (460 and 230 volts), when the middle wire fuse on the Board of Trade panel has blown, owing to a fault on either outer, what are the advantages and disadvantages of: (1) earthing the middle wire through a 16 c.p. lamp; (2) or earthing the middle wire through a low resistance, say about 6 ohms? Also state the electrolytic actions which occur under the above conditions. It may be mentioned that the middle wire of this system is somewhat faulty.

Answer to Question No. 1,199 (*awarded* 10*s.*).—(1) Earthing through a 16 c.p. lamp has the advantage of indicating the presence of a fault on the system and a rough idea of its magnitude according to the brightness of the lamp. Its disadvantage is that it allows a re-distribution of pressures between each main and earth, and creates detrimental stress on any weak parts of the network and consumers' installations. (2) The advantages of earthing through a low resistance are that we retain the "anchoring" of the middle wire to earth, and it does not set up severe stress on the system. It frequently allows of the fault burning itself clear, if on consumers' premises, by blowing their fuses, and it provides ocular demonstration to the department men when they are localising the faulty section. On the other hand, it has the disadvantage that it allows a fairly heavy current to flow through the fault, which on small systems sets up a serious out of balance until disconnected.

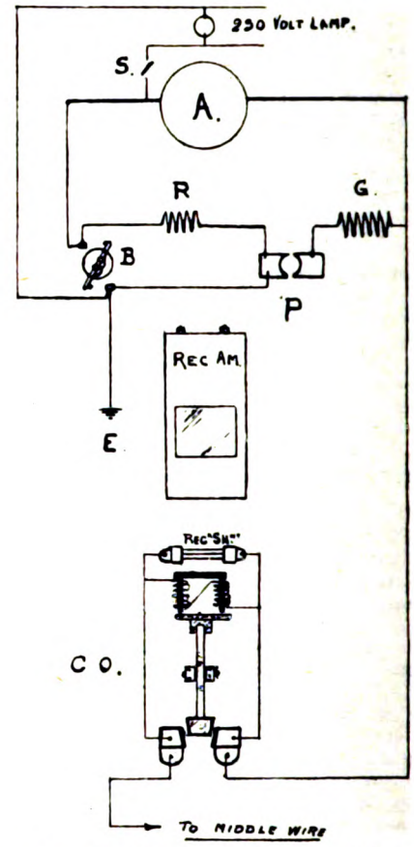
In a three-wire network which is insulated throughout its length, except at the generating station, we may say that it is imperative that the station earth should *never be entirely broken* for purposes of the daily tests. Even during normal working this should not be done, on account of the undesirable stresses to which the system is subjected. For these really necessary tests, see THE ELECTRICAL ENGINEER, October 2, 1908. Mr. F. C. Raphael, in "The Localisation of Faults," gives a method by which the insulation is calculated; not by breaking the middle-wire earth, but by increasing its resistance for the few moments that the test occupies.

A middle-wire panel to meet all these conditions is shown in Fig. 1, where A is a low resistance centre zero ammeter of resistance r; B is the circuit breaker; R is the low resistance of approximately same value as the insulation of the network; G is a shunt resistance of value R + r; P is a plug to insert G between middle-wire and earth; and C O is an automatic cut-out for recording ammeter.

The insulation of the network is arrived at by tripping C O and the breaker B, then open switch S and take reading d_1 on A. Afterwards insert P and note reading d_2. Then—

$$F = \frac{d_1 - d_2}{2d_2 - d_1} G$$

Electrolysis.—The subject of electrolysis is a very complex one, and its vagaries are occupying the minds of mains engineers more keenly every day; some hundreds of yards in the writer's district are on the borders of condemnation from this cause. As the middle-wire of the querist's system is "somewhat faulty," it is to be hoped that the bonding of his lead-covered cables is not in like condition, especially if there is a tramway service in the locality. A fault to lead on an outer under such conditions of bonding will cause serious disintegration of the lead at the nearest water pipe, gas pipe, the low "Fault resistance" of the middle-wire, or other short cut to the station. It will inevitably cause trouble sooner or later.



One cannot earth the lead indiscriminately at each and every point, for we must remember that we are not only making it easy for currents to leave the cable, but lending a helping hand for any vagabond current to climb on to it. It does not require a potential of 1·5 volts to produce electrolytic corrosion, but its ravages may be set up with as low as 0·5 of a volt potential difference to earth. I have yet to come across a system of any size which does not embody the conglomerate ideas of at least two engineers. The fate of lead-covered cables largely depends on the system of bonding in use. MAINS ENGINEER.

Answer to Question No. 1,199 (*awarded* 5*s.*).—Great variety of opinion exists as to the extent to which the middle-wire of a three-wire system should be earthed. That it should be earthed in some way there can be little doubt, though some systems have run for many years with an unearthed neutral without any apparent trouble arising therefrom. Nevertheless, the obvious reason for the advisability of earthing the neutral is that by so doing the negative outer cannot gradually assume earth potential by electric osmosis, so causing the positive outer to rise 400–500 volts above earth potential, unduly straining the insulation and making it possible to obtain a 400 volt shock from the positive outer to earth, which is, of course, contrary to the Board of Trade regulation limiting the maximum pressure above earth in such cases to 250 volts. The Board of Trade stipulates that the middle-wire of every three-wire system shall be earthed at the generating station, and efficiently insulated over the rest of its length. In designing the section of the earthing wire, the rule formulated by the German electrical engineers may be adopted, though a more liberal allowance is preferable. The V.D.E. rule is 1 mm² of copper per 10 amps. of the maximum earth current to be carried, with a minimum section of earth-wire of 16 mm² adequately protected from mechanical and chemical injury.

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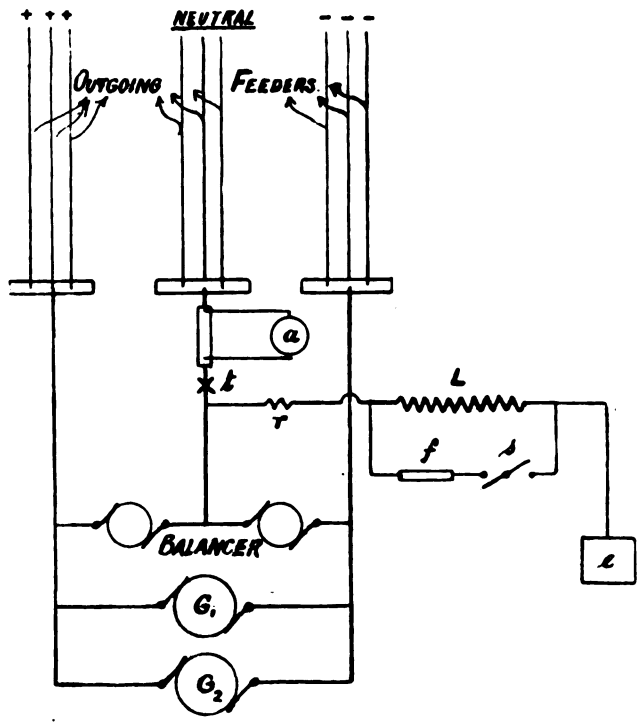
If the "earth" at the generating station is through an appreciable resistance, as is advisable for the reason given below, this earth should be the only one on the neutral wire *which should be thoroughly insulated at all other points* —if, as here, this precaution be not duly attended to, much trouble will ensue, as explained below.

The middle wire of a three-wire system should never be provided with fuses or automatic cut-outs so that by their opening the middle wire is completely cut off from earth. If they are fitted at all, it should only be at the generating station, as in Fig. 1, and a shunt circuit of considerable resistance should always be placed across the fuse or circuit breaker to form an alternative path. The middle wire forms the balancing wire of the system, and any interruption of its continuity may cause serious unbalance of p.d. across the two halves of the system if the loads on these halves be unequal (as is usually the case to a greater or less degree). A "short" or other serious fault on either outer tends to raise the p.d. across the other side of the system, and to make this tendency a minimum it is necessary to reduce the neutral resistance as far as possible. This may be done, without extra expenditure on copper, by stoutly inter-connecting the neutrals of all the distributor sections of a system, the outers naturally being isolated section to section in the usual way.

Value of Resistance in Earth Circuit.—Though complete interruption of the "neutral" such as at present is effected on the occurrence of a heavy earth current is undesirable on the above grounds, the unhindered flow of such a heavy current would cause serious damage to the cable sheaths, etc., into which it passed *en route* for the fault. The most satisfactory earth connection, where the middle wire is insulated except at its earthing point, is, therefore, that shown in Fig. 2. A suitable resistance shunting the fuse *f* may consist of a bank of lamps carrying 10–15 amps. when subjected to half the voltage between the outer; *f* may be of, say, 50 amps. capacity. A fault on either outer resulting in an earth current from the neutral of over 50 amps. blows *f* and the current simultaneously with its diversion *viâ* L is reduced to 10 or 15 amps. Against this arrangement is, of course, the argument that the continued flow of 10 or 15 amps. till the fault is removed may cause a considerable amount of damage at the fault. However, the fault should be very rapidly isolated by the fuses or breakers controlling it, and the fact that the middle wire is still earthed leads to a restoration of the pressure balance directly the fault is removed, and may save the station from a complete shut down. Otherwise, the balance would not be restored till *f* was replaced and *s* re-closed, and intermittent faults would cause a deal of trouble. It is usually advisable to insert a small resistance *r* permanently in the earth circuit, so as to bring the normal resistance of the wire from *m* to *e* up to about 1½ to 2 ohms. This, while being sufficient to limit sudden surges of current below the limit at which *f* will blow, is not sufficient to raise the potential of the neutral above earth so far as to cause electrolytic and heating troubles as below.

The passage of an earth current C_E from the neutral through resistance *r* in the earth wire will raise the potential of the neutral *v* volts above earth where $v = C_E$. If the resistance of the neutral between a certain point and the earthing point at the station = R ohms, and the current in the middle wire be constant between these points (which it seldom is owing to local equalising currents between different parts of the circuit), then the potential at the distant point would be *V* volts above earth where $V = C_E (r + R)$.

Assuming a failure in the insulation of a neutral wire earthed as above, the conductor will normally be V volts above earth at the fault (this p.d. may be increased or decreased, as the case may be) by local currents in the neutral), and hence a leakage current will flow to earth, which, besides the electrolytic damage it causes to the cable, has been known to fire the insulation and melt the lead sheathing. These troubles naturally rise with V and so with r. The points to be emphasised are, therefore: (*a*) that *r* should be low (preferably below 6 ohms even, a 16 c.p. lamp being far too high), the emergency resistance L being designed as above and fulfilling quite a different and exceptional duty; and (*b*) that the insulation of the middle wire should be very carefully maintained at every point except the actual earthing point. (This, a Board of Trade regulation, is apparently ignored here).



The satisfactory maintenance of the neutral insulation is only possible if it be tested frequently, and to facilitate such tests it is convenient to install an isolating switch *t* to enable the neutral to be quite disconnected from earth for testing purposes. This switch should only be opened at night (between 12 midnight and 6 a.m., say), when the earth current is low and likely to remain so. The ammeter *a* is provided with a universal shunt to enable a wide range of "neutral" currents to be read. Normally, the instrument should be left with its most insensitive connections.

Any faults in the neutral insulation are liable to rapidly increase themselves or to create faults in adjacent cables by osmotic attraction or repulsion of moisture according to the usual polarity of the fault; as a rule the fault is positive to earth, and so repels moisture; electrolytic corrosion is then serious.

Where three-core concentric cables are used in three-wire systems, the outer is invariably the neutral, and may be laid bare (the copper being, however, sheathed with lead to prevent corrosion by acidic constituents of the soil). In such a case the neutral is thoroughly earthed throughout, and though the dangers of electrolytic action, present in an "insulated" neutral completely earthed at one point and more or less perfectly earthed at various faults in the insulation, are thus avoided, the possibility of unrestricted rushes of earth currents quite incapable of control and able to seriously damage adjacent cable sheaths is a great disadvantage of this system, which is, therefore, seldom used.—"L. C."

Answer to Question No. 1199. (*Awarded* 5*s.*).—It will depend entirely on the insulation resistance of the middle-wire main as to whether it will be most advantageous to use a 16 c.p. lamp or a 6 ohm resistance in the "earth" wire, to be put into circuit in the event of the "earth" fuse blowing.

A 16 c.p. lamp will have a resistance of approximately 800 watts. Suppose the insulation resistance is high on the middle wire, then in the event of an earth on either of the outers the current due to the fault will be limited to $\frac{230}{800} \propto$. But if the 6 watt resistance was used instead of the lamp it would be possible for a leakage current to rise to $\frac{230}{6} \propto$. This current has to find its way from the fault to the station earth plates by way of water, gas and other pipes, damp

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soil, etc., and, of course, sets up an electrolytic action wherever it changes from one kind of conductor to another, and, slightly, in all parts of its paths. It is, therefore, absolutely essential that this current shall be kept down, and where the IR of the middle wire is at all good, say to $\frac{1}{10}$ megohm, the high resistance is the best to use.

But the case is entirely altered if the middle wire has any faults on it (and most middle wires have). Now, if the high resistance is in the earth circuit, the current will flow from the fault on the outer to the middle wire through the faults on that wire, thus completing its circuit. This current may rise to anything, but the ammeter on the station earth wire will only show $\frac{230}{800}$ ∝.

The local current from the fault will set up electrolysis in its path from the fault on the otuer to those on the middle, and at the latter points will very probably cause an excessive electrolytic action, thus making those faults worse. At the same time, unless the fault current has a fair ratio to the load on the mains, there will be nothing to indicate at the station the amount of the leakage current.

If the 6 watt resistance were used the current would be diverted from the middle wire faults, or, at any rate, the current through those faults would be reudced, and from the value of the current in the earth wire at the station the resistance of the fault could be judged.

Electrolysis will in this case be reduced, though, perhaps, not entirely stopped.—J. H. D.

COMPANIES' MEETING.

BROMLEY (KENT) ELECTRIC LIGHT AND POWER.

The directors of the Bromley (Kent) Electric Light and Power Co. have declared an interim dividend of 4% per annum (2s. per share), less income-tax, on the Ordinary shares for the past half-year, payable October 1.

COMPANIES REGISTERED.

Electrical Trolly Head Co., Ltd.—Registered September 8, by the Solicitors' Law Stationery Society, Ltd., 28-9, Chancery-Lane, W.C. Capital, £6,000, in £1 shares. Objects: To adopt an agreement with J. T. Cherry and E. H. Clive for the acquisition of certain patents, and to carry on the business of electrical engineers, manufacturers of and dealers in electrical trolly heads, etc. Minimum cash subscription, 1,000 shares. The first directors (to number not less than two nor more than seven) are S. J. Harris and J. Griffin. Qualification, 10 Ordinary shares.

Kent Electric Power Syndicate, Ltd.—Debenture for £1,038, dated August 5, 1909, charged on the company's undertaking and property, present and future, including uncalled capital. Holders—Kent Electric Power Co., Strood. Satisfaction (*a*) in full on November 8, 1905, of charge, dated February 14, 1905, securing £4,275; (*b*) to the extent of £1,300 on July 24, 1908, of charge, dated May 26, 1905, securing £1,850; and (*c*) in full on August 13, 1906, of charge, dated July 3, 1905, securing £750, also notified on August 21, 1909.

Llandudno and Colwyn Bay Electric Railway, Ltd.—Trust deed, dated July 27, 1909, to secure £75,000 First Mortgage Debentures, charged on the railway undertaking, authorised by the Llandudno and Colwyn Bay Light Railway Orders, 1898 to 1907, and the company's general assets, present and future. Holders—Trustees Executors and Securities Insurance Corporation, Ltd., Winchester House, Old Broad-street, E.C. Satisfaction in full on July 27, 1909, of Debentures, dated March 11, 1909, securing £50,000.

Mittons Fittings, Ltd.—Registered September 3, by J. Burgess, 12, Vernon-street, Stockport. Capital, £1,500, in £1 shares. Objects: To acquire a certain patent for an invention relating to improvements in suspension fittings for inverted gas-burners; to adopt an agreement with D. Mitton; and to carry on the business of manufacturers of and dealers in fittings used in connection with inverted gas-burners and electric lamps of the incandescent type, etc. Private company. The provisional directors are: D. Mitton, E. B. Shepherd and T. Kelley. Qualification of subsequent directors, £50. Holders of shares allotted under purchase agreement may not vote on a poll until the whole of the capital has been applied for. Registered office, 12, Vernon-street, Stockport, Cheshire.

National Lighting Corporation, Ltd.—Registered August 30. Capital £1,000, in £1 shares. Objects: To carry on the business of electricians, manufacturers of and dealers in electric lights and electrical appliances and novelties, etc. Private company. Registered office: 35, Cock-lane, Snow-hill, E.C.

Plutte, Scheele & Co., Ltd.—Registered September 3, by Cecil J. Rawlinson & Son, 47, New Broad-street, E.C. Capital, £6,000, in £1 shares. Objects: To adopt an agreement with F. Plutte for the acquisition of the business of Plutte, Scheele & Co., and to carry on the business of manufacturers and sellers of articles and accessories required in the electrical and allied trades, etc. Private company. The first directors (to number not less than two nor more than five) are: J. N. Cooper and P. Küppers. Remuneration, as fixed by the company. Registered office, 18 and 19, Queenhithe, E.C.

Robert Bowran & Co., Ltd.—Registered August 19. Capital £10,000, in £1 shares (3,000 Preference). Objects: To take over the business of a general and electrical engineer and agent, iron and steel merchants, etc., carried on by R. Bowran, as Robert Bowran & Co., at 4, St. Nicholas-buildings, Newcastle-on-Tyne. Private company. Registered office: 4, St. Nicholas-buildings, Newcastle-on-Tyne.

Sterry-Singleton Co., Ltd.—Registered August 16. Capital £1,000, in £1 shares. Objects: To adopt an agreement with F. W. Sterry & W. A. Singleton and to carry on the business of financiers, concessionnaires, promoters, agents, bankers, electrical and general engineers, contractors, dealers in oil sleepers and rails, manufacturers of and dealers in engines, accumulators, dynamos, motors and rolling stock, etc. Private company.

CONTRACTS OPEN.

HOME.

Bristol.—Education Committee.—Electricians' work at new school, Alexandra Park, Fishponds. (Spec., £2 2s., Rodway & Doning, Gaunt House, Orchard-street.) September 21.

London, S.W.—London County Council.—Tenders are invited for the following:—(1) Manufacture, delivery, and erection in certain of the Council sub-stations of two 500 kw. and one 150 kw. motor generators; (2) manufacture, delivery and erection of high and low tension switchgear for Woolwich and other sub-stations; (3) manufacture, delivery and erection at the Greenwich electricity generating station of steam, exhaust feed and drain pipes, valves, water tanks, etc. Persons desiring to submit tenders may inspect drawings and obtain specifications, bills of quantities, form of tender, and other particulars at the County Hall, Spring-gardens, S.W., upon payment to the Cashier of the Council of £2 for each section. This amount will, after the Council or its Committee shall have come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a *bona-fide* tender and not have withdrawn the same, but in no case will the fee be returned unless a *bona-fide* tender is submitted. Full particulars of the work may be obtained on application at the County Hall before payment of fee for specification, etc. Rate of wages, etc., clause to be observed. Each tender is to be delivered at the County Hall in a sealed cover, addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked "Tender for Motor Generators," "Tender for High and Low Tension Switchgear," "Tender for Pipes, Valves, Water Tanks, etc.," as the case may be. September 21 (by 11 p.m.).

OVERSEAS.

Brussels.—At the offices of the Société Nationale des Chemins de Fer Vicinaux.—To supply the aerial electric equipment of the Anderlues-Lobbe section of the Carniéres-Thuin Light Railway. September 20.

Constantinople.—Admiralty.—Insulated copper cable, commutators, incandescent lamps, brackets, etc. (Part., Ministère de la Marine, A.).—Treasury.—Installation and exploitation of (underground) telephone service for town and district for 30 years. (Part., Ministère des Finances, A.). October 14.

Frankfort-a-M.—Two electrically worked movable cranes of 20 tons each and 12·260m. span; one ditto 5 tons and 13·340m. span; two ditto hand or electrically worked, two 3 tons and 7·195m. span each. Spec., 2s. 6d. (P.O.O.) Eisenbahndirection Hohenzollernplatz 35.

Johannesburg.—Tramway and Lighting Committee.—For additional plant: Boiler-house—Four boilers, each capable of evaporating 14,000 lb. of steam per hour, £9,460; four mechanical stokers, £3,200; economisers, £2,000; one chimney and necessary flues, £2,200; steam, exhaust, and circulating piping (£600 has already been passed), £1,500; two cooling towers, £2,000; cooling pond, £750; two feed-pumps and house, £600; one borehole and pump, complete with house, and reboring existing borehole, £790; removing four Stirling and two Ruston-Proctor boilers, steam pipes, etc., £500; total, £23,000. Engines: Scheme "A," "B" or "C," say £34,000; contingencies, £1,000; total, £58,000.

Melbourne.—Postmaster-General.—100,000 porcelain insulators. November 9.

New South Wales.—At Petersham telephone exchange.—Supply, delivery, and erection of a branching metallic multiple magneto switchboard. November 10.

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NORTH SYDNEY TELEPHONE EXCHANGE.—For the supply, delivery and erection of a common battery switchboard at the Exchange, and also for the supply and delivery of apparatus for use on subscribers' premises, in accordance with specification No. 266. Specifications, general conditions, plans, etc., may be seen at the General Post Offices, Sydney, Melbourne, Brisbane and Adelaide. The work must be tendered for in accordance with schedule, New South Wales, E.E. 144/08, and the shortest time in which the apparatus would be delivered, and the country of manufacture, must be stated. Tenders must be endorsed "Tenders for Switchboard and Apparatus, North Sydney," and addressed to the Deputy Postmaster-General, Sydney, by 2.30 p.m., January 12, 1910. A deposit, or receipt for deposit, must be enclosed with each tender, of 5% on the amount thereof up to £1,000, and 2½% on the amount over that sum. Tender forms, specification, etc., may be obtained, and preliminary deposits paid, at the Commonwealth Offices in London, 72, Victoria-street, S.W.

PARIS.—Military Telegraph Corps.—2,000 kilos bimetallic wire. Papers by September 21. (Part., Direction d'établissement central du matériel de la télégraphie militaire, 51bis, boulevard de Latour-Maubourg. September 30.

SPAIN.—At the Port Works offices, Valencia. To supply six electric (1-ton power) towers for discharging coal. November 2.

TORONTO (Canada).—The City Council.—For the following electric motors:—Four 1,500 h.p. synchronous motors, two 1,500 h.p. induction motors, four 500 h.p. synchronous motors, four 500 h.p. induction motors, two 225 h.p. synchronous motors, with exciters, switchboards, connecting material, etc. For specifications, etc., apply to the City Engineer, by noon, October 14.

VALENCIA.—Harbour Board.—Six 1-ton electric cranes for timber unloading. (Part., Junta de Obras del Puerto.) November 2.

SOME CONTRACTS.

INDIA.—The D. P. Battery Co.'s contracts during the past week include orders for the supply and erection at Howrah of a storage battery having a capacity of 800 kw. hours, for the East Indian Railway Co., and another for New South Wales. In the home trade the company have secured contracts for 13 batteries for country house lighting, installations for the purpose of Government tests, and metal depositing work, as well as sundry renewal orders.

ONTARIO.—In connection with the construction of the Government's power transmission system, we hear that the contracts for the erection of the transformer stations at St. Mary's, Stratford, Berlin, and Guelph, were given to Messrs. Edge & Gutteridge, of Seaforth, while those at Preston, Paris, Woodstock, and St. Thomas were let to Mr. John Hayman, of London, Ontario. The contract for the supplying of 12,000 galvanised clamps to carry the cable was awarded to Messrs. Pratt & Latchford, of Brantford.

KORUMBURRA (Victoria).—Messrs. McLean & Co., of Melbourne, have signed the contract for the supply and erection of electric lighting plant at a cost of £2,160, the contract to be completed within nine months.

The Premier Accumulator Co., Ltd., Northampton, have recently secured orders for 56 lighting type cells for Lord Rosebery, and also 55 lighting type cells for Lord Fitzwilliam, a lighting battery of 56 cells for Melbourne, and another lighting type battery for India, together with 264 cells in lead-lined wood boxes and automatic reversible booster and switch-gear for the Wallasey U.D.U., with 10 years maintenance. The Company have completed an extension to their works in order to cope more efficiently with increased orders.

TENDERS ACCEPTED.

WORTHING.—The offer of the Beck Flame Lamp Co., to supply Beck Lamps at a cost of £638 was accepted, it being proposed to substitute these for the present arc lamps.

BUSINESS NOTES.

LIGHTING AND GENERAL—Home.

ABERDEEN.—A number of employés of the Great North of Scotland Railway Co.'s locomotive works, Inverurie, paid a visit of inspection at the City Electricity Works. The party, numbering about 80, assembled at the junction of Justice Mill-lane and Holburn-street, where they were met by Mr. A. M'Kay, mains superintendent. At this point they entered the cable sub-way, and proceeded to the works, where they were divided into five sections, under the direction of Mr. M'Kay, Mr. W. Hodson, Mr. W. C. Kennedy, Mr. H. Smythe, and Mr. W. M'Kessock. The various sections were then taken over the boiler and engine rooms, offices, workshops, etc., and everything was most interestingly explained and described. At the close of the visit, Mr. William Cowie, foreman, thanked Mr. J. A. Bell (City Electrical Engineer) for granting permission for them to be shown round the works, where so much was seen to interest them. He thanked Mr. M'Kay and his assistants for acting as guides, and making their visit so enjoyable and profitable.

ABERDEEN.—The annual accounts of the Electricity Committee, as submitted to the Town Council, showed that the net revenue, after charging £9,657 8s. 4d. as depreciation on machinery, etc., and £6,426 8s. 8d. for sinking fund, leaves £227 to be credited to the reserve fund, and that the total liabilities of the undertaking, after crediting the reserve fund with £14,000, amounts to almost £238,928 2s. 2d. Councillor Gray, in moving the adoption of the accounts, said that in view of the fact that they were, so to speak, marking time in the matter of their output, he had no doubt that the Council would endorse the wisdom of their refraining in the meantime from going on with the proposed extension of buildings at the Dee Village Works. The committee had resolved to recommend that the practice hitherto followed of allowing a certain sum for depreciation should be discontinued, and that the amount allocated each year to the sinking fund should be largely increased. The committee had resolved to introduce a flat rate of 3½d. per Board of Trade unit, with alternative terms to large consumers, as explained in our last issue. Consumers of power current taking over 10,000 Board of Trade units per half-year were able to obtain all over 10,000 units at ⅞ of a 1d. per unit, while the Corporation tramways, which took nearly two million units per annum, or one million units per half-year, had to pay 1½d. per unit, whereas they ought to be able, if they were on the footing of other users, to obtain 990,000 of these units every half-year at ⅞ of a 1d. per unit. He could not attempt to justify the price which was charged for electricity to tramways other than on the ground of expediency and on the ground that to vary the price by way of reduction to such a large consumer would be to throw the whole of other prices into confusion, and might be the means of wrecking the undertaking. The report was adopted.

AMBLE.—The question of the proposed lighting of the town by electricity was discussed at the Urban Council meeting. A vote had been taken of the people by means of a circular, and the Chairman read the figures as follows:—For the scheme, 251; against the scheme, 129; majority for, 122. It was further stated that 230 had sent in papers with the question unanswered, and over 1,000 had been sent out. Mr. Wanless suggested that they employ an expert to examine and report upon the scheme and advise them in the matter, and then take a second vote of the people. Mr. Brown seconded, and this was agreed to. The Council decided to advertise for an expert.

BACUP.—It has been decided to appoint representatives of the Council to meet a Committee of the Rochdale Corporation, with power to arrange terms for the lease and working of a suggested scheme for the extension of the Whitworth tramways from the Bacup boundary at Britannia to the centre of the town.

BRAY.—The Electricity Committee advised the Urban Council that they had had under consideration a report from the Electrical Engineer with reference to the substitution of an oil engine plant for a gas engine, which had been formerly recommended. The Engineer's report recommended that the Local Government Board be asked for formal sanction to a loan of £1,000, particulars of which were submitted at the recent inquiry; that sanction be asked to substitute a Diesel oil engine, originally proposed; that the Engineer be instructed to prepare specifications for one 50 b.h.p. Diesel oil engine, and high and low tension, disconnecting boxes, and that tenders be invited for the necessary works. The report was adopted.

BRIDLINGTON.—The Borough Electrical Engineer (Mr. Arthur J. Beckett) reports that, in spite of many difficulties, the deficit on the undertaking for the year has been reduced from £275 8s. 8d. in the previous year to £188, for this year being a net improvement in the working of over £87 8s. 8d. A most noticeable feature in the year's working is that for the first time since the undertaking commenced, the revenue from private lighting and other sources has exceeded that of the public street lighting, and there has been an increased revenue of £387 11s. 11d. for the year ended March 31 last, and an increase of 34,007 units sold.

CARDIFF.—The capital expenditure on the Electricity undertaking amounts to £262,967. The income during the past year totalled £41,976, an increase of £2,765. The expenditure during the year came to £25,853, an increase of £1,207. The gross profit carried to net revenue was £16,122, and the loan charges and sinking fund amounted to £16,025. Therefore, exclusive of provision for depreciation, the year's working resulted in a credit balance of £97.

DUBLIN.—The electric lighting so much admired at the recent dance given by Colonel the Hon. Charles Crichton at Mullaboden, Ballymore-Eustace, was installed by Messrs. Maguire & Gatchell, of Dawson-street, Dublin, who have also completed similar installations for the Earl of Dunraven; Colonel St. Leger Moore, Naas; Major Close, Drumbanagher, Newry; F. W. O'Hara, Esq., Castlebar House, Sligo; Sir Horace Plunkett, Kilteragh, Foxrock; W. A. Conduit, Esq.,

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Massbrook, Crossmolina; etc. The same firm were entrusted by the Board of Works with the electric lighting in the Vice-regal Lodge for the Earl and Countess of Aberdeen.

DYSART.—The agreement between the Kirkcaldy and Dysart Councils respecting the scheme for extending the Kirkcaldy tramways to Dysart has been before the Council, and various minor alterations approved. The Town Clerk of Kirkcaldy having applied for the Dysart Council's consent to include in the Provisional Order powers to supply electricity for lighting in Dysart burgh, inquiry is to be made into the matter.

ECCLES.—The accounts of the Corporation Electricity Department show that the profit for the year ended March 31 was £860 6s. 11d., compared with £443 18s. 8d. the previous year. There was an increase in the sale of current amounting to £1,861 8s. 5d., against which had to be set increases of £84 7s. 5d. in loan charges and £1,360 12s. 9d. in general working expenses, leaving a net increase of £416 8s. 3d. Of the surplus, £333 15s. 9d. was carried to the reduction of the Preliminary Expenses account, which was thereby brought down to £706, the amount sanctioned by the Local Government Board. The balance of the arbitration account of £499 9s. 6d. was paid off, and the sum of £27 1s. 8d. carried to the reserve fund.

HASLEMERE.—The Parish Council had before them a letter from the Hambledon Rural District Council, stating that the conditions on which the Haslemere and Hindhead Electric Lighting Co. proposed to supply electric light in Haslemere were 2s. 6d. per quarter per lamp, that there should be no less than four lamps in each house connected, and that the owner or occupier should agree to pay for at least three years whether the house was occupied or not. It was decided to ask that the condition of there being not less than four lamps should be reduced to two.

HOVE.—At the Council meeting it was announced that the 'Bus Co. had for use on the road between Hove and Brighton four electric 'buses.

KILWINNING.—The Northern District Committee of the Ayrshire County Council appointed a sub-committee in connection with a proposed scheme for electric lighting at Ardrossan and Stevenston.

LEEDS.—Sanction has been given by the Corporation Electricity Department to the expenditure of £25 on domestic electrical appliances for heating, ironing and other purposes, with the object of inducing householders who utilise the electric light to increase their consumption by extending the uses to which the current may be put. The appliances will be loaned to selected customers.

MALVERN.—The Electrical Engineer reported to the Rural Council that there was an increased demand over last month equal to 89·8 c.p. lamps, making a total now connected in 8 c.p. lamps of 15,672. There were now 194 consumers. A report was made as to the necessity for an electric sub-station in the vicinity of the College, and the terms upon which the Rev. S. R. James (headmaster) was prepared to provide a site. The Electricity Committee recommended that the terms be accepted subject to an agreement, and this proposal was approved.

NEWCASTLE (Ireland).—Messrs. J. W. Fraser & Co., Lewisham, have notified the Urban Council that they are applying to the Board of Trade for a Provisional Order, authorising them to generate and sell electricity for lighting and power purposes within the Council's area. "As we understand the Council do not contemplate taking the matter up themselves," the firm added, "we, therefore, venture to rely on their support to our application." The Council decided to inquire from Messrs. Fraser as to the probable date of completion of works, nature of construction, and approximate charges.

RYHOPE.—Plans for the provision of an electric sub-station have been approved by the Sunderland Rural Council.

SHEFFIELD.—At the City Council meeting Councillor Neal moved "That it be an instruction to any Committee of the Council (including the Education Committee) requiring work doing by an electrician not to apply for or accept any tender for such work—but that the same be entrusted to the Electric Supply Department of the Corporation; which department is hereby instructed to execute such work at the actual net cost thereof, with an addition of 5% to cover standing charges." The general opinion was that frequent competition from outside traders was necessary in order to keep the Corporation departments in proper order, and that it was not right for the Corporation to interfere unduly with private manufacturers. The motion was lost, 10 voting in its favour and 30 against.

TAVISTOCK.—At the Urban Council meeting Mr. Foster moved that the Council apply to the Board of Trade for a Provisional Order granting them the power to erect works for the purpose of supplying electric light and power in Tavistock. They had had the order of an outside firm, but he thought it was desirable that if there was to be electric lighting the persons to control it were the public authority, and the proper persons to receive the benefit of the profits to be derived were the ratepayers. The matter was allowed to remain in abeyance.

TORQUAY.—The Local Government Board wrote asking for the observations of the Council upon a communication which they had received from residents in Beacon-terrace, in close proximity to the electric lighting station, calling attention to the nuisance therefrom caused by vibration and dirty smoke fumes. They asked that no loan should be granted for any new municipal buildings until the electric lighting station was removed to another part of the town, where it would cease to be a nuisance. The Council decided to refer the matter to the Electric Lighting Committee.

WATFORD.—The annual income of the Urban Council's Electric Lighting undertaking from private consumers has increased from £4,907 17s. 2d. in 1905 to £8,315 8s. 4d. last year. The number of consumers now appears as 712 against 425 in 1905. To the Electric Light Committee, the Clerk reported that after conference with the Chairman he had consented to the deletion of Clause 36 relating to the supply of electric fittings from the Bill, as it was deemed better to rely on the provision of the Electric Lighting Amendments Act Bill, which was now before Parliament, and would probably be passed this Session.

WEDNESBURY.—The Borough Electricity Supply accounts for the year ended March 31 last show that the gross receipts were £2,086 5s. 2d. Generating expenses absorbed £1,133 2s. 5d.; distributing expenses, £59 5s. 8d.; and management expenses, £346 18s. 1d.; and after defraying other expenditure there remains a gross profit of £438 4s. 5d. The Department purchased approximately 148,000 units, and generated 195,000 units. The quantity sold totalled 223,700 units, and the quantity lost in conversion to direct current, used on works, lost in storage, and on mains appears as 119,300 units. Owing to the works meters being out of use for part of the period, due to change in system of supply, the figures for electricity used on works in conversion and storage and lost in distribution are approximated.

WORCESTER.—At the City Council meeting the Finance Committee recommended that application be made to the Local Government Board to sanction a loan of £656, for the storage and handling of coal at the Hylton-road Electricity Works, repayable in seven years; and that, notwithstanding the proposal to borrow the above sum, it be repaid out of the revenue of the Electricity Department by three yearly instalments. The Council, however, adopted an amendment to the effect that the Electricity Committee should repay the sum in five years.

LIGHTING AND GENERAL—Overseas.

AUSTRALIA.—A series of large pumping plants for irrigation on the River Murray is being installed by the Victorian State Rivers and Water Supply Commission. The Government stipulated that the necessary machinery should as far as possible be made in Australia, and Messrs. G. Weymouth Pty., Ltd. of Richmond, secured the orders for all the plants. The pumps, auxiliaries and electric lighting sets were from Messrs. Weymouth's own works. The total capacity of the whole of the plants is 34,500 c.f. of water per minute, or sufficient to flood about 1,150 acres one foot deep per day.—The Ballina (N.S.W.) Municipal Council has invited applications for a scheme of electric lighting for a period not exceeding 10 years, after which the Council is to have the right to purchase the plant at a valuation.—The Fremantle and East Fremantle Municipalities have successfully floated a joint loan of £30,000 for tramways and electric lighting purposes.—Messrs. Noyes Bros. (Sydney), Ltd., have completed the installation of an electric light plant at the Lithgow Iron Works. The plant consists of a 10 kw. Westinghouse 125 volt, compound wound direct current generator, coupled to a Westinghouse "Standard" vertical two-cylinder high speed engine. The light is provided by 21 enclosed arc lamps, which will enable the rolling mills and the bolt and engineering shops to work at night.

BOLIVIA.—A British Consular report indicates that the installation of electric power works in Sucre has created a favourable opening for the introduction of electricity for power purposes in local industries. The works are situated about eight miles from Sucre, and the wires to the town are carried overhead on wooden posts, which the Consul states are unsightly, and cannot last long. British manufacturers are invited to consider if they could not produce cast-iron posts at less than 6s. 8d. per 8 ft. length that would better suit the purpose.

CANADA.—We hear that plans are in preparation by the British Columbia Electric Railway Co., and the Vancouver Railway Co., of Vancouver, B.C., for the construction of a water-power plant on Vancouver Island for the supply of power to Vancouver and Victoria.

CHARLTON (Victoria).—It is proposed to form an electric lighting company with a capital of £2,900.

FOOTSCRAY (Victoria).—An effective departure has been made in the manner of firing blasting charges at Mr. C. E. Eldridge's Standard Quarries, the old-time fire-fuse being replaced by an electric current.

INDIA.—The Calcutta Electric Supply Corporation, Ltd., are increasing their capital to the extent of £400,000, with the object of providing for the further extensions of mains necessary

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to meet the constantly increasing demands for current, and for the purpose of purchasing a site and erecting thereon and equipping a high-tension generating station.

KALGOORLIE (Western Australia).—The revenue of the electric lighting department for June amounted to £1,801, and the working expenses to £911, leaving a profit of £890. The revenue for the six months showed an improvement of £62 as compared with that for the same portion of last year, the profit having increased by £502. The electrical engineer reports that the number of consumers is steadily increasing.

LAUNCESTON (Australia).—The City Council has instructed Messrs. Strike and David, the municipal engineers, to prepare plans and specifications for the construction of a proposed tramway.

LONDON (Canada).—A scheme for the provision of underground transmission wires in connection with the installation of Niàgara power has been favourably considered by the Council. The cost is estimated at $70,000.

MONTE ROSA.—The advantages of the telephone have now been extended to the Margherita Observatory on Monte Rosa. The cost of the line, which is probably the highest on record, was defraved by Queen Margherita of Italy. From the Observatory, which is situate over 15,000 ft. above sea level, the staff will be able to speak to Rome and Milan.

ROSS (New Zealand).—Messrs. Maben & Welch, of Wellington, have installed for the Ross Goldfields, Ltd., the electrical machinery for the transmission of 1,000 h.p. from Kanieri Forks to the mine at Ross, a distance of about 23 miles.

SHEPPARTON (Victoria).—A deputation has been appointed by public meeting to urge upon shire Council that the time is opportune for the installation of the electric light in the district.

SOUTH AFRICA.—From an extract from the *Cape Times* it appears that, on one of the Rand mines, underground telephonic communication has been established. It is said that the installation of telephones underground is likely to be carried out on the Randfontein estates and Langlaagte, as well as on other mining properties. H.M. Trade Commissioner for South Africa (Mr. R. Sothern Holland) has forwarded an extract from the *South African Mining Journal*, according to which tenders are to be invited for the supply, to the Johannesburg Town Council, of electric generating plant, etc., to the value of some £57,000, as follows:—4 boilers, each capable of producing 14,000 lbs. of steam per hour, £9,460; 4 mechanical stokers, £3,200; economisers, £2,000; 1 chimney and necessary flues, £2,200; steam, exhaust and circulating piping, £1,500; 2 cooling towers, £2,000; cooling pond, £750; 2 feed-pumps and house, £600; 1 borehole and pump, complete with house, and reboring existing borehole, £790; removing 6 boilers, steam pipes, etc., £500; engines, about £34,000.

ST. CATHERINE'S (Canada).—The Ridgeville Electric Light and Power Co., Ltd., has just been formed, with a capital of $40,000, to supply electric light and power to places in the townships of Thorold, Pelham and Gainsboro'. A franchise has been obtained in the two townships first named.

TIFLIS.—A new loan is proposed for the provision of a hydraulic power station, irrigation and other purposes.

VADO.—A scheme for the provision of a central electric generating station has been approved by the Italian Railways Executive Council. The cost is estimated at £60,000.

VICTORIA (Australia).—During last year permits were granted with respect to electric light or power works to the municipal councils of Prahran, Camperdown, Terang and Sunbury, also to the Leongatha Butter Factory Co. Under the Electric Light and Power Act, electricity for light or power is now supplied in Melbourne and part of the suburbs, also in Ballarat, Bendigo, Geelong, Nhill, Inglewood, Hamilton, Kerang, Donald, Sunbury, Camperdown, Kilmore, Leongatha and Mildura.

VIENNA.—The communal authorities of Gloggnitz, according to a Vienna report, are arranging to erect electrical works, the power to drive which will be obtained from the Weissenbach waterfalls. It is proposed to contract a loan for the carrying out of the works in question, which it is estimated will cost 267,000 kronen (about £11,000).

WELLINGTON (New Zealand).—The annual report by the Electrical Engineer (Mr. Stuart Robinson) states that the gross revenue of the municipal Electric Light Department for the year ended March 31 last amounted to £44,321 8s. 2d., made up as follows:—Private lighting, £37,836 2s. 8d.; public lighting, £1,148 6s. 8d.; power supply, £5,117 7s. 9d; and miscellaneous receipts, £219 11s. 1d. The total working expenses, including renewals to plant for the year, amounted to £25,018 19s. 2d. After providing for interest on debentures, 2% sinking fund in repayment of debentures, and setting aside a sum of £5,466 11s. 9d. as depreciation, there is a net surplus of £4,272 6s. 6d. The total number of units generated amounted to 2,571,688. Private lighting installations absorbed 1,464,389 units, and power consumers took 409,391 units. In addition to this, 130,524 units were supplied for street lighting, and 50,229 units used in the works. During the year the tender of Messrs. C. A. Parsons & Co., of Newcastle-on-Tyne, for the supply of a 1,500 kw. turbine generating set, was accepted. Part of this plant has already come to hand, and will be erected in the new part of the station. The working of this set, which will be available in about three months' time, will add materially to the efficiency of the station. The revolution in electrical lighting effected by the metallic filament lamps is already having a considerable effect in decreasing the gross revenue of the department, but the electrical engineer believes the electric light will be so greatly popularised that the corresponding increase in business will enable the city to continue the undertaking on a sound financial basis.

TRACTION—Home.

BELFAST.—To the Tramways and Electricity Committee the Electrical Engineer (Mr. T. W. Bloxam) submitted for approval plans showing the proposed new positions of tramway poles and alterations necessary to the equipment to allow of the removal of the centre poles at the junction of Howard-street, and Bedford-street, at the Albert Memorial, at the corner of Ann-street and Victoria-street, and the junction of Ann-street and Oxford-street, as recommended by the City Commissioner of Police; and also plans and estimates of the cost of the removal of all the centre poles in the city, with a view to doing away with all obstructions to street traffic. The committee considered the proposals most valuable in the interests of street traffic, while not interfering with the efficiency of the overhead equipment, and instructed the officers concerned to have the alterations carried out, taking the most congested thoroughfares first in hand.

HAMPSTEAD.—Electric cars commenced running on the third and final portion of the London County Council tram route from Holborn to Hampstead, *viâ* King's-cross and Camden Town. The portion of the route between Holborn and Park-street, Camden Town, was opened up a short time ago.

TRACTION—Overseas.

AUSTRIA-HUNGARY.—The district authorities of Hohenfurt have arranged to construct as soon as possible an electric railway from Zartlesdorf to Lippnerschwebe. The cost of construction is estimated at 3,000,000 kronen (£125,000), to cover two-thirds of which it is proposed to issue a loan.

MOSCOW.—Most of the plant for the tramway system now being electrified, has been ordered from Germany. The funds were obtained by a loan raised in London.

PARIS.—The railways radiating from Paris to Versailles, St. Germain, and Argenteuil are to be electrified at a cost of £6,000,000. The work is to be completed in 10 years.

ROME.—The Technological Bureau is receiving offers to supply electric connections for rails and trolley lines for the tramways over 12½ kilos. of route.

SPAIN.—The *Gaceta de Madrid* of August 22 notifies that Don José Curbera Fernandez has applied to the Dirección General de Obras Públicas, Madrid, for a concession for the construction and working of an electric tramway in the city of Vigo and suburbs, and that a period of one month from the date of the *Gaceta* is allowed for the presentation of competing offers at the above-mentioned Dirección. The *Gaceta* of August 25 contains a notice, issued by the Dirección General de Obras Públicas, Madrid, inviting tenders for the construction and working of an electric tramway to run from Calle de Villanova to Calle de Wad-Ras, in Barcelona. Tenders, enclosed in sealed envelopes, and accompanied by a deposit of 3,193 pesetas (about £114), should be addressed to the above-mentioned Dirección, where they will be opened at noon on November 3. An application respecting this concession has already been submitted by the Sociedad Anonima Tranvias de Barcelona á San Anrdés y Extensiones, who have certain preferential rights in the competition. For further particulars, copies of the *Gaceta* referred to may be seen by British firms interested on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C. The *Gaceta* of August 23 contains a notice issued by the Dirección-General de Obras Públicas, granting provisionally to Don Carlos E. Montañés a concession for the construction and working of the Metropolitan Railway (Electric) at Valvidrera. It appears that the work will involve the boring of a tunnel. Two years are allowed for the completion of the work, excluding tunnel operations.

TURIN.—The Italian Government having decided to electrify the line between Modane and Turin, through the Mont-Cenis Tunnel, for local train services, the Municipality of Turin has consented to let one of its stations for a yearly rent of 200,000 lire (£8,000). This is the hydro electric station of Chiomonte, on the Dora-Riparia. This will give sufficient power not only to work the line through the Mont-Cenis, but also along the steep gradients between Modane and Turin.

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AMERICAN NOTES.

(From our Correspondent.)

NEW YORK.

Business is exceptionally brisk both in the wholesale and retail branches of the electrical industry. The demand for electric plant for mills and factories is just about as active as engineers can do with, and numerous notifications are made of inability to accept fresh orders for delivery before February 1, and, in some cases, March 1. The General Electric Co. has this week supplied a 1,500 kw. rotary converter to the New York Central Railroad Co. for lighting service in that portion of the new Grand Central Station which has already been completed, and other sales include an electrically driven installation, with 450 kw. engine-driven generator, for the Firth Carpet Co., of Firthcliff, N.Y.; 500 kw. turbo-generator for the Brighton Mills at Passaic, N.J., and complete installation for the Standard Oil Co.'s plant at Montrose, N.Y. The entire force of the Westinghouse Electric & Manufacturing Co. at East Pittsburgh is now working 10 hours a day, and there are between 10,000 and 11,000 men on the pay-rolls, as compared with 6,000 at the low point last year. The gross business is now running at about $2,500,000 per month, or $30,000,000 per year.

Domestic Appliances.

Retailers report an extraordinarily active demand for accessories, especially electric irons, electric saucepans, chafing dishes and grillers, and economical types of electrical heating and cooking stoves. A new heating stove now on the market, neatly finished in black, sells at 85, or, say, one guinea in English money. Its consumption is one kw. for the first half-hour, and 250 watts per hour thereafter. A big trade is being done in this line. A director of one of your big electrical firms at Home who is over here tells me that there is nothing in the English market at present to come anywhere near this heater in point of cheapness and efficiency. But I think there will be when he gets back again.

Electricity for the People.

This same manufacturer from the Old Country also told me that he had come across nothing in England like the efforts made here by central stations and manufacturers to popularise the household uses of electricity. He mentioned the instance of a large municipal electrical undertaking in the Midlands whose manager refused to wire private houses (already taking current for lighting) for less than £2 per house, and also declined to permit the use of stoves with self-contained meters. On this side, central stations do everything they possibly can to increase consumption, but according to my Manchester friend, that is not the case on your side. I am bound to say I find this difficult to believe, but I send you this statement in order that it may meet with the refutation which I feel convinced will be promptly forthcoming.

Electric Drive for Cotton Mills.

The Allis-Chalmers Co. is furnishing the new Nashawena Mills, in New Bedford, Massachusetts, with two 3,000 kw. and one 500 kw. steam turbines. The same company has also contracted with the Whitman Mills, of New Bedford, for power house equipment, including one 2,000 kw. steam turbine, and with the Byron-Weston Co., of Dalton, Massachusetts, for 1,750 kw. steam turbine. The Allis-Chalmers Co. has recently sold to New England cotton mills 27 steam turbines with an aggregate of 36,000 h.p.

High and Low Pressure Turbine.

A new method of operating a steam turbine has been put in force by the Canton Electric Co., of Canton, Ohio, where a 500 kw. Curtis turbine is sometimes operated in the ordinary way by supplying high pressure steam to the first stage, and thence to the second stage, and sometimes used as a low pressure turbine in connection with the exhaust of one of the steam engines; the exhaust being supplied to the second stage, and the first stage being put out of action. The second stage, says the *Electrical World*, works as a low pressure turbine deriving most of its power from the vacuum maintained by the condenser. In order to provide against slowing down the turbine under over-load, the throttle is open so that high-pressure steam will be supplied by the governor to the first stage whenever the speed falls below a predetermined amount. The governor is so adjusted that under ordinary conditions no high-pressure steam is supplied, but the instant the speed falls the governor opens the valve to supply high-pressure steam.

Sea-Air by Motor.

A generation ago Edison laid down the dictum that there was nothing that electricity could not do. Neither he nor Röntgen had then foreseen the X-ray, and the Herzian wave was barely a ripple. The "Gold brick" man has been busy since with ingenious devices for utilising electricity to extract gold from the ocean, but the yellow metal has generally, I fear, come from the pockets of a confiding public. But now we not only have a machine for making sea-air, with all its health-giving properties, by means of electrical discharges of high frequency, but at least two firms have put this machine on the market at a price at which almost anyone can test it and prove its absolute genuineness. It is to Chicago, in the first instance, that the credit belongs of introducing this wonderful contrivance to the public. It is described as a machine for the generation of ozone by means of electrical discharges. Two firms, the Ozone Pure Airifier Co. and the National Air Filter Co., are offering machines small enough for home and office use and others large enough for public halls. The generators are made for alternating current, and with the addition of a small motor generator, for direct current also. Their value has been proved to demonstration in sick rooms, as well as in crowded assemblies.

Electric Drive for War Vessels

Prof. Reginald Fessenden has submitted a proposition to the United States Navy Department for the experimental equipment of a war vessel with turbo-electric drive. Professor Fessenden's plan is to use steam turbine three-phase generators, with induction motors on the propellor shafts. He claims that higher power can be obtained with less weight under this system than any other. The Navy Department has the matter under the consideration of experts, and the proposal will probably be adopted.

Tungstens Again.

The boom in tungstens still continues. Everybody is talking tungstens just now. Nearly all the technical magazines carry this month full-page advertisements from the General Electric Co. setting forth the value of these lamps for household lighting, and this is only the beginning of an extensive campaign that has been planned for the purpose of popularising tungstens. The advertisements will be published simultaneously in the leading popular periodicals, and travellers will be sent all over the country with sample lamps which, in many cases, will be left with private consumers for trial.

Indiana Tributes.

At the first convention of the Indiana Electric Light Association, held at French Lick, Indiana, the tungsten lamp occupied a very prominent position. Mr. Merrill, of the National Electric Lamp Association of Cleveland, opened the ball with a paper on "The Commercial Effects of the Tungsten Lamp and Its Later Developments," with special reference to the relation between the lamp manufacturer and the central station. *The* stations, said Mr. Merrill, have found the tungsten lamps valuable in attracting much new business by low rates adapted to the new lamps, which stimulate a desire for more light. "Public interest in lamps and lighting is aroused as never before. The tungsten lamp makes possible a degree of illumination which would have been prohibitive a few years ago on the score of expense. The residence customer who cuts down his current consumption for light by using the tungsten lamp is apt to install electric flat-irons or other convenient electric devices, thus helping the day load and the load factor of the station. Never before has the central station been in such an excellent position to meet gas competition."

Outdoor Use.

Mr. Merrill pointed out that low-voltage tungstens are used for outdoor decorative and sign lighting, lamps of 4 c.p. being large enough. These require low-voltage circuits, and 8-volt to 12-volt tungstens can be procured. They must be burned in series or series-multiple, or with transformers if alternating current is available. The transformers should be controlled from the primary side. Voltage drop in secondaries must be small, and the transformers should be operated at as near full load as possible. Sign and decorative lighting is most frequently done on a flat-rate basis, so that by the saving afforded by tungsten lamps a reduction in rate can be made to the customer, while the company secures a better return. Tungsten lamps are also being rapidly introduced for train and automobile lighting, often supplanting gas or oil. The pocket flash-lamp is another form where the new filament is particularly advantageous. Mr. George C. Osburn, of the General Electric Lamp Works, Harrison, N.J., spoke of the opportunities afforded by the tungsten lamp of getting much lighting now done by gas companies. The series tungsten lamp is particularly useful for central stations furnishing street lighting. Mr. Charles H. Howe, of the Holophane Co., of Chicago, said the tungsten lamp should be used to place the central station in a better position in the eyes of the public.

TYNESIDE NOTES.

(From our Correspondent.)

NEWCASTLE.

One or two events in this area during the past few days have demonstrated the somewhat acute state of "nerves" into which the public has fallen with regard to the employment of electricity in mines. The situation is getting almost as dreadful as the fear of the average man for the cable which lies under the street pavement. Any explosion is sure to be

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caused by electricity. In the same way, the Miners' Association for the County of Durham had before them a resolution at their meeting on the 4th inst., embodying the idea that electric cables and machinery should be removed from the mines in which they at present exist, inasmuch as they are regarded as a source of great danger. It was, however, explained that an expert committee is, according to an announcement by the Home Secretary, about to be appointed in order to revise the rules relating to the use of electricity in mines, and on this account the subject was allowed to drop.

Electricity in Mines.

In connection with this matter, the local sections of the Institution of Mining Electrical Engineers are taking a great interest, and there is a strong feeling on the part of the members that the Institution should be represented on the expert committee, and that, moreover, members from each mining district should be allowed to give evidence. That this is a wise precaution to take in the interests of the electrical community is shown by another incident occurring this week in this area. On Tuesday, the 7th inst., in reporting an unfortunate fire which occurred underground at the Bothal pit, Ashington, Northumberland, a correspondent of the *Newcastle Daily Chronicle* reported that it was stated that the fire was caused by the fusing of a wire in connection with an electric hauling engine situated about a quarter of a mile from the shaft. This report was inaccurate, as I have received an authorised statement from the offices of the colliery concerned that the fire was not caused by electricity in any way. In fairness to the *Newcastle Daily Chronicle* it should be stated that this journal corrected the information in a very prompt and full manner; but the incident is instructive as showing the tension of opinion which exists in this area as to the safety of electricity in mines.

Telephone Novelty.

I have received from the Secretary of the Newcastle Chamber of Commerce a copy of his recent report on an interesting telephone novelty in the shape of an automatic telephone exchange. The invention makes it unnecessary for the subscriber to ring, this being done automatically. The apparatus consists of a disc on which are 10 holes, numbering from nothing to nine, and the subscriber presses in turn each of the numbers he requires. The subscriber having finished terminates the connection by hanging the receiver on the hook, and immediately another person can be called up. Should a subscriber wish to call whilst a number is in use he can get no connection until the user has ceased conversation, and this does away with the annoying feature in automatic telephones of being interrupted in the midst of a conversation by someone breaking in.

Orders for Plant.

The use of electricity for industrial purposes is proceeding satisfactorily in the Blyth district, in the north of the county of Northumberland. Messrs. Crompton & Co., Ltd., have recently supplied the Morpeth Road Works of the Star Foundry, Blyth, with a number of motors of various sizes, together with a main distribution board for controlling three-power circuits and a separate starting panel for each motor. The transmission is affected by means of insulated cables to the top of poles, and from pole to pole, by bare copper wire. The first of the motors to be installed was a belt-driven 5 b.h.p. machine running at 1,200 r.p.m. for a fan producing the blast for the forges in the blacksmith's shop. Another 5 b.h.p. motor fitted with a raw hide pinion and geared into a cast iron spur wheel drives a punching and shearing machine; a 25 b.h.p. motor running at 900 r.p.m. drives various tools in the main shop, and a 75 b.h.p. motor at 750 r.p.m. is for a blower for steel castings. Messrs. Crompton & Co., Ltd., have also on order a five-ton crane with wiring complete. The crane is by Messrs. Chatteris, and is equipped with Crompton motors and controllers of the following capacity: one 8 b.h.p. motor for lifting; one 5 b.h.p. motor for longitudinal traverse; and a 1½ b.h.p. motor for cross traverse. The installation also includes the lighting by means of Crompton-Blondel flame arc lamps running 10 in series on 460 volts. A number of lamps have been installed at the copper works, and a 5 b.h.p. motor for driving a pipe-bending machine at the Croft-street premises of the Star Foundry Co. Another order which Messrs. Crompton have obtained from the north-eastern district is in connection with the equipment of the Blyth shipyard, for which they are supplying the following motors: a 13 h.p. motor for mounting on the top of the punch, shear and cutting machine, driving by means of belt; an 8 h.p. motor for driving fan; a 26 h.p. motor situated in the workshop for driving various tools; a 50 h.p. series reversible motor fitted with gearing for driving cold rolls; and a 15 h.p. motor driving through gearing for raising and lowering the rolls.

Corporation Tramways Report.

During the past week the annual report of the General Manager of the Newcastle Corporation Tramways has been published, and this year it affords more than usually interesting reading, both from an engineering and financial point of view. To maintain the plant in good condition, the two batteries formerly installed at the generating station have been replaced and two automatic reversible boosters have been installed in order to work in conjunction with these batteries. Although it is impossible yet to give definite figures as to the actual saving effected by the boosters, it is now possible to run through the heavy evening loads with one large generating set running in conjunction with the batteries, whereas formerly, owing to the workmen's traffic, heavy peak loads were experienced in the winter, necessitating the paralleling of two of their largest generating sets. During the summer months the running plant can now be shut down for some hours during the night, the batteries taking the load. Two sets of new pumps have been installed in the pumping station on the river side, and an additional suction pipe 2 ft. in diameter has been laid from the pumping station to the river. This plant shows a saving of 25% in power used for circulating water purposes. The disadvantages, however, of having the power-house removed some distance from the river are shown by a clause in the report referring to the doubts and uncertainties of a breakdown in connection with the pipe line for circulating water between the pumping station and the power-house, which can only be duplicated at great cost. In this respect the Corporation Station is unfavourably situated as compared with the power-houses of the Newcastle Electric Supply Co., situated practically upon the river bank both at Carville and Neptune Bank. The consumption of coal per unit has been reduced from 4·8 lbs. in the year 1904–5, to 3·57 in the year 1908–9, the units in the two years being respectively 8,581,301 and 9,864,969. There has been a reduction of 143,616 units in the output during the past year because of the curtailment of the service of cars during the strike period which prevailed in the Tyneside district during the year. In connection with the Corporation extensions and improvements at the quayside, a temporary lighting and power installation has been fitted up, and on the completion of these works the plant will be permanently installed. There are now 183 passenger cars in stock, together with one water car and three salt and sand cars.

Reserve Fund for Renewals.

The wisdom of providing a reserve fund for renewals to the extent of £62,699 has been demonstrated by the fact that the expenditure on the maintenance of the cars now shows a tendency to increase as the cars become older. Mr. Hatton is faced with a difficulty which exists in the changing of fares, owing to the fact that there is no intermediate English coin in general circulation between the limits of a penny and penny half-penny. A tentative suggestion is mooted as to the advisability of having, for tramway systems with general characteristics as obtained in Newcastle, a minimum penny half-penny fare, with books of tickets to be purchased at such a reduction as to place the revenue of tramway undertakings on the flexible and controllable basis. The situation is rendered somewhat piquant by the fact that Alderman Sir Joseph Baxter Ellis, who is Chairman of the Newcastle Tramway Committee, has communicated to the local papers his disagreement with such a proposition. The problem appears to be rather a question of differing first conceptions of the problems than of any conclusion therefrom, and I hope to refer more fully to the subject in my next week's communication. In the meantime it may be stated that Mr. Hatton's proposition appears to afford a satisfactory solution to a difficult problem which has to be faced by practically every tramway undertaking in existence.

New Appointment.

A change has recently been made in the teaching staff at the Sunderland Technical College, and Mr. William T. Maccall, M.Sc., A.M.I.E.E., who was formerly teacher of engineering at the Woolwich Polytechnic, and who is now resident in Halifax, has been appointed head of the electrical engineering department.

TRAMWAY STANDARDS AS STAY POLES.

A curious accident, illustrating the trouble which might arise from using tramway standards as stay poles, is described in the *National Telephone Journal* by Mr. E. Harper, local manager N.T.C., Bournemouth. Six or seven years ago, when the electric tramways were constructed, a small route, carrying a few wires, was placed underground where it crossed the tramways, the cable terminating on the poles at either side of the road. Permission was given in one case for the back stay to be stayed back to the nearest tramway standard, which happened to be in the direct line of pull. Recently the trolley arm of a car jumped the trolley wire, and the driver pulled up at a point which caused the metal end of the trolley arm to connect the live wire with the trolley arm supporting it on the standard to which the stay was attached. This standard was not apparently connected to earth beyond that which it obtained through being set in cement in the ground. A portion of the tramway current passed along the stay, which was touching the pot-head at the top of the pole, and thus found its way to earth along the lead sheathing of the cable, burning a hole about two inches long in the cable sheathing. Mr. Harper explains that in order to avoid further trouble one of the tramway authority's strain insulators has been inserted in the stay wire.

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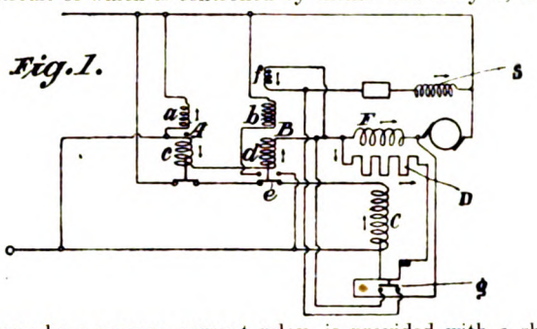
PATENTS.

Control of Dynamo Electric Machines.

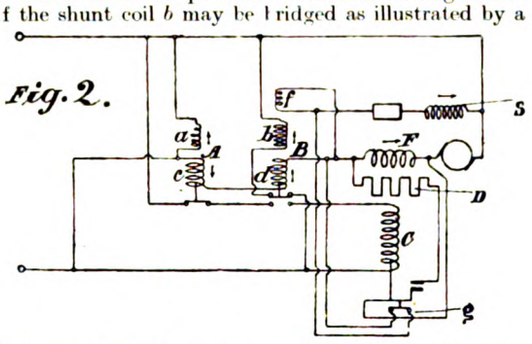
16997.—1908. British Thomson Houston Co., Ltd., London. This improvement refers more particularly to compound wound traction motors, adapted to be run as generators while the vehicle is coasting or reducing its speed so as to return energy to the line. The object is to arrange the controlling mechanism so that when an overload occurs the motor will be provided with a full series field so as to bring down the speed, and also that the shunt field will be opposed by a full series field when the motor begins to act as a dynamo and generate current. In the diagram A and B represent the relays, and C is the contactor, the circuit of which is controlled by them. The relay A, which

Fig. 1.



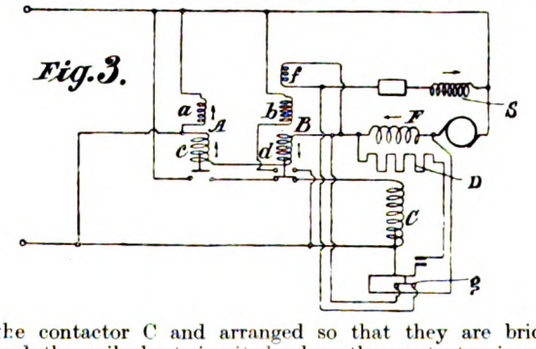
may be a reverse current relay, is provided with a shunt coil *a*, which is nearly strong enough to cause the relay to operate. A series coil *c* is also provided on relay A through which current passes in such a direction as to oppose the shunt coil while the machine is running as a motor, but in a direction to assist the shunt coil *a* when the machine is running as a generator. The second, or overload relay B, is also provided with a shunt coil *b* and a series coil *d*, which are so wound as to assist one another when the machine is running as a motor, but in this case the circuit of the shunt coil *b* is only completed when the relay has operated through an overload on the series coil *d*. This prevents the series field F of the motor from being short circuited again until the controlling switch has first been returned to its off position. The interlocking contacts of of the shunt coil *b* may be bridged as illustrated by a con-

Fig. 2.



tact *e* carried by the core of the relay, or they may be arranged in proximity to the contactor C, which controls the shunt through the diverter D about the series field F of the motor so as to be bridged when the contactor is opened. The overload relay B may be also provided, as illustrated, with a third coil *f* so arranged as to cause the relay to operate with a smaller current when the shunt field S of the motor is weak than when this field is strong. Coil *f* may be connected in series with the shunt field and wound so as to oppose the series winding *d* of the relay, and may have short circuiting contacts *g* controlled by

Fig. 3.



the contactor C and arranged so that they are bridged and the coil short-circuited when the contactor is open. During normal operation the position of the relays and contactor is as illustrated in Fig. 1. It will be seen from this figure that the contactor C is closed, thus establishing a shunt circuit about the series field F of the motor through the diverter D. If, however, an overload occurs in the circuit the overload relay B will operate and cause the bridging contact *e* to break the circuit of the coil of the contactor C as illustrated in Fig. 2. The contactor, therefore, opens and breaks the short circuit about the series field, at the same time bridging the contacts *g* and short-circuiting the coil *f*. The direction of the current through the coil is indicated by the arrows in all the figures. When the motor is acting as a generator, as shown in Fig. 3, it will be seen that the direction of the current through the coil *c* is reversed, and that this coil now assists coil *a* and causes the relay to operate, thereby breaking the circuit through the coil of contactor C and short-circuiting the coil *f*.

Apparatus for Wireless Telegraphy.

16546.—1908. G. Marconi & Marconi's Wireless Telegraph Co., Ltd., London. The station for duplex wireless telegraphy is provided with a transmitter, comprising a disc having studs in its periphery and means for driving the disc rapidly between the terminals of the oscillation circuit and with one or more commutators which are coupled mechanically or electrically so as to rotate in synchronism with the disc and disconnect an aerial wire, or otherwise render the receiver inoperative when the studs on the disc bridge the gap in the oscillation circuit in the transmitter, but connect an aerial wire, or otherwise render the receiver operative, during the time the studs on the disc are not bridging the gap in the oscillation circuit of the transmitter, the latter times being considerably longer than the former.

Telephony and Telegraphy.

16183.—1908. Dr. J. Schiessler, Berlin. A telephonic and telegraphic relay in which for the purpose of strengthening the very weak microphone or telegraphing currents they are transmitted by inductive, electric, or purely galvanic coupling to a strong circuit provided with an incandescent resistance, with which there is connected in parallel a Thomson or Duddell oscillating circuit comprising a regulatable self-induction coil and a variable capacity.

Detecting Faulty Insulators in High Tension Conductors.

14952.—1909. R. Greiner, Strasburg, Alsace. Celluloid rings are arranged around the insulators in proximity to the conductor wire. When short circuiting or earthing occurs, which is invariably accompanied by a flame, the rings are speedily destroyed, and their absence at once indicates which insulator has become defective.

Preparing Asbestos Fibre for Insulating Purposes.

7530.—1909. H. L. Owen, York, U.S.A. The asbestos *is fed* from the carding machine to wheels rotatably mounted near to the delivery combs of the carding machine. A tape feeds the fibre on to the reels, and conveys and retains the fibre in a thoroughly even state ready to be applied to the wire.

Trolley Poles for Trams.

20575—1908. S. Bryan, California. This more particularly relates to that class of trolley pole which is resilent in directions transversely of the motion of the vehicle, but is

Fig. 1.

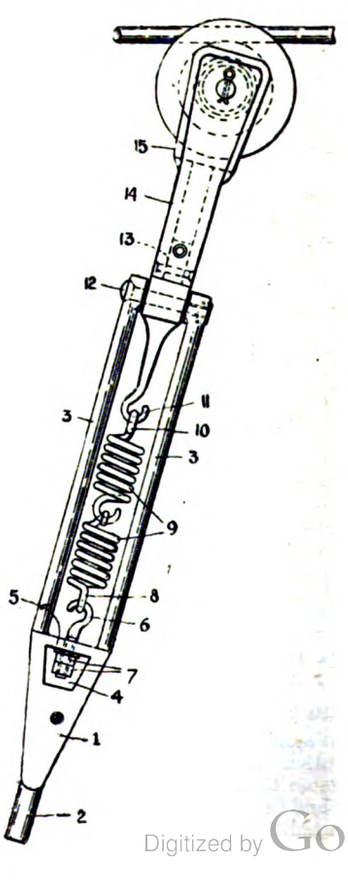
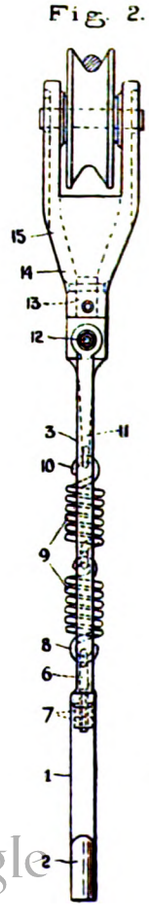


Fig. 2.



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held rigid in the same direction as the motion of the car. This provision prevents accidents which are liable to occur in consequence of the wheel leaving the wire, as, for instance, when the vehicle travels around curves. Fig. 1 is a side elevation of an improved attachment. Fig. 2 is a front view of the attachment. This attachment comprises a stock 1 provided with a shank 2 adapted to be attached to a trolley pole by means of a socket and set-screw. The stock is bifurcated to form two parallel arms 3 below which is an aperture 4 which forms a bridge 5. A hook 6 is fitted in the bridge between the arms, and is retained in place by nuts 7 within the aperture 4. The hook 6 engages one end 8 of two coiled springs 9 which are linked together end to end, the remaining end 10 being engaged by a hook 11 which is mounted transversely between the ends of the parallel arms 3 on a pivot 12. This hook projects beyond the arms in alignment with them, and has a shank 13 for attachment to the socket 14 of the trolley wheel fitting 15, or a continuation of the pole when the device is applied intermediate the ends of the pole. By the employment of two springs linked together, resiliency is increased and, consequently, strong springs can be used. The springs are protected by the arms 3. It will be understood that the hook 11 is kept in alignment with the attachment by the tension of the springs, but can rock upon its pivot when the strain is applied sidewise to the pole. The tension of the springs can be regulated by means of the nuts 7 on the hook 6.

Systems for Lighting Railway Trains by Electricity.

5544.—1909. SIEMENS BROS. DYNAMO WORKS, LTD., F. G. BROADHEAD & T. F. WALL, Stafford. The overcharge device, instead of being mechanically operated, is electrically controlled from an extra contact on the main lamp switch. It can thus be placed in any desired position on the train instead of having to be in close proximity to the lamp switch.

Flyers of Machines for Covering Electric Wires.

1125.—1909. C. DEMUTH, Wien. The machine flyer has a hollow fixed pillar, the interior of which is connected with the bearing surface of the rotary flyer by radial channels. The channels lead to an annular oil chamber, from which oil filters through and lubricates the flyer in an efficient manner.

Means for Reversing the Connections of Dynamo Electric Machines.

27685.—1908. H. LEITNER, Woking. A flat disc is mounted upon the armature shaft in such a manner that the disc revolves in the same direction as the armature. A scroll is cut into the disc, having an inner circle concentric with, or adjacent to, the shaft, and a second outer concentric circle near the circumference of the disc. The said two circles are connected by a spirally wound scroll in such a manner that a slipper or pin would remain in the inner circle when the disc is rotating in one direction, but on the reversal of the rotation would pass along the scroll and into the outer concentric circle, and *vice versâ*. The movement towards or away from the shaft of the armature which is thus obtained is transmitted to the brush-rocker or other like device for accomplishing the necessary displacement of the brushes.

Automatic Electric Circuit Breakers.

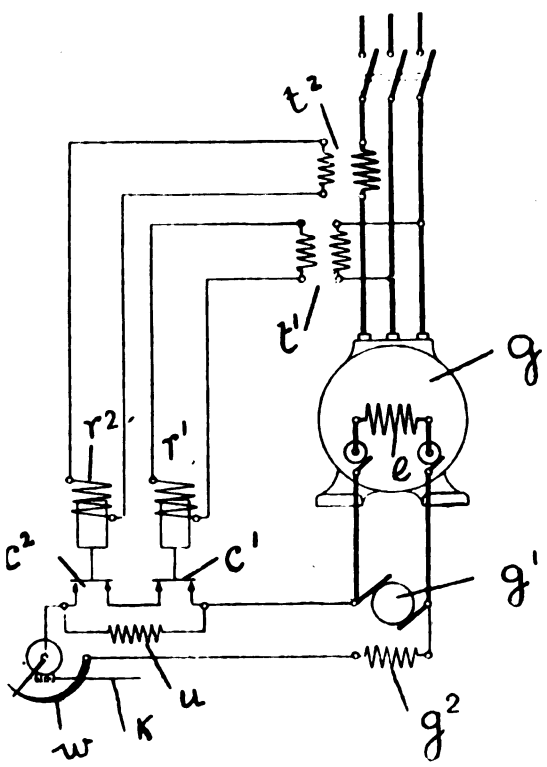
17748.—1908. ELECTRICAL MANUFACTURING CO., Wisconsin, U.S.A. This is an improvement in automatic means for breaking an electrical circuit when the voltage of the current passing through the circuit is increased beyond a safe limit. Combined with the switch are means for opening the switch upon the passage of a current of high potential and a conductor leading from the switch to the earth, a solenoid in circuit with the conductor, a block of high resistance carbon arranged in parallel with the solenoid, means controlled by the solenoid for breaking the line to the earth, and a casing enclosing the solenoid and the make and break devices operated thereby.

Electrically Blocking a Single Line Railway.

14784.—1908. SIEMENS & HALSKE, A. G., Berlin. An arrangement of a contact in a block element is provided, which element is moved into blocking position when the signal is put to line clear, and is moved into unblocking system when the train-in-section block element is operated. By this means the circuit which allows the cancelling of permission for a train to depart can be interrupted.

Control of Current and Voltage in Dynamo Electric Machines.

1509.—1909. SIEMENS BROS., LTD., London. Dynamo electric generators are usually provided with some kind of safety apparatus which is designed to prevent damage through overloading in the event of a short circuit. Such an apparatus is especially necessary with generators having automatic voltage regulators for preserving constant voltage at varying current, as it is clear these regulators will have an unfavourable effect on the dynamo in the event of a short circuit and will cause the current to increase to a dangerous value. Moreover, with automatic relay regulators the failure of one of the contacts might bring about a large increase in the terminal voltage and current of the dynamo machine, causing, for example, fuses to blow or lamps to burn out. Fuses and automatic cut-out switches are frequently employed for guarding against a current overload, but there are objections to their use, since their operation cuts off the supply to the circuit until they can be re-set. The diagram shows an improvement applied by way of example to a three-phase alternating current generator g, having an exciting winding e which is fed from the separate exciting dynamo g^1. The field winding g^2 of the latter is connected in series with a regulating resistance or resistance switch w, and also in series with the contacts c^1 and c^2 of two relays r^1 and r^2, both of these contacts being bridged by a resistance u. The winding of r^1 is connected through a voltage transformer t^1 across one of the phases of the generator g, and the winding of



r^2 is connected in series with the secondary winding of a series transformer t^2, the primary winding of which is in series with one of the phases of the main generator. The resistance switch w is used in connection with an automatic voltage regulator, or the resistance could be controlled by means of a small reversible electric motor mechanically connected to the worm shaft k, this motor being operated in one direction or the other according to whether the voltage across the mains of g is too high or too low, by means of a relay switch having its winding connected across one of the phases of g. Now as soon as the voltage across the mains of g increase beyond a certain predetermined value, the relay r^1 will operate and break the contacts c^1 and the field current will, consequently, be diverted through the resistance u, which is large enough to prevent a dangerous voltage being reached. The relay r^2 operates the contacts c^2 in a similar manner as soon as the main current becomes excessive, and the insertion of the resistance u then helps to prevent a dangerous value of main current being reached. If desirable, two separate resistances, one bridging each of the contacts c^1 and c^2, may be employed instead of the common resistance u.

Commutators for Dynamo Electric Machinery.

16911.—1908. HON. C. A. PARSONS & G. L. PARSONS, Newcastle-on-Tyne. The insulation between the commutator bars is formed of thin layers of hard metal and somewhat thicker layers of soft material laid alternately. This form of insulation will wear at the same rate and remain at the same level as the copper.

Dynamo Electric Machinery.

16704.—1908. HON. C. A. PARSONS, C.B., & A. H. LAW, Newcastle-on-Tyne. The invention consists in an arrangement for holding conductors in dynamo electric machinery, wherein each conductor is held to the core by locking a portion of the conductor into a suitable groove or slot in

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the core, with or without additional expanding means for keeping it in the slot. The conductors are formed of a strip of copper or aluminium, with an enlarged end shaped to fit into a core slot with a dovetail connection, the slot and the part of the conductor therein being suitably insulated.

Electric Telegraphy.

16462. - 1908. P. P. O'Neil, Hounslow. One-current impulse is employed for each letter signalled or sent into the line, each current impulse being subjected to consecutive alternations of polarity as it is sent direct into the line. The system is suitable for use with simplex or duplex working. It is claimed that by this system the signalling is expedited and is rendered more accurate, less difficult to operate, and more readily decipherable than the ordinarily adopted systems.

Electric Motor Generator Sets.

5209.—1909. General Electric Co., Schenectady, U.S.A. The armatures of the two machines comprising the set are connected in series across a potential supply circuit. Each machine has one set of brushes short-circuiting the armature on a line displaced approximately 90 electrical degrees from the line of field magnetisation, and a second set through which the armature is connected displaced approximately 90 electrical degrees from the first set, and a load circuit of variable resistance connected across the generator terminals.

Electrical Conductors.

16620.—1908. Hon. C. A. Parsons, C.B., J. H. Greaves & A. E. Hemsted, Newcastle-on-Tyne. The object of this invention is to provide improved stranded cables free from the disadvantages usually attending such cables. The invention consists in a flattened coreless stranded cable made flat entirely, or in part, from the first, so that it requires very little pressing afterwards. Or the cable may be formed inside a flat tube.

Electrical Control of Mechanism from a Distance.

14396.—1908. C. G. Lohay, Paris. The apparatus comprises a controlling device and a receiving device. The controlling device is provided with a switch which connects two electric motors to a source of current. One of the motors forms part of the receiving device and operates the mechanism to be controlled, while the other forms part of the controlling device and operates indicating means which enable the operator of the controlling device to check the operation of the distantly situated mechanism.

Electric Galvanic Batteries.

14609.—1908. G. Schauli, London. The battery is composed of a negative element consisting of a number of zinc plates from pressed zinc sheet connected together by a cast zinc frame, and a positive element carried by a carbon rod and composed of plumbago and charcoal or charcoal and manganese oxide. A mixture of metallic chloride and zinc chloride surrounds the positive element. The electrolyte is composed of amylon chloride and alum. The whole of the materials are combined and contained within the battery.

Electric Conduit Jointing.

16863.—1908. T. G. Hann, Manchester. The coupling piece is formed in two longitudinal parts. Each part has grooves which, when the two parts are put together, form complete annular recesses in which the flared ends of the tubes to be joined may lie and be firmly held against an endwise movement.

Dry Cells for Generating Electricity.

14615.—1908. H. Hunte, London, E.C. The depolariser is composed of magnese peroxide, lead peroxide, sulphuric acid, plumbago, ammonium, chloride and zinc chloride made into a paste. The mass is pressed round a carbon rod on to which is attached the negative terminal of the cell. A number of holes are bored through the depolarising block to admit the free circulation of air, the hydrogen of which is absorbed by the composition of the block, thus feeding and giving life to the cell. The block is surrounded by a fabric previously coated with a paste composed of 49% flaked rice, 1% zinc chloride, 25% ammonium chloride, and 25% distilled water.

Electrical Typewriter Operating Attachment.

16791.—1908. G. A. Mayrand, Quebec. The apparatus comprises a typewriting machine, a keyboard located at a distant point, electro-magnets connected with the key-bars of the machine and in circuit with the keyboard. Means are provided for operating the machine carriage and platen. A signal is designed to denote when the carriage at the receiving station reaches the end of a line.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last prices. £
Alliance Electrical Co., 5 p.c. Cum. Pref., Nos. 1-70,000	1 ..	⅛-¼
—— Ord., 1,125,000	1 ..	⅛-¼
Aron Electr'ty Meter, 6 p.c. Cum. Pref. Sh's, 1-125,000	1 ..	¾-⅞
—— Ordinary, Nos. 1-125,000	1 ..	⅝-¾
British Aluminium Co., Ordinary, 1-40,000	5 ..	½-⅝
—— 7 p.c. Cum. Pref., 1-40,000	5 ..	1-2⅛
—— "A" 6 p.c. Cum. Pref., 1-20,000	5 ..	3⅛-3⅜
—— 4 p.c. Funding Certificates, 1-20,000	5 ..	2⅛-3⅛
—— 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	71-76
—— 5½ p.c. Loch Leven Deb. (Reg.), Red., 1-3,000	100 ..	96-99
British Insulated and Helsby Cables, Ord. 1-100,000	5 ..	7¼-7⅝
—— 6 p.c. Cum. Pref., 1-100,000	5 ..	6⅛-6½
—— 4½ p.c. Mortgage Debentures	100 ..	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	89-94
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 275,001-475,000	3 ..	3/16-7/16
—— p.c. Mortgage Debenture Stock	100 ..	38-42
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	0-¼
—— Non. Cum., 6 p.c., Pref.	2 ..	0-¼
—— 4 p.c. 1st Debenture Stock	100 ..	41-46 xd
—— 4½ p.c. 2nd Debenture Stock	100 ..	27-31
Callender's Cable, Debentures	100 ..	105-107
—— Ordinary	5 ..	10¼-11⅛
—— 5 p.c. Pref.	5 ..	5¼-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7/9
Crompton and Co., Nos. 1-85,000	3 ..	¾-1⅛
—— 5 p.c. 1st Mort. Reg. Debs., Nos. 1-900 of £100, and 901-11,100 of £50, Red.	— ..	90-93
Dick, Kerr, and Co., Ordinary, 1,260,000	1 ..	1¼-1 5/16
—— 6 p.c. Cum. Pref., 1-305,000	1 ..	1 5/32-1 9/32
—— 4½ p.c. Debenture Stock.	100 ..	100-103
Edison and Swan United, "A" Shares, 1-99,261	3 ..	3/16-5/16
—— "A" Shares, 01-017,139	5 ..	1-1⅛
—— 4 p.c. Deb. Stock, Red.	100 ..	68-73
—— 5 p.c. Debentures	100 ..	84-87
Electric Construction, Nos. 1 to 112,100	2 ..	10⅛
—— 7 p.c. Cumulative Pref.	2 ..	1 3/16-1 7/16
—— 4 p.c. Perp. 1st Mort. Deb.	100 ..	65-69
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	71-77
General Electric Company (1900) 5 p.c. Cum. Pref.	10 ..	7⅞-8¼
—— 4 p.c. 1st Mort. Deb. Stock	100 ..	85-88
W. T. Henley's Telegraph Works, Ordinary	5 ..	12⅛-13⅜
—— 4½ p.c. Preference	5 ..	5⅛-5⅞
—— 4½ p.c. Debentures	100 ..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10 ..	14⅛-15⅛
—— 4 p.c. Debentures	100 ..	100-102
National Electric Construction Co., 1-170,000	1 ..	⅛-¼
Telegraph Construction and Maintenance	12 ..	34⅛-36
—— 4 p.c. Bonds	100 ..	100-102
White, J. G., and Co., 6 p.c. Cum. Pref., 1-15,000	10 ..	10-11

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4⅛-5⅛
Bournemouth and Poole, Ordinary	10 ..	9⅛-10
—— 4½ p.c. Cum. Pref., 7,501-15,000	10 ..	9⅛-10
—— 6 p.c. Cum. Second Pref., 15,001-22,500	10 ..	10-10⅛
—— 4½ p.c. Debenture Stock, Red.	100 ..	100-104
Bromley (Kent) Electric Light and Power Co.	5 ..	4⅛-4⅜
—— 4½ p.c. 1st Debenture Stock, Red.	100 ..	93-96
Brompton and Kensington, Ordinary	5 ..	7⅜-7⅝
—— 7 p.c. Preference	5 ..	7⅛-8
Calcutta Electric Supply Corp., Ord., Nos. 1-100,000	5 ..	6⅛
Cambridge Electric Supply Company, £10 Ord.	8 ..	12⅛-13⅛
Canadian General Electric Co., Common Shares	$100 ..	122-127
—— 7 p.c. Cum. Pref. Stock	$100 ..	119½-121½
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100 ..	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5 ..	88/1⅛
—— 4½ p.c. Cum.. Pref., 1-80,000	5 ..	4⅛-4⅜
—— 4 p.c. Debenture Stock, Red.	100 ..	96-99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5 ..	3⅞-4⅛
Chelsea Electricity Supply	5 ..	73 9
—— 4½ p.c. Debentures	100 ..	100-103 xd
City of London, Ordinary	10 ..	10⅛-10⅜
—— 6 p.c. Cumulative Pref.	10 ..	11⅛-12⅛
—— 5 p.c. Debenture Stock	100 ..	121-124
—— 4½ p.c. 2nd Deb. Stk, Red.	100 ..	100-103
Cordoba Light and Power Co., 1st Mt. Sf. 5 p.c. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	1⅛-2
—— 5 p.c. Preference, 1-50,000	5 ..	3-3⅛
County of London Elec. Supply, Ordinary	10 ..	7⅛-8⅛
—— 6 p.c. Cum. Pref.	10 ..	10 27/32
—— 4½ p.c. Debentures Prov. Certs. Al pd., Rd.	100 ..	104-107
—— 4½ p.c. 2nd Debentures Prov. Certs.	100 ..	100-103
Edmundson's Electricity Corporation, Ord., 1-80,000	5 ..	⅛-5/16
—— 6 p.c. Cum. Pref.	5 ..	⅛-¼
—— 4½ p.c. First Mort. Deb.	100 ..	58-61
Electrical Development Co. of Ontario, 5 p.c. 1st Mort. 30-year Gold Bonds, 10,751-15,750	— ..	84 7/16
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100 ..	91-94
Folkestone Electric Supply, Ord., Nos. 1-10,000	5 ..	4⅛-5
—— 5 p.c. Cum. Pref., Nos. 1-10,000	5 ..	5-5⅛
—— 4½ p.c. First Deb. Stock, Red.	100 ..	97-100
Hove Electric Lighting, Ord., 1-13,000	5 ..	7⅛-7⅜
Indian Electric Supply and Traction Co., 6 p.c. Construction Deb. Stock, Red.	5 ..	1⅛-2
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100 ..	75-80
Kalgoorlie Electric Power and Lighting, 6 p.c. Cum. Pref., 1-150,000	1 ..	⅜-27/32
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000.	5 ..	6⅛-7
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100 ..	98-101

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Name.	Amount paid. £	Last price. £
London Electric Ordinary	3 ..	1⅞-2⅛
—— 6 p.c. Pref.	5 ..	5-5 1/16
—— 4 p.c. 1st Mortgage Debenture Stock, Red.	100 ..	93-96
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100 ..	76-80
Metropolitan Ordinary, 100,001-300,000	5 ..	85-85
—— 4½ p.c. First Mortgage Debenture Stock	100 ..	105-108
—— 4½ p.c. Cum. Pref.	5 ..	4⅞-5
—— 3½ p.c. Mortgage Debenture, Red.	100 ..	83½-84
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,000 ($500) M 1-4,400 ($1,000)	— ..	82-1
($500), 4,001-14,000 ($1,000)	— ..	88-⅛89½
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	96-99
Newcastle-upon-Tyne Electric Supply, Ord., 1-87,500	5 ..	85/
—— do. 87,501-137,500 (issued at £1 prem.). All paid (Prov. Certs.)	5 ..	4⅞-5⅛
—— do., 5 p.c. Pref., 1-87,500 (Prov. Certs.)	2 ..	4⅛-5
—— 5 p.c. Pref., 87,501-137,500 (Prov. Certs.)	4 ..	4⅛-5⅛
Notting Hill Electric Lighting	10 ..	11-12¼
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6-6¼
—— 4 p.c. Debenture Stock	100 ..	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1 ..	1 5 16-1 7 16
—— 6 p.c. Non-Cum. Pref., 1-100,000	1 ..	1-1⅛
—— 5 p.c. Debenture Stock, Red	100 ..	103-106
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5 ..	5 7 16 5 11 16
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5 ..	5⅛-5 15 16
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100 ..	102 104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	— ..	105-107
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	9 16-13 16
South London, Ordinary	4 ..	57 6 5
South Metropolitan Electric Light and Power, Ord.	1 ..	5 16-9 16
—— 7 p.c. Cum. Pref.	1 ..	1⅛-1⅛
—— 4½ p.c. 1st Mort. Deb.	100 ..	103
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	8½-9
—— 7 p.c. Pref.	5 ..	7-7½
—— 3½ p.c. Deb.	100 ..	84-88
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	½-1
—— 5 p.c. Cumulative Preference, 50,001-80,000	5 ..	1½-2
—— 4½ p.c. First Mort. Debenture Stock, Red.	100 ..	77-81
Westminster, Ordinary	5 ..	8½-8 17 32
—— 4½ p.c. Cum. Pref., 110,101-138,251	5 ..	5-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 10 p.c. Non-Cum. 2nd Pref., 260,008-280,007	5 ..	4½-4⅝
—— Permanent 6 p.c. Debenture Stock, 1888	100 ..	91-92
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	102-105
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	⅛-¼
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1 ..	9 16-11 16
Bir'ham & Midland Trams., 1½ p.c. 1st Db. Stk., Red.	100 ..	87-91
Blackpool and Fleetwood Tramroad	10 ..	13¼-13⅝
Bombay Elec. Supply and Trams. Co., 6 p.c. Cum. Pref.	10 ..	9½-10
—— 4½ p.c. Deb. Stock, Red.	100 ..	93½-95⅛
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	6⅞-7
—— 5 p.c. Cum. Pref., Nos. 1-75,000	5 ..	5-5⅛
—— 4½ p.c. Deb. Stk., Red., Prov. Certs., all pd.	100 ..	100-103
British Columbia Electric Railway Co., Ord. Def.	100 ..	142-147
—— Ord. Pref.	100 ..	116½-⅞
—— 5 p.c. Cum. Perpetual Pref. Stock	100 ..	105-109
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	102-104
—— 4½ p.c. Vancouver Power Deb.	100 ..	102-105
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10 ..	9 16-13 16
—— 6 p.c. Cm. Pf., 30,001-60,000	10 ..	2-2½
—— 5 p.c. Perpetual Debenture Stock	100 ..	84-87
—— 4½ p.c. 2nd Deb. Stock	100 ..	63-67
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	81-86
Buenos Ayres Gd. Nat. Trams. Co., 5½ p.c. Pref. Deb. Bonds, Red., 1-1,500	100 ..	102-107
—— 6 p.c. Deb. Bonds, Red., 1-2,275	100 ..	103-106
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	97-99
Calcutta Tramways, Ord., No. 1 137,610	5 ..	5⅛-1/16
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5 ..	4⅞-5
—— 4½ p.c. 1st Deb. Stock, Red.	100 ..	97-100
Cape Electric Tramways, Nos. 1-491,222	1 ..	3 16-7 16
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5 ..	4⅛-5⅛
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	97-101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5 ..	5⅛-6
—— 4 p.c. Deb. Stock, Red. (1985)	100 ..	98-101 xd
Colombo Electric Tramways and Lighting, 5 p.c. 1st Mortgage Debenture Stock, Red.	100 ..	98-101
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 p.c. Cum. Pref.	10 ..	12½-13¼
—— 4 p.c. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12¼-13⅛
—— 6 p.c. Pref., Nos. within 1-60,000	10 ..	12¼-13½
—— 3½ p.c. Mort. Debs., 1-3,000 Red.	100 ..	90-95
Hastings & Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	76-81
Havana Electric Railway Consolidated Mort. 5 p.c. 50-year Coupon Bonds of 1952, 1-6,957	$1,000 ..	92-96
Imperial Tramways, Ordinary	all ..	18-19
—— 6 p.c. Cum. Pref.	all ..	14-14½
—— 4½ p.c. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 p.c. Cum. Pref., Nos. 30,001-80,000	5 ..	¾-1¼ xd
—— 4 p.c. 1st Mt. Db. Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/32-3/32
—— 5 p.c. "A" Deb. Stock	100 ..	91-94
—— 6 p.c. "B" Deb. Stock	100 ..	66-70
Kidderminster & District Lighting & Traction, Pref.	5	9 15/16-10 3/16
Lancashire United Tramways, Limited, 5 p.c. Prior Lien Deb Stock, Red	100 ..	88½-90⅛
—— £296,500 2nd Mort Deb Stock	— ..	—
—— £83,330 Deferred Deb Stock (all fully paid)	— ..	—
Lisbon Elec Trams, Limited, Ord, Nos 1-594,188	1 ..	29/32-1 1/32
—— 6 p.c. Cum Pref, Nos. 1-425,553	1 ..	15/16-1 3/16
—— 5 p.c. Mort. Deb., 1-5,000, Red.	100 ..	98-102
London United Trys (1901) 5 p.c. Cum. Pref.	10 ..	2¼-2⅜
—— 4 p.c. 1st Mt. Db. Stock, Red.	100 ..	67-70
Madras Elec. Trams. (1904) 5 p.c. Deb. Stk., Red	100 ..	93-96
Manila Elec. R.R. & Ltg. Corp., 5 p.c. 1st Lien & Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000 .	95-97
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5 ..	4⅛-5
—— 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	86-91
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	1/32-5/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1 ..	11/16-13/16
—— 4½ p.c. Deb. Stock, Red.	100 ..	94-96
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 p.c. Gold Bonds	— ..	91⅛
Milwaukee Electric Rail and Light, 5 p.c. 30-yr. Con. Mort. Bonds (1926) 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ p.c. Sterling Deb., 601-2,000 (1922)	100 ..	102-104
New General Traction, 6 p.c. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	⅛-⅜
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100 ..	100½-103½
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	⅛-⅜
—— 5 p.c. Cum. Pref., 300,001-545,000	1 ..	⅛-⅜
—— 4½ p.c. Debenture Stock	100 ..	86-89
Provincial Tramways Co., Ordinary, 1-24,912	10 ..	4-4½
—— 6 p.c. Cum. Pref., 1-10,000	10 ..	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5 ..	5⅛-5⅜
—— 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	99-101
San Paulo Tramway, Light, and Power Co.	$100 ..	147-150
—— 5 p.c. 1st Mort. Deb., Red. (1929) 1-12,000	$500 ..	102¼
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	⅛-⅜
—— 4 p.c. Deb. Stock, Red. (1940)	100 ..	70-74
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red., 1-1,600	100 ..	81-85
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5 ..	⅛-⅜
—— 6 p.c. Cum. Pref., 1-46,261	5 ..	1⅜-2⅛
—— 4½ p.c. 1st Deb. Stock, Red.	100 ..	81-85

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100 ..	62-64
—— 4 p.c. Pref.	100 ..	85-87
—— „ „ deferred	100 ..	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	102
City and South London, Consolidated Ordinary	100 ..	31-32
—— 4 p.c. Debenture Stock	100 ..	100-102
—— 5 p.c. Pref. Stock '91	100 ..	108-110
—— „ „ „ '96	100 ..	101-107
—— „ „ „ '01	100 ..	100-103
—— „ „ „ '03	100 ..	96-100
Liverpool Overhead, 5 p.c. Pref.	10 ..	4½-5
—— Ordinary, 1-50,000	10 ..	⅜-⅝
—— 4 p.c. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 p.c. 4½ p.c. Bds.	— ..	88-90

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10 ..	2¼-3⅛
—— 5 p.c. Debs., Red., within 1-1,069	100 ..	93-96
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000 ..	96-98
Anglo-American Telegraph Co., Ordinary	100 ..	61-63
—— 6 p.c. Preferred Ordinary	100 ..	104-105
—— Deferred Ordinary	100 ..	21¼-21½
Anglo-Portuguese Telephone Co., 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	101-103
Chili Telephone Co., 1-44,000	5 ..	8-8⅛
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100 ..	90-92
Cuba Submarine Telegraph Co., Ordinary, 1 16,000	10 ..	8½-9⅛
—— 10 p.c. Preference, 1-6,000	10 ..	17-18
Direct Spanish Telegraph Co., Ordinary	5 ..	3-3⅛
—— 10 p.c. Cum. Preference	5 ..	8½-8⅝
—— 4½ p.c. Debs., 1-600	50 ..	100-102
Direct United States Cable Co.	20 ..	13-13½
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100 ..	100-102
Eastern and South African, 4 p.c. Mort. Debs., within 1-3,000 (1909)	100 ..	100-100⅛
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	25 ..	100-102
Eastern Extension, Australasia and China, 1-300,000	10 ..	12⅞-⅛
—— 4 p.c. Mort. Deb. Stock, Perp.	100 ..	102-104
Eastern Telegraph Co., Ordinary Stock	100 ..	130⅛
—— 3½ p.c. Preference Stock	100 ..	86⅛
—— 4 p.c. Mortgage Debenture Stock	100 ..	105
Great Northern Telegraph Co. (of Copenhagen)	10 ..	26-27
Halifax and Bermudas Cable Co., 4½ p.c. 1st Mort. Debs., within 1-1,200, Red.	100 ..	100-102
Indo-European Telegraph Co.	25 ..	51½-53⅛
Marconi's Wireless Telegraph Co., Nos. 256,128-384,190	1 ..	⅛-⅜
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	⅛-⅜
—— 5 p.c. Preference, 1-86,492	1 ..	⅛-⅜
National Telephone, Preferred	100 ..	106⅛
—— Deferred Stock	100 ..	122
—— 6 p.c. Cum. First Pref.	10 ..	10¼-10⅞
—— 6 p.c. Cum. Second Pref.	10 ..	10¼-10⅞
—— 5 p.c. Non. Cum. Third Pref.	5 ..	5 7/16-5 11/16
—— 3½ p.c. Deb. Stock, Red.	100 ..	98-100
—— 4 p.c. Deb. Stock, Red.	100 ..	100-102
Oriental Telephone and Electric Company	1 ..	1 5/16-1 7/16
—— 6 p.c. Cum. Pref.	1 ..	1 1/16-1 3/16
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100 ..	100-102
United River Plate Tele. Co., Ordinary, 1-100,000	— ..	6¼-⅞
—— 5 p.c. Cum. Pref., 1-40,000	5 ..	5⅛-5⅜
—— 4½ p.c. Debenture Stock, Red.	100 ..	104-106
Telephone Co. of Egypt, 4½ p.c. Deb. Stock, Red.	100 ..	100½-102½
West African Telegraph Co.	10 ..	12¼-13⅛
West Coast of America, 1-30,000 and 53,001-53,008	2½ ..	1⅛-1⅛
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	100-102
West India and Panama Telegraph Co., Ordinary	10 ..	13 13/16
—— 6 p.c. Cum. 1st Preference	10 ..	8⅛-8⅞
—— 6 p.c. Cum. 2nd Preference	10 ..	8-9
—— 5 p.c. Debs., Red., 1-800	100 ..	101-103
Western Telegraph Co., 1-207,930	10 ..	13¼-13⅞
—— 4 p.c. Debenture Stock, Red.	100 ..	103-105

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile
	Ending	1909.	1908.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Sept. 8	1,491	1,404	+ 87	— 513	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5·35
Ayr Corporation	„ 11	330	302	+ 28	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Aug. 7	2,770	2,650	+ 120	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Sept. 5	1,182	1,076	+ 105	— 375	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	„ 4	6,314	6,356	— 42	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	„ 1	1,061	1,122	— 61	— 988	24·5	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,329	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Sept. 5	2,375	2,243	+ 132	— 575	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29¼	29¼	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Sept. 4	5,098	4,735	+ 363	+ 2,477	98	98	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	„ 12	1,168	1,052	+ 116	+ 1,235	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	„ 10	5,546	5,075	+ 471	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	„ 11	1,367	1,239	+ 128	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	„ 5	265	287	— 22	—	10	10	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Sept. 11	4,968	8,287	— 3,319	— 21,864	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	„ 7	3,695	3,515	+ 180	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Sept. 5	2,970	3,102	— 132	+ 1,170	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Sept. 9	510	470	+ 40	—	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·47
Croydon Corporation	Aug. 20	1,693	—	+ 254	+ 798	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·16a
Darwen Corporation	Sept. 4	243	249	— 6	— 228	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	„ 4	268	255	+ 13	— 368	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Sept. 10	138	150	— 12	—	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	„ 10	5,416	5,584	— 168	+ 961	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	„ 8	1,207	—	— 84	— 514	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	„ 11	1,010	906	+ 104	+ 3,322	13	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	July 17	15,961	17,286	— 325	— 2,745	185½	179	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·49
Gloucester Corporation	Sept. 8	295	270	+ 25	+ 583	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Aug. 7	4,430	4,480	— 50	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	„ 21	1,741	1,645	+ 96	+ 771	28½	28½	„ 31	84,704	16,200,020	1,960,320	1·29	10·37	2,421	5·16
Hull Corporation	Sept. 11	2,039	2,436	+ 202	+ 1,892	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	July 31	487	498	— 11	+ 687	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Sept. 9	136	142	— 6	—	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	„ 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	„ 8	1,467	1,298	+ 169	— 403	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 4	6,839	6,453	+ 386	+ 2,814	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	„ 4	2,196	2,212	— 16	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Aug. 28	10,818	10,611	+ 207	— 2,375	104	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·91
Liverpool Overhead Railway	Sept. 5	1,379	1,333	+ 46	— 90	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Aug. 28	36,667	33,166	+ 3,501	+ 20,701	124	122½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	„ 17	216	258	— 42	— 743	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Sept. 4	209	197	+ 12	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	„ 4	14,868	14,951	— 83	— 3,406	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Sept. 11	9,253	9,213	+ 40	—	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Aug. 22	13,951	13,839	+ 112	+ 1,658	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Sept. 4	136	130	+ 6	— 85	2½	2½	Mar. 31	7,362	2,060,712	204,7·0	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	„ 4	3,663	3,723	— 60	— 1,160	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·9a
Newport (Mon.) Corporation	„ 4	649	647	+ 2	— 308	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Sept. 9	631	637	— 6	— 114	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·8a
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 6	4,586	4,487	+ 99	— 3,394	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	July 18	5,718	5,528	+ 190	— 1,112	68½	66½	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·4a
Southampton Corporation	Sept. 1	1,223	1,151	+ 72	— 421	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·3a
Southend-on-Sea Corporation	Aug. 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·7a
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Sept. 1	154	157	— 3	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 17	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Sept. 11	971	934	+ 37	—	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·5a
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	„ 2	2,412	2,118	+ 294	+ 3,377	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·5a
Wolverhampton Corporation	„ 8	776	789	— 13	— 963	20½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·5a

a Train miles. *h* Half-year's figures.

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NOTES.

GOVERNMENT CONTRACTS.

Some anxiety has been evinced in the highly nervous atmosphere of St. Stephen's as to the position of electrical contractors and the Admiralty. Mr. Renwick, representing Newcastle-on-Tyne, darkly hinted, as is the way with Members of Parliament sitting in opposition, that as the firms placing the electric light installations and search-lights on new ships had German branches, there was danger of secrets leaking out. Of old, it was rather the boast of the Briton that he dreaded-nought, but that is not the way of timorous persons of to-day. However, Mr. McKenna was able to explain that only British-made cables, machinery and fittings are to be used, and only British subjects employed on the jobs. Moreover, the following provision has been embodied in recent contracts: "This contract involves an obligation of secrecy within the meaning of Section 2 of the Official Secrets Act, 1889. The contractors shall at their own expense take all such measures and precautions to ensure secrecy in connection with the design, construction, equipment, and completion of the said vessel as may be necessary, including therein all such measures and precautions as may be regarded as necessary by the Commissioners, and the contractors shall, if so required at any time by the Commissioners, afford to them such evidence as the Commissioners may consider satisfactory that all such measures and precautions have been, are being, and will be taken." This is excellent, and really we do not see what other safeguards could be taken, unless critics of the Admiralty insist upon the immediate slaughter of all workers as soon as they have completed a job, which would ensure soothing sleep to all concerned.

ELECTRICITY AND EARTHQUAKES.

"The man in the train" is quite as interesting, if less instructive than the "man in the street." The other day he was explaining to the writer that the recent series of earthquakes from which the world had been suffering were due to the iniquity of electrical engineers, who by their unholy activities had so filled the ether with loose electricity, that the bowels of the earth were drawn forth. In fact, we were turning the world not upside down, but inside out. Quite a pretty little theory. Observation however, has established that earthquakes and electricity are intimately correlated. Only last July M. Fabry was telling the Paris Academie des Sciences that during the earth tremors in Provence there had been remarkable electric phenomena, manifesting themselves in the form of sparks and high frequency discharges. Armed with these facts, Signor Maccioni began to theorise. If the electrical disturbance originated at the seat of the upheaval, then this might be utilised for the benefit of mankind, for it is manifest that the electric waves would travel much faster than the mechanical waves. And the theory has borne fruit in the shape of a radio-telegraphic earthquake alarm.

MACCIONI EARTHQUAKE ALARM.

An ingenious little apparatus was exhibited by Signor Maccioni before the Academy of Science of Tuscany. The base of the apparatus is a coherer, the terminals enclosing the metal filings being so spaced that the instrument does not respond to ordinary atmospheric electric disturbances (such as occur in thunderstorms). The appliance also comprises a small galvanic battery and a very sensitive galvanometer. These are connected with a second battery, energising a register, clock and alarm bell. The coherer is connected by a wire to a buried metal plate, so that any earth tremor is at once noted, and announced more or less loudly and persistently by the bell, according to the nature of the disturbance. In slight tremors it was found that the electric waves were noted four minutes before the mechanical disturbance was manifested. It is evident that in this clever device we have the germ of what may prove a great discovery, benefiting millions of people dwelling within the earthquake zones.

ELECTRIC ORE SMELTING.

Canada is taking up the problem of iron ore smelting in a serious spirit. This is only fitting, seeing that Dr. Haanel, Deputy-Minister of Mines of the Dominion, is himself the originator of what promises to be a most successful process. But Sweden has shot ahead in this matter of smelting, and it is from Sweden that the latest expert, Mr. A. Grosswall, has been called to Canada. His mission is to establish quite a number of iron smelting furnaces in the dominion on an improved Haanel process. From this to the setting up of electric blast furnaces for the manufacturer of steel is but a step. Indeed, Canada is showing a splendid appreciation of the possibilities of electricity in the development of her wealth.

CANADA FOR ELECTRICIANS.

Canada is opening up with such marvellous rapidity that it offers a wonderful outlet for electrical enterprise. Take the Grand Trunk Pacific Railway line extensions to Prince Rupert. Over a score of town sites along this line have been put up for sale in lots, and something like 600 lots promptly acquired. The country round about is already fairly well settled with agriculturists, and the towns are mostly located on the banks of rivers. In Alberta itself, no doubt, natural gas will long offer itself as the successful rival of electricity in the matter of lighting, but for other purposes the demand for electric energy is growing apace in all Canadian cities, especially on the coast belt in the mining and manufacturing districts. The Americans are keenly alive to the openings in Canada; we ought not to be behind in this, especially as we have the benefit of both natural and fiscal preference.

CANADIAN COMMON SENSE.

A point strongly in favour of electricity in Canada is that the Dominion Government has appointed a permanent Commission for the conservation of the natural resources, such as forests, minerals, and water power. This will, of course, lead to the encouragement of methods for the most economical way of raising and utilising power. The Commission is to consist of thirty-two members, representing the Dominion and Provincial Governments, the universities, and the chief industries.

HARTON COLLIERY ELECTRIFICATION.

One of the most gratifying incidents of the annual general meeting of the Institution of Mining Engineers at Newcastle was the visit paid to the Harton coal mines and workshops. In welcoming the visiting members, Sir Lindsay Wood, chairman of the Harton Coal Co., Ltd., said that the company had become very large consumers of electricity in their mine, and in their opinion it was an economical mode of working. The winding-engine, worked entirely by electricity, had not been in use very long, and as it was the first of its kind, he could not say what was the exact saving on it as compared with a steam-worked winding-engine. He expected, however, that the use of the electrically-driven winding-engine would be found to be advantageous, and would tend to increased output. No steam

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was now used in the Harton Colliery, all the machinery being electrically driven. In view of the abortive anti-electricity resolution of the Durham Miners' Association, such a practical expression of opinion is pleasing.

ANOTHER GERMAN ELECTRIFICATION.

Norderney, the fashionable island health resort off the East Friesland coast, is to be connected by an electric railway with the main line terminus at Norddeich on the mainland. The passage, although short, is usually very bad, and the building of the viaduct presents some difficulties. The platform for the permanent way will be supported on 25 great reinforced concrete piers, with pile foundations sunk in the sandy bottom. The total distance of the line will be about 6 miles, and the cost will be over £100,000. The overhead trolley system with high frequency is, we understand, to be adopted. The line is to be reserved for passenger traffic during the daytime and for goods transport during the night.

ELECTRICAL ENGINEERS' TRAINING.

The high standard of education which is demanded of the modern engineer as compared with that required a few generations ago is one of the more remarkable features of the progress. The engineer of 50 years ago was not so much a widely-read man and a mathematician as a shrewd observer of character and a handicrafts' man. But the successful engineer of to-day has not only to be well educated and have good address, but he must also be a man of wide general reading, with a good command of English, and a knowledge of at least one other European language. He must also have special knowledge of mathematics and applied services; and, further, he must have had some training in the handicraft of engineering work and in draughtsmanship. In no other profession is so much required of its members, and the young electrical engineer of to-day, having a shop training and a degree from a university, probably represents the highest trained intellect of any profession. The engineer of a generation or so ago used to find it difficult to speak in public, and his English in private was not all that could be desired. But this is all changed now, for it is part of an engineering graduate's training to become a fluent speaker, and his studies and examinations train him in exact expression when writing. The lawyer and politician are masters of ambiguous phrasing; the clergyman cultivates a persuading style; but the engineer must be exact and precise always. His business is with facts, and he must also have the reasoning faculty strongly developed if he is to be successful.

DEVELOPMENT BY POWER GAS.

Although there have been some setbacks in the use of producers and large gas engines, as, for example, at Johannesburg, this new method of developing power from coal is making steady progress and there is not the slightest doubt that it will win out in the end. The Power Gas Corporation has recently issued a catalogue giving the names of the firms supplied with Mond gas producers, the coal burnt per day, the approximate horse-power developed, and the purpose for which the gas is being used. The history of the Mond gas producer only goes back about seven years, and yet nearly 100,000 h.p. in gas engines has already been installed in conjunction with Mond gas producers. This included 52 engines ranging from 500 to 2,500 h.p. One of the largest installations is, of course, at Brumner Mond & Co.'s Works, Northwich, where the gas made represents 25,000 h.p. This is, however, dwarfed by the Cargo Fleet Iron and Steel Co., Middlesbrough, where no less than 390 tons of coal are burnt per day in producers, which represent about 39,000 h.p. The Farnley Iron Co., Leeds, has plant equal to 13,500 h.p., and John Brown & Co., Clydebank, develops 12,000 h.p. in producers. The bulk of the above gas is used for heating steel and chemical furnaces, etc., but there are many installations which use the gas for power only. Chief amongst these is the South Staffordshire Mond Gas Co., 16,000 h.p.; the British Westinghouse Co., Manchester, 2,000 h.p.; Cochrane & Co., Dudley, 2,000 h.p.; and the Brodsworth Colliery, Doncaster, 1,250 h.p., etc. Two power installations of special interest are the Midland Railway Co., 1,000 h.p., for the electric railway from Lancaster to Morecambe, and for electric cranes at Heysham Harbour; also a 500 h.p. installation at the University of Birmingham.

SULPHATE OF AMMONIA.

The English firms that are making sulphate of ammonia as well as gas are Brumner Mond & Co., the South Staffordshire Mond Gas Co., the Langwith Bye-Product Co., the Farnley Iron Co., John Brown & Co., Tweedales & Smalley, and Ashmore, Benson, Pease & Co. As the demand for nitrogeneous manures increases, as increase it will, this side of the Mond gas producer process promises to become more and more important. Indeed, it is likely that in the near future producer plants will be laid down primarily to make sulphate of ammonia, and the gas will be the bye-product. Brumner Mond & Co. have been selling gas to the Northwich electric power station at 2d. a thousand cubic feet for about 6 years now.

Who shall say after the record of the Power Gas Corporation becomes generally known that there is anything experimental about a gas producer plant? All that is wanted is sound common sense engineering in laying down the installation, and some good men to run the plant when erected. The latter is, of course, always a difficulty when any new method of developing power comes to the front, but where there is a demand men are soon forthcoming to fill it.

ELECTRICALLY DRIVEN ROLLING MILL.

In view of the interest which is being taken by electrical engineers in the electrical equipment of iron and steel rolling mills, we may give a brief description of a small plant of this character recently erected in South Staffordshire by Messrs. S. Jevons, Ltd., of Birmingham. In the case of reversing mills, the conditions are such that specially designed and very costly plant is necessary, but where there are two sets of rolls and the direction of rotation of the main rolls shaft is constant, it is possible to make use of a motor running at a uniform speed with consequent great reduction in first cost. In the present instance, the rolling plant consists of a 9 in. guide mill, with four sets of rolls, rolling mild steel rod from 2 in. round or square down to No. 6 gauge. The power is supplied from the 200 volt, two-phase alternating current mains of the Midland Electric Corporation to a Siemens' 70 h.p. slip-ring induction motor, running at 750 revs. synchronous speed, and having an overload capacity of 80%. The motor shaft carries a steel pinion, 9 in. diameter by 6 in. face, having 18 teeth of 1·56 circumferential pitch. This engages a cast-iron spur-wheel on a shaft running at 200 revs. per min., which is coupled direct to the rolls-shaft on one side, and on the other is extended to carry a fly-wheel weighing about 5 tons, the weight of the latter being supported by an outer bearing. The controlling gear consists of a 200 amp. combined switch and circuit breaker, with overload and no-volt release, and the usual rotor resistance. The latter is placed close to the motor. The advantage of the fly-wheel will be appreciated when it is stated that within 3 sec. or less the h.p. taken varies between 5 h.p. and 120 h.p., although the circuit breaker is set to open at 350 amp. only. Another point of interest is that experiment shows that the heaviest load on the motor is not, as might be expected, during the first breaking down of the billet, but occurs on the fifth and sixth passes. This is accounted for by the relatively longer time taken to go through the rolls and by the metal having become cooler.

ELECTRIC POWER SIGNALLING.

An electric power signalling system has been installed at Yarnton Junction by the Great Western Railway Co. Throughout the system continuous current at 120 volts pressure is used. The generating plant includes a Hornsby oil engine, developing 12 b.h.p., coupled direct to a four-pole shunt wound dynamo, with an output of 44 amperes at 170 volts. There are two batteries of accumulators, each consisting of 60 E.P.S. cells. The main power cable is carried direct from the switchboard to a double-pole main switch in the signal-box, and an ammeter is also provided in the signal-box. The system is devised on the "constant detection" principle.

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TRAMWAY PROBLEMS IN THE FUTURE.*

By A. L. C. FELL.

(*Chief Officer, L.C.C. Tramways.*)

In this short address, I do not propose to deal with the history of electric traction from its inception up to date, but it is necessary just to give a few figures to show the position of affairs at the present moment. It appears from the latest Board of Trade returns that there are 305 undertakings in the United Kingdom, 177 of which belong to local authorities and 128 to companies and private individuals. The tramways open consist of 1,522 miles of double and 941 miles of single line, or a total of 2,463 miles, compared with 2,394 miles in the previous year. The total capital expended being £68,199,918, compared with £64,092,091 in the previous year. The total number of passengers carried was 2,625,532,895, compared with 2,454,807,487. Gross receipts were £12,439,625, compared with £11,849,175. Working expenses were £7,792,663 compared with £7,363,762 in the previous year.

The returns clearly indicate that the rush with regard to the construction of electric tramways is over, and that improved results are chiefly due to gradual development of existing systems and the reconstruction of horse, cable and steam tramways. For some considerable time no new large schemes have been brought before Parliament.

Although the mileage of tramways opened during the past year has increased very little, the number of passengers carried has steadily increased, showing the great popularity of this means of locomotion.

The Best Use of the Thoroughfare.

The popular fallacy has existed for some time that the installation of a tramway increases the congestion in the street. Under general conditions this is not the case, but, of course, the isolated cases where tramways terminate in narrow, congested streets are always quoted, and in most instances by those people who have opposed the extension of the tramway, when the promoters have attempted to do away with the dead ends by the construction of a connecting link or loop line.

Experience clearly shows that congestion of traffic is relieved by the introduction of electric tramways, one reason being that the vehicular traffic is formed up into straight queues, the slow traffic keeps more to the side of the road and the fast traffic follows the tramway. It has been proved beyond doubt that in handling large crowds of people entering theatres and other public buildings that if queues are formed they can be dealt with much more expeditiously and without danger. The same arguments apply even more forcibly in the case of traffic regulation, and where electric tramcars are introduced, the speed of the traffic generally is increased and the liability to accident is minimised.

Rail-less Trolley Systems.

Many interesting reports have been issued during the past year on inspections which have been made by various deputations of the so-called "*trackless* trolley system" on the Continent. I am afraid that the *trackless* trolley system will not be seen until air ships are in general use, and I expect when this is the case the trolley wires will disappear, as there is every reason to suppose that it will be possible by that time to operate air ships by wireless transmission.

An interesting example of a rail-less trolley system has been installed by the Metropolitan Electric Tramways Co. at Hendon, and arrangements have been made for this to be inspected.

In special cases, the rail-less system will have its uses. For instance, in London, I think it would be advantageous as a connecting link between the tramways which run to either side of the Blackwall and Rotherhithe Tunnels under the Thames, in these cases a tramway could not be satisfactory, but in ordinary service I am afraid the cost of maintenance of the rail-less system will be too high. It will be interesting to note the action taken by the authorities responsible for the up-keep of the roadway when any of these systems are installed in this country, and as to whether street improvements will be charged against the new form of traction.

It is suggested that the rail-less system might be used for so-called "missionary work," to ascertain the best route for a tramway, but, in my opinion, it is a question as to whether this is really necessary. If people think that the route is only an experimental one, they will not settle down and take houses on lease, but if a well-thought-out tramway is installed they have a feeling of security, and the property in the vicinity of the tramway route rapidly develops. This security of tenure is one of the chief advantages of a tramway route compared with an omnibus route, as the latter may be changed at a few hours' notice.

Standardization.

Much has been said and written about standardization in connection with tramway matters. Most of the large undertakings are doing everything possible to standardize their plant, but it is to be regretted that many smaller municipalities are still "discovering" electric traction, and are constantly changing the types of their cars and equipment. It is essential that, as far as possible, the working parts of all cars, trucks and electrical equipments should be interchangeable, not only to avoid having to hold an enormous stock of spare parts, but that the men who are responsible for the maintenance and operation of the cars may have a thorough knowledge of every part, and through this knowledge increase the safety of the public.

The Past and the Future.

Twenty years ago we looked to America for guidance in tramway matters, and in a rough and ready manner America showed us how it should be done; to-day we rather think that we can show America how it should be done, but our indebtedness to that country still remains, as through its bold policy of development the tramway world has been able to benefit by the pioneer work, by avoiding the weak and assimilating all the good points.

The tramway men in this country in their turn have endeavoured to re-model and improve, with the result that British tramway installations are now looked on all over the world as examples of solid permanent work. We have had many enquiries from Australia, Canada, and New Zealand, and I feel certain that this Association will be glad to do anything possible to assist our fellow-subjects over the seas.

I venture to think that twenty years hence tramways will predominate, and rare specimens of an extraordinary vehicle which was called a motor omnibus will be found in the South Kensington Museum. The question of local railway competition will be settled, and internal pick-up traffic will be recognised as legitimate tramway work, and all longer distance through traffic will be dealt with by the railway companies; the tramways acting as feeders for railway undertakings.

In conclusion, I would like to thank the Members of the Association generally and the Executive Committee especially for their loyal support during the past year.

*Abstract of Presidential address before the Eighth Annual Conference of the Municipal Tramways Association, London, Sept. 22nd.

CENTRAL REPAIR DEPOT, L.C.C. TRAMWAYS.*

By W. E. IRELAND.

(*Rolling Stock Superintendent, L.C.C. Tramways.*)

The present building, which has a capacity for dealing with the overhaul of 600 cars per annum, has been planned with a view to future extension without in any way breaking up the continuity of the several shops, stores, etc. The first extension or depôt is now in progress. Temporary galvanised iron screens have been provided to enclose the portion of the building now in use, and due provision made for the escape of employés in case of fire.

The buildings are arranged on a definite scheme for dealing expeditiously with the cars during the two weeks each has to be in the shops for its annual overhaul and renovation. The Metropolitan Police regulations require the body work and painting of each car to be thoroughly renovated once in every 12 months. Advantage is, therefore, taken of this regulation to systematically overhaul and put into first-class condition the whole of the mechanical

* Abstract of paper read before the 8th Annual Conference of the Municipal Tramways Association, London, September 22, 1909.

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and electrical equipments of the cars. The lay-out of the depôt is arranged so that regular and synchronous progression of the work in the several shops is ensured.

Describing the shops and the equipment, the wheel shop, situated at the south-eastern end of the building, is 117 ft. long by 65 ft. wide, and is equipped with three high-speed tyre turning lathes, three high-speed tyre boring mills, one 150 ton power wheel press, one wheel boring machine, one 4-hole gas tyre heating hearth, with jib crane and pneumatic hoist, and a half dozen jig saws for cutting off tyres. The tyre turning lathes of a special type, built by Tangyes, Ltd., to the Council's specification, are motor-driven, and capable of taking the heaviest cut on high carbon steel tyres that modern high speed steel will withstand. In considering the power required for these machines, a cut ·5 in. by ·125 in. at 50 ft. per min. was taken as a good all-round average to aim for, and it was assumed that a cutting pressure for high carbon steel tyres would be equal to about 80 tons per square inch, and taking the cut area as equal to ·0625 square inches at a cutting speed of 50 ft. per min. gives approximately the h.p. required. Thus: area of cut in inches multiplied by speed in feet per minute multiplied by cutting pressure in lbs. for each tool—

$$\frac{\cdot 0625 \times 80 \times 2{,}240 \times 2 \times 50}{33{,}000} = 33{\cdot}9 \text{ h.p.}$$

Each lathe is, therefore, driven by a 36 h.p. polyphase motor direct coupled to a change speed gear box. The maximum purchase through the gears is 712·5 to 1. One of the most important points to consider when specifying for or designing a machine for turning high tensile tyres is the rigidity of the machine. Both tramway engineers and machine tool makers appear to have treated this point too lightly in the earlier types of lathes with the result that, the work took far too long to do, and owing to the vibration set up in the machine only light cuts could be taken even with high speed steel tools. Tests have been made in the Council's shops on both types of machines, and it has been noted that the tools failed much sooner with a light cut on a machine which "chattered" than with a heavy cut on a rigid machine, and whereas in the earlier type of lathe from eight to ten hours were required to return a pair of tyres or an average of six pairs per week of 54 hours, with the machines now in use the average output of each machine is six pairs per day or 34 pairs per week of 54 hours. The life of steel tyres made to the Council's specifications averages 56,000 miles for pony wheels and 50,000 for driving wheels, this gives an average rate of wear per $\frac{1}{8}$ in. radial reduction of thickness of 5,090 miles and 4,545 miles respectively. The tyre boring mills were specially built to the Council's specification for dealing with the work of boring high tensile steel tyres, are capable of taking the heaviest cut at the highest cutting speed that modern high-speed steel will withstand. Pneumatic hoists are carried on jib cranes above the mills for lifting the tyres on to and off the machines. At the present time some 430 new tyres and 575 pairs of wheels complete are handled in this shop per month, or an average of 5,160 and 6,900 respectively per year.

The machine shop, situated on the western side of the building adjoining the smiths' shop, is 143 ft. long by 43 ft. wide, and is equipped with one 3 ton overhead 3 motor electric crane running the full length of the shop. This crane operates at the following speeds: Longitudinal travel, 200 ft. per min.; cross traverse, 100 ft. per min.; hoist, 30 ft. per min.

The centre of the shop between the machines is occupied by fitters' benches equipped with the usual parallel quick-action vices and also a marking-off table. The line shafting is of bright steel, 3 in. dia., running at 250 r.p.m. in self-aligning bearings, with Tilston's forced lubrication, and is driven by five 36 h.p. polyphase motors, each attached to the upright stanchions. The shafting is divided into five sections, coupled by means of claw couplings, so that any section may, if necessary, be run independently of the others. Several of the machine tools in this shop are adapted for work of a special character. A machine has been provided for boring and facing bearings, and is fitted with a self-centreing chuck, with collets to take each size of bearing used, the boring being done by means of boring bars carrying both roughing tool finishing cutters and facing cutters. It has two spindle speeds, one giving 200 r.p.m. and one 114 r.p.m. for boring and facing respectively, the speeds being arranged so that the change may be made while the machine is running, a single lever placed close to the operator's left hand controlling both speeds and the stop motion. The feed is constant at 120 per inch of travel.

The power hack saws, special vertical milling machine, and four spindle drilling and tapping machine form the main part of a special plant for machining magnetic brake shoes, of which a very large number are used. The material for making these shoes is obtained in the bar direct from the rolling mills, and is cut into lengths by the power hack saws; after cutting to correct length, the bars are placed in a jig on the milling machine table, which will accommodate 48 shoes. The cutter is of special form to the author's design, and carries 14 high-speed steel tools for roughing and two tools for finishing. The diameter of the cutter determines the width of the register cut in the shoe and the depth of the cut averages $\frac{3}{16}$ in. The rate of feed of the table varies from 2 in. to 4 in. per min., according to the size of the cutter used, and the cutting speed of the tools is 70 ft. per min. This machine when working on shoes for the largest magnet will machine the gap $18\frac{3}{4}$ in. in length by $\frac{3}{16}$ in. deep, at the rate of 60 shoes per hour. The power required for cutting at this rate is about 25 h.p.

In each shoe two $\frac{3}{4}$ in. holes require to be drilled and tapped, and the four spindle machine was designed to deal with this work: the shoe, carried in a jig which slides along the table, is first set under the drill spindles and the two holes drilled simultaneously, it is then moved to the tapping spindles and the two holes tapped simultaneously.

The general store, which contains a 20 ton weigh-bridge and some 7,000 steel bins, is used for the storage and distribution of such parts as are usually obtained from outside manufacturers. The truck overhauling shop, situated on the immediate western side of the traverser pit, is 195 ft. long by 46 ft. wide, and is equipped with two 5-ton 3-motor electric cranes, which operate at the following speeds: Longitudinal travel, 200 ft. per min.; cross traverse, 100 ft. per min.; hoist, 5 ton, 15 ft., $2\frac{1}{2}$ ton, 30 ft. per min.; and the usual fitters' benches, vices, pneumatic drills, hammers, chippers, etc. There are 14 working tracks, each capable of accommodating four bogie trucks or three single four-wheeled trucks. A narrow gauge industrial railway track runs along the full length of the shop on the side adjacent to the stores, with branch lines between alternate pairs of truck tracks. Two small battery power motor-driven service wagons are in course of construction for the purpose of transferring material from or to the stores and other parts of the depôt, and the men employed on truck overhauling.

The Council's method of dealing with the gear wheel and pinion problem gives excellent results. Some difficulty was at first experienced in obtaining a suitable steel at a reasonable cost, and it was found after several trials had been made with pinions cut from various steels, the steel which gives the best results from all points of view has the following analysis: Carbon, ·15%; silicon, ·02%; sulphur and phosphorus (not to exceed), ·05%.

The pinions are specified to be case-hardened to a depth of not less than $\frac{1}{16}$ in. from the surface of the teeth, the centre being left soft.

Lubrication is also an important factor in the life of gears, a mixture which gives excellent results, and is at the same time cheap, has been in use for some four years, this is composed of black axle oil and sawdust mixed in the proportion of 42 galls. of oil to 216 lbs. of sawdust, the cost of which works out at approximately 4s. $8\frac{1}{2}$d. per cwt.

The traverser pit occupies a central position in, and extends the full length of, the building. B.S.S. No. 4 C track rails are laid at 13 ft. 6 in. gauge with standard L.C.C. conduit work in the centre, the arrangement of electrical conductors, etc., being similar to that employed for street tracks. Power is supplied to the traverser motor from the conduit conductors by means of a standard car plough. The traversers, only one of which has up to the present been installed, are built to working drawings made in the department. All the gears, pinions, wheel centres, tyres and electrical equipment being made inter-

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changeable with similar parts of the rolling stock. Warping gear is provided by means of which cars, trucks, etc., may be hauled either on to or off the tracks or traverser as required. When the second or exterior traverser pit is constructed, it is proposed to lay a pair of rails on each side of the centre conduit at 4 ft. 8½ in. gauge, and make use of this as a track for testing the cars, each of which will be run and the brakes and equipment tested before being sent to the car sheds for service.

The small gallery, located immediately above the stores and between the machine and truck shops, is 260 ft. long by 20 ft. wide, is reached by means of a staircase in the centre and an electric lift at the south end.

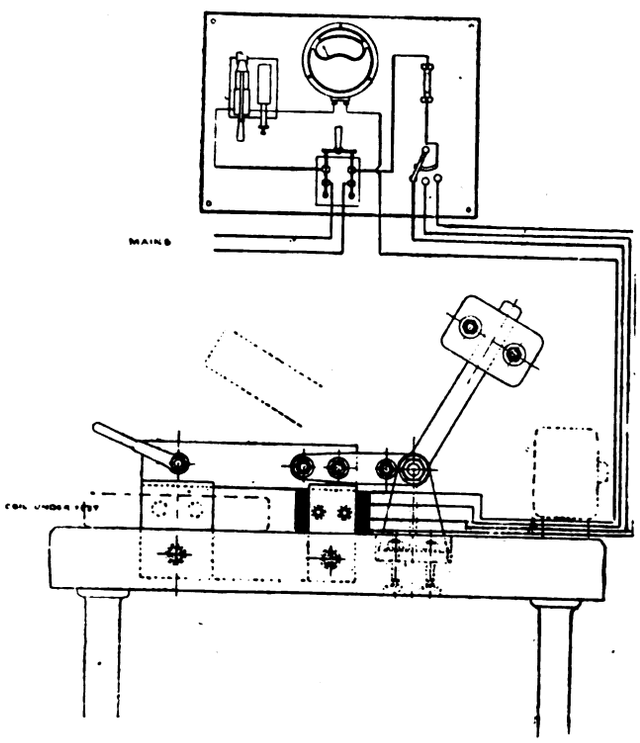

Fig. I. Testing Transformer.

The tool shop is equipped with one 48 in. Starrett micrometer, one Cincinnatti drilling machine, one Cincinnatti universal grinder, one G shôlt tool grinder, one pillar milling machine by Parkinson, and one 6½ in. S.S. and Sc. lathe by Dean Smith & Grace, Ltd., and on the gallery are benches for light repairs to parts of the equipments, such as circuit breakers, canopy switches, trolley heads, brush holders, etc., and the following machine tools: One 6½ in. S.S. and Sc. lathe by Dean Smith & Grace, Ltd.; one 7 in. S.S. and Sc. lathe by Bradford; one 6½ in. S.S. lathe by Lang; two 6½ in. capstan lathes by H. W. Ward & Co.; one 20 in. disc grinder by Roberts; two shaping machines; four double spindle sensitive drilling machines; and three single spindle sensitive drilling machines by Tangye, Ltd. One 20 h.p. polyphase motor with auto-starter operates all the tools on this gallery.

The large gallery, located above the traverser pit, is 275 ft. long by 48 ft. wide, and is reached by two separate staircases from the south end, with a central staircase and an electric lift. This gallery is served by a 3-ton 3-motor electric travelling crane by Applebys, Ltd., operating at the following speeds: Longitudinal travel, 350 ft. per min.; cross traverse, 100 ft. per min.; hoist, 40 ft. per min.

The southern end of the gallery is occupied by the test room. Here all re-wound and repaired armatures are placed in testing frames and run on load in both directions, the artificial load being absorbed by a Froude water dynamometer. Brake magnet and field coils are tested for continuity, internal short circuits and ohmic and insulation resistance, before being replaced on the cars after overhaul, and all repaired and new ploughs pass under the inspection of the test room attendant before being despatched to the car sheds for use on the cars.

The method of testing field and brake magnet coils for internal short circuits presents some points of interest, and in view of its simplicity is perhaps worthy of description. A frame of Swedish transformer iron, which is shown by Fig. 1, has a hinged yoke across the top, which is counterbalanced as shown, and made to lift clear of the front limb of the frame.

The back limb carries a permanent coil, which is excited from one phase of the A.C. supply and forms the primary coil of the transformer. The coil to be tested is placed on the front limb and the hinged yoke dropped into position. Just above the transformer is a panel containing the ammeter, which indicates the current flowing in the circuit. If the coil to be tested has no short circuit, the current flowing the primary circuit will be so small as to be scarcely readable on the ammeter; if, however, there is a short circuit in the coil, even if but one turn, an appreciable current will flow and be indicated by the ammeter.

With the exception of the space at the northern end of this gallery floor, occupied by the office block and the Advertisement Plate Stove, the remainder of the gallery is used as an electrical repair shop. Here the following plant is installed: Two commutator turning and grinding lathes, two armature banding lathes, five coil winding machines, all by Tangye, Ltd., and one coil winding machine by Pfeil & Co. Here all ploughs, motors, armatures, controllers, field and brake magnet coils are dealt with.

The plant installed for vacuum drying and impregnating armatures, field and brake magnet coils, etc.; the cylinders have been made by Heenan & Froude, Ltd. These are heated by means of steam coils, and an inner cylinder of sheet steel is provided to keep the coils and varnish out of contact with the hot pipes. All the ploughs required for operating the cars on the conduit system are made and repaired at the depôt. There are two types of plough in use, one of which is made with a solid hard rubber base and the other is made with a built up wood base; in both cases the fittings are similar and interchangeable one with another.

Fig. 2 shows the general arrangement of the latest type of rubber base plough in use. The collector shoes are of cast iron, and fastened to a spring by a wedge. These shoes have an average life of 8,000 miles and cost about 3¼d. per pair. The friction plates marked F. on the

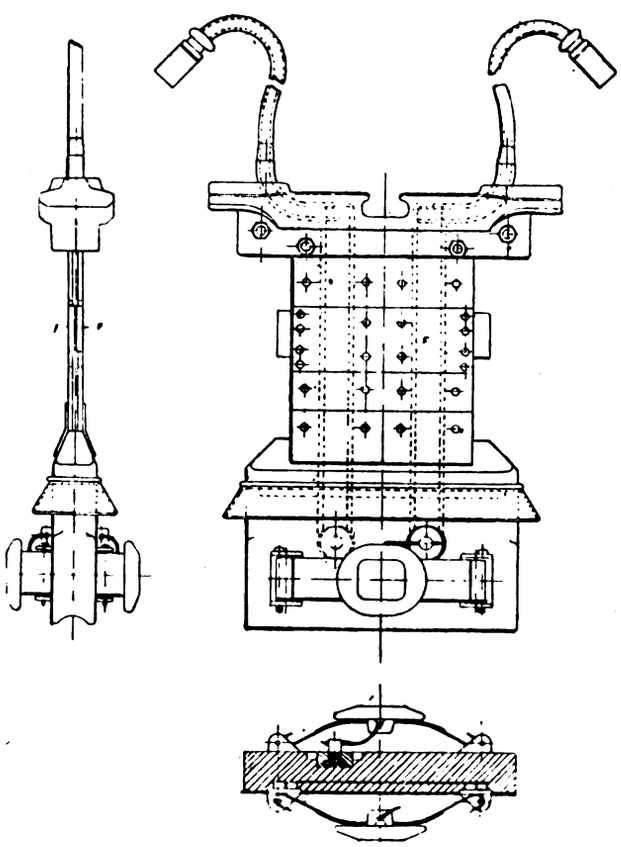

Fig. II. Standard Plough.

illustration are of steel, have an average life of 3,000 miles, and cost about 9s. per 100, which includes the cost of labour in producing them. This works out at 1s. 10d. per 100.

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The total maintenance cost of ploughs, including all renewals during the last financial year, was ·05d. per car mile. A new rubber base plough costs about 107s.

In the timekeeper's office is located the master clock by Stockall, which controls all the time recording and other clocks in the depôt, together with an automatic bell-ringing arrangement, which will cause all the bells to ring in synchronism at pre-determined times to warn the workmen of starting and finishing times, together with a small telephone exchange, placing each shop in telephonic communication with the superintendent's office.

The depôt is lighted throughout, both inside and outside, with the exception of the paint and inspection shops, and the offices, by 60 Sunrae flame arc lamps by Davy, arranged in series of 10 on the 500 volt D.C. supply. The power supply is by three-phase H.T. 6,600 volt current direct from the generating station at Greenwich to the transformer room, which is situated outside the depôt. The high tension current is controlled by means of a H.T. automatic oil switch, with an overload time limit relay. Four 150 k.w. single-phase transformers of the Berry type, one of which is a spare, have been installed. These transform the current from 6,600 volts to 220 volts. A switchboard by Spagnoletti has been installed for controlling the H.T. and L.T. alternating current, and the D.C. supply. Each feeder panel carries two feeders, one of which has in each case been provided to meet the demand in the extensions; additional spaces have been left for further panels to be erected when required. The feeders from the panels are led in underground ducts to various sections of the depôt, where they are connected to fuse distribution boxes, from which each motor circuit is taken. All feeders are of the 3-core paper insulated lead covered type, the cables for the small ventilating fan motors are of the 3-core V.I.R. type. The installation of the electric lighting, power supply, and telephones has been supervised by Mr. J. H. Rider, M.I.C.E., M.I.E.E., Tramways Electrical Engineer.

The whole of the 4 ft. 8½ in. gauge track work within the building is made up of bullhead flat bottom rail spiked to transverse and longitudinal creosoted wood sleepers. The industrial tracks are of flat bottomed rail laid to a gauge of 21½ in., with hand switches and curves arranged for outside flanged wheels on the small trucks. The track work in the yard is laid with No. 4 British Standard Section rails on a concrete bed, whilst the siding tracks are laid with bullhead rails spiked to transverse wood sleepers metalled as in ordinary railway practice. The whole of the track work was carried out under the supervision of Mr. J. Welling, the Tramways Permanent Way Engineer.

MAGNETIC TESTING OF IRON WITH ALTERNATING CURRENT*

By ALBERT CAMPBELL, B.A., Assoc. M.I.E.E.

(From the National Physical Laboratory.)

The introduction of high resistivity iron alloys with low hysteresis loss has made it more than ever desirable that sheet material for use in transformers, or other alternating machinery, should be tested for hysteresis and eddy current loss by means of actual alternating current. The object of the present paper is to describe the method by which these tests are carried out at the National Physical Laboratory, and to include some of the more interesting results obtained during the past year. Before describing our own work, however, brief reference must be made to that of earlier experimenters. The subject has been investigated by a number of persons in this country, the Continent, and America; but I may single out, as being of fundamental importance, the work of Dr. G. Roessler,† as he was the first to point out the influence of the form factor of the alternating voltage used. This theory forms the basis of the thorough investigations made by Gumlich and Rose,‡ and in what follows I have made considerable use of their clear treatment of the subject. While our experiments were in progress, a paper appeared by Messrs. Lloyd and Fisher,§ describing the method of test employed at the Bureau of Standards, Washington: their method is very similar to that used by us, and is thoroughly discussed in their paper; and, lastly, an interesting paper has appeared by Lloyd‖ on the "Dependence of Magnetic Hysteresis on Wave Form."

* Original communication to the Institution of Electrical Engineers.

† *Verband Deutscher Elektrotechniker*, July 9, 1895. (*Electrician*, vol. xxxvi., p. 124, 1895.) Almost immediately his results were independently established by the experiments of Beeton, Taylor, and Barr (*Journal of the Institution of Electrical Engineers*, vol. xxv., p. 474, 1896).

‡ *Elektrotechnische Zeitschrift*, p. 403 and p. 503, 1905.

Influence of Form Factor.

When an iron ring is magnetised by an alternating current of frequency n ∽ per second, the eddy current losses in the iron not only depend on n and the flux density, but also on the form factor f of the induced secondary voltage, where f is equal to V/v_{mean}, v_{mean} being the mean value of the induced voltage without regard to sign, and V the effective value of the same. According to Roessler, at constant temperature the iron losses in watts per cubic centimeter due to hysteresis and eddy currents respectively are given by the two terms of the expression—

$$10^{-7}(\eta n B_{max.}^{1.6} + E n^2 f^2 B^2_{max.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

were—

B_{max} = maximum value of the flux density,

η = Steinmetz's coefficient,

and—

E = eddy current coefficient.

If w = watts per kilograme at frequency n, we have—

$$w = \frac{10^{-7}}{D}(\eta n B_{max.}^{1.6} + E n^2 f^2 B^2_{max.} \quad . \quad . \quad . \quad . \quad (2)$$

where—

D = density of the iron.

The main object of the investigations here described was to test the accuracy of this formula for various materials and widely different values of the form factor f ¶—*i.e.*, for widely different wave-forms. As will be seen below, this led to a convenient method of separating the hysteresis and eddy current losses. It is usual to take 50 ∽ per second as standard frequency, and $B_{max.} = 10{,}000$ as standard flux density. Most of our results were obtained with frequencies quite near 50 ∽ per second, and all of them were reduced to the standard, the watts per kilograme being $50\ w/n$. Except where otherwise mentioned, observations were always made with $B_{max.}$ exactly 10,000.

Method of Test.

All the specimens were in the form of rings, usually of inner and outer diameters, 12 and 15 cm. respectively: these were built up of stampings with paper insulation between them, and each was wound with at least two secondary coils of 10 and 30 turns respectively, and sometimes one of 100 turns was added. The primary windings were 30 or 100 turns. All the windings were evenly distributed over the ring. The method of test consisted in the determination of the $B_{max.}$ and the form factor of the induced voltage by the help of a commutator as used by Sahulka* and Townsend,† while the corresponding power lost was measured by a sensitive wattmeter whose shunt circuit was connected to one of the secondary windings of the ring after the method of Steinmetz.‡ The connections are shown in Fig. 1.

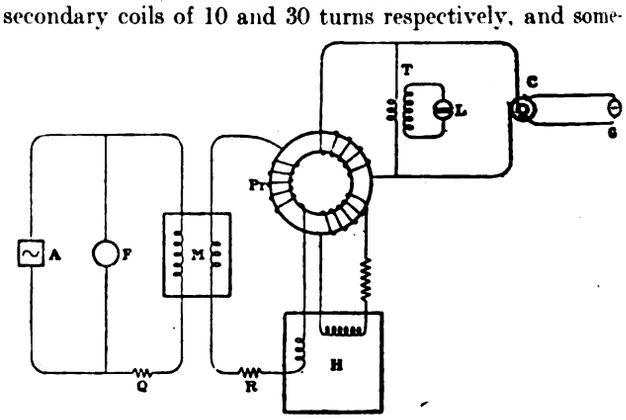

FIG. 1.

§ *Bulletin Bureau of Standards*, vol. iv., p. 467, 1908.

‖ *Bulletin Bureau of Standards*, vol. v., p. 381, 1909.

¶ Gumlich has found it true with certain samples for small variation of f and also for a considerable range of frequency. It is clear that it cannot be true for very high frequencies.

* *Zeitschrift fur Elektrotechnik*, p. iv. (16), 1898.

† *Am. Inst. Elec. Engs. Trans.*, vol. xvii., p. 5, 1900.

‡ *Am. Inst. Elec. Engs. Trans.*, vol. ix., p. 624, 1892. The method seems to have been used first in this country by L. W. Wild (*Electrician*, vol. iv. p. 128, 1904).

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An alternator or rotary converter A, working through the transformer M, supplies current to the primary of the ring D, the frequency being measured by the Campbell frequency teller F. The primary current passes through the series coils of the wattmeter H, and the shunt circuit of the wattmeter is connected through a high resistance to the secondary winding S. Another secondary coil Z (of 10 turns) is connected through the high ratio transformer T to the 100-volt electro-static voltmeter L, and also through the commutator C to the galvanometer G, which, by the addition of suitable high resistance, is arranged to read voltage directly. The commutator is run by a synchronous motor supplied with current from the alternator A; it reverses the connections to the galvanometer circuit twice per period, and when, by shifting round a pair of movable brushes on C, the phase of the reversals is set to give a maximum reading on the galvanometer, this reading will measure $v_{mean.}$ the mean value of the voltage induced in the winding Z.§

The reading of the voltmeter L multiplied by the transformation ratio of T gives V, the effective voltage induced in Z, and hence f, the form factor (which is equal to V/v_{mean}) is immediately found. The galvanometer reading also gives B in the ring since—

$$B_{max.} = \frac{10^8}{4 N_2 s n} v_{mean},$$

where s is the cross-section of the ring (in square centimeters), N_2 the number of turns in Z, and n the frequency.

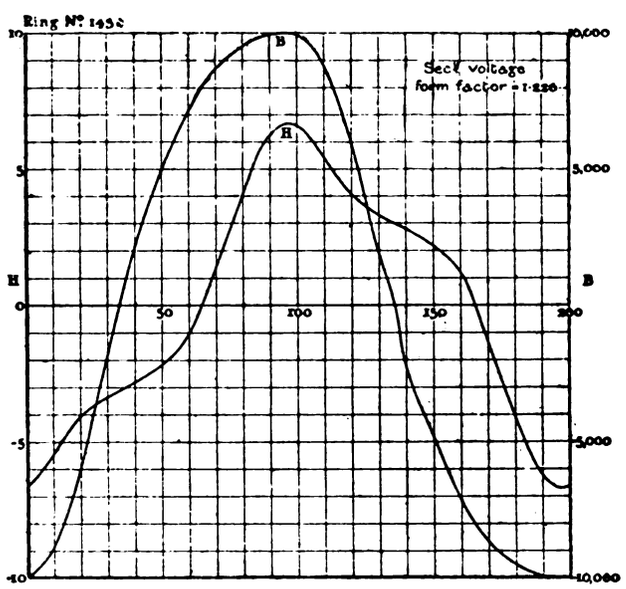

FIG. 2.

If N_1 and N_2 are the numbers of turns in P and S respectively, then the total power spent in the ring is equal to (N_1/N_2) × (watts read by wattmeter H). The wattmeter was a sensitive reflecting one, built manily of white marble and ebonite to avoid eddy currents; with a moving current of 25 ohms and a total shunt resistance of 6,500 ohms, 1 watt (at 1 volt) gave 100 mm. at 1 m. This sensitivity allowed rings of small section to be tested without requiring an inconveniently large number of secondary turns. The transformer T had a core of Stalloy rings uniformly wound with primary turns (50 up to 400), and with 40,000 secondary turns. Thus various ratios up to 1 : 800 could be obtained. Its primary circuit took such a small current that putting it in circuit scarcely affected the galvanometer reading or that of the wattmeter. The frequency teller was of the type with a single vibrating strip which could quickly be adjusted to resonance with the actual frequency. It could be read to 1 in 500, and was carefully calibrated at each frequency used. Usually the temperature of the iron while under test was observed by the help of an iron-constantan thermo-junction inserted between the sheets before the ring was wound. With rings of large volume and high eddy current loss it is very necessary to know the temperature, especially when (as in nearly pure iron) the resistivity alters considerably with change of temperature.

§ See J. Sahulka (*loc. cit.*), also T. Lyle (*Phil. Mag.*, p. 549, 1903, and p. 102, 1905).

The results given below were corrected to standard temperature on the assumption that for such thin sheets (at the moderate frequencies used) the eddy current loss is inversely proportional to the resistivity.

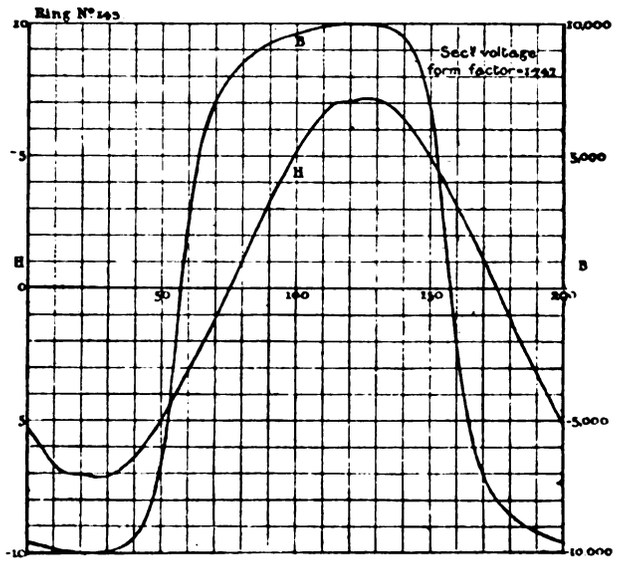

FIG 3.

Typical Results.

In making the tests of total loss, in most cases it happened to be most convenient to keep the frequency nearly constant and to alter the form factor (f). This was done in several ways, *e.g.*, by altering the ratio of transformation of M and the resistances Q and R, by omitting M and connecting directly to A through a resistance, or by altering the number of primary turns used on the ring. Although the converter used gave almost exactly a sine-wave voltage, by these means it was found easy to obtain a wide range of form factor.* This is illustrated in Figs, 2, 3, and 4, which show three widely different cases with the same ring and the same machine, the curves for the magnetising current i_1 (and hence H) and the flux density B being drawn by Sahulka's and Townsend's methods with the commutator already mentioned. For i_1, the current i_1 is passed through the primary of an air-core transformer of known mutual inductance, whose secondary is connected to the commutator; for B the connections are as in Fig. 1. In both cases one pair of commutator brushes is shifted round to various angles and corresponding readings are taken on the galvanometer G. Complete curves of both i_1 and B can be drawn in about three minutes if the galvanometer is properly dead-beat.

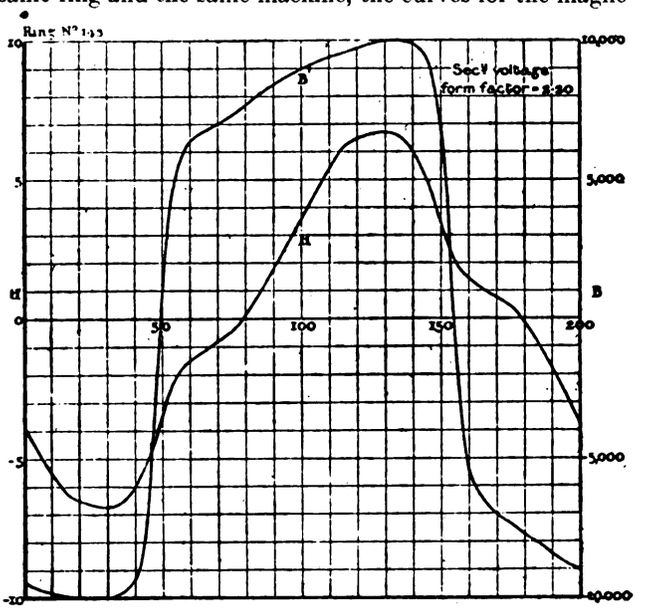

FIG 4.

From the observations already mentioned were deduced the total watts per kilograme, namely 50 w/n for 50 •

* The lowest form factors of the secondary voltage were obtained with the greatest number of primary turns and the smallest transformation ratio and resistance, while the highest were got with few primary turns, no transformer, but considerable resistance in circuit.

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per second and $B_{max.} = 10,000$; and the values found were plotted against $n f_2$. Fig. 5 shows the curves thus obtained for a number of widely different materials, while Table I. gives for each of them the approximate thickness of the sheets, the resistivity, the permeability at B = 10,000, and the hysteresis coefficient n. The dimensions were found in the usual way by measuring the outer and inner

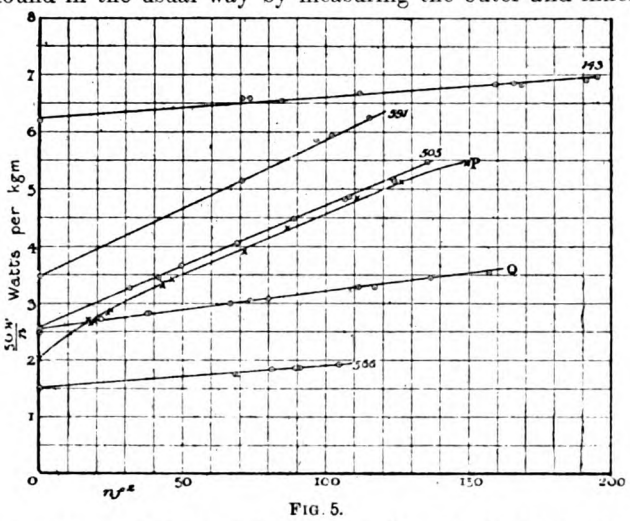

FIG. 5.

diameters and determining the density and the total mass.

It may be mentioned that No. 591 was ordinary tinplate, (P) had been annealed at 800° C. and aged at 100° C., while (Q) and No. 566 were high resistivity materials.

To obtain the total loss at 50 ∾ per second for the standard conditions, namely, with induced voltage of sine-wave form (for which $f = 1{\cdot}111$), it is only necessary to read the ordinate of each curve for $n f_2 = 50 \times (1{\cdot}111)^2$, *i.e.*, 61·7. As the curves are practically straight lines near this value, if we wish to determine total loss alone, it is only necessary to take readings for two different form factors (or frequencies) not very far apart, join the points obtained (by a straight line), and find where the ordinate at $n f^2 = 61{\cdot}7$ cuts the joining line. This method of different form factors is very useful when the frequency cannot be varied—for example, in working with a public supply circuit or when the alternator is inaccessible. There is no need whatever to use a sine-curve machine, provided there are no dimples in either the H or B curves.

In Fig. 5, however, much more has been included. (*a*) The points shown for $n f^2 = 0$ are the values of the hysteresis loss obtained for each ring by the ordinary ballistic method: they are sometimes called the values of the "static hysteresis." (*b*) The points below $n f^2 = 50$ were obtained by using lower frequencies. (*c*) A few of the higher points were obtained with frequencies as high as 70 ∾ per second, the majority of the points, however, being for $n = 50$ ∾ per second.

TABLE I.

Sample.	Approximate thickness of Sheets	Resistivity at 150° C.	Permeability at B = 10,000	Static n.
	Millimeter.	Microhm-cm.		
143	0·24	17·3	1,370	0·00384
591	0·46	12·6	1,868	0·00215
505	0·50	13·6	2,512	0·00158
P	0·43	14·0	2,878	0·00123
Q	0·40	43·0	1,873	0·00155
566	0·48	60·3	2,820	0·00090

Consideration of the curves in Fig. 5 leads to the following conclusions:—

1. For all the specimens except (P) the lines are practically straight and pass through the "static hysteresis" points. Hence, over the range of $n f^2$ shown, the hysteresis loss is constant, and the total loss per ∾ can be represented by the expression $F + G n f^2$, the two terms representing the hysteresis and eddy current losses respectively.

2. The specimen (P), on the contrary, shows a curve which is by no means a straight line, but clearly bends in coming down to the static hysteresis point. It also falls slightly at the higher values of $n f^2$. Except for the intermediate part of its range, the total loss cannot here be represented by the expression $F + G n f^2$. It is interesting to notice that (P) and (505) are very similar in total loss and also hysteresis, except at the upper and lower ends of the range.

The final conclusion is that, although some materials give excellent straight lines in the diagram of total loss for a wide range of frequency or form factor, other materials give lines that are distinctly curved, indicating that the hysteresis loss increases considerably as the frequency is raised from 0 upwards. There seems no doubt that this effect must be attributed to magnetic viscosity (*see* Lloyd, *loc. cit.*). In corroboration of this I may mention that, in the ballistic test of (P), if an additional evenly wound secondary circuit was kept closed during the test, a quite distinct alteration was shown in the values obtained for the permeability and hysteresis for $B_{max} = 10,000$. The slight drop in the (P) curve at the higher values is probably due to "skin effect," the higher frequencies causing B to be not quite uniform throughout the thickness of the sheet. I should mention that several other samples gave lines bent similarly to that of (P).

The above results appear to throw some light on an old-standing controversy. Several observers have stated that hysteresis loss is practically independent of frequency (at the lower values), while others affirm that it varies with frequency and wave-form. Gumlich and Rose incline to the former view, and Lloyd appears to agree with them. It seems likely, however, that some of the experimenters have been testing specimens like (505) and (591), while others have had experience of more abnormal materials like (P).

Effect of Thickness of Sheets.

The experimental results for total loss at $B_{max} = 10,000$ are only strictly valid when the thickness of the sheet is such that B_{max} has time to get practically uniform throughout the thickness in each half-period. To investigate this point experimentally a set of specimens of different thicknesses, but of as nearly as possible similar material, were tested for total loss. The material was "electrical steel," made by Messrs. J. Lysaght, Ltd., who have kindly permitted the results to be published.

Fig. 6, curve (*a*) shows the results obtained for eddy current loss with (mean) $B_{max} = 10,000$, and $n = 50$ ∾ per second. In the same Fig. curve (*b*) is the theoretical curve calculated, on the assumption that the permeability is constant, by the formula of J. J. Thomson, as given by Russell.* The formula states that the eddy current loss, for given *constant* permeability u, resistivity ρ, and frequency n, varies, as—

$$\frac{\sinh 2ma - \sin 2ma}{\cosh 2ma - \cos 2ma},$$

where—

$2a$ = thickness of sheet

and—

$$m = 2\sqrt{un/\rho},$$

ρ being in absolute units.

It will be seen that the two curves agree as well as could be expected, considering the uncertainty due to want of uniformity of material. For the smaller thicknesses the

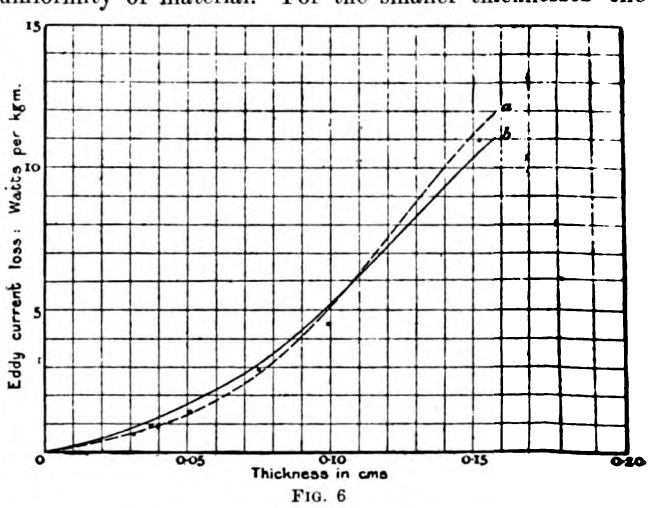

FIG. 6

* A. Russell, "Alternating Currents," vol. i., pp. 360 and 362.

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eddy-current loss is proportional to the square of the thickness of the sheet. The agreement of the two curves in Fig. 6 only has reference to the variation in thickness, for they were arranged to coincide at one point. The absolute results given by the complete formula are less than those observed by large amounts varying from 10 to 100% according to the material, showing that the want of constancy of the permeability and the co-existence of hysteresis largely modify the conditions.

Proper Dimensions of Ring Stampings.

In almost all magnetic tests there arise difficulties due to the alteration of the material due to the mechanical processes used in preparing the test-pieces, such as stamping, cutting, or turning. The greater the width of the test-piece (whether ring or strip), the less the result will be affected by the edge hardening. In the case of rings, however, the radial width must not be taken too large in relation to the mean diameter, otherwise the magnetic force will not be sufficiently uniform over the width, being greater at the inner edge than at the outer. The same remark applies to almost any arrangement of strips, such as those used in building up the square of the Epstein apparatus. Thus, if it is not allowable to obliterate the effects of the mechanical treatment by annealing after stamping or cutting, the proportions of the test-pieces must be fixed by making a compromise between the two conditions—namely, maximum width of strip and greatest uniformity of H.

The question of the amount of error in the usual energy determinations, due to the want of uniformity of H, has been very fully worked out by Richter * for rings of rectangular section, and lately his results for the simple case, where the permeability is constant, have been clearly tabulated by Lloyd,† who has also investigated the case of a ring of circular section. Lloyd points out that his results would be somewhat modified in practice because of the permeability not being constant. He mentions that the errors in the energy loss depend on the difference between (mean B_{max})$^{1\cdot6}$ and the mean of $(B_{max})^{1\cdot6}$ over the width of the ring. When working with B_{max} = 10,000, I found that the assumption of constant permeability may exaggerate the errors considerably. As this value of B has been much used in standard tests, I think it will be of interest to describe briefly my calculations.

Let the ring (of rectangular section) be divided into a number of elementary annuli of equal radial width. If the mean radius of one of these be r, then for that annulus $H = 2 N_1 I_1/10 n r$ or $H \propto 1/r$. If now the curve H B be known, we can find the value of B for each annulus, choosing the medial value near 10,000 for example. In a test of total loss it is the (mean $B_{max.}$) that is observed, the mean being taken over the width of the ring, and the hysteresis loss corresponding to this value should be proportional to (mean $B_{max.}$)$^{1\cdot6}$, but the loss actually measured by the wattmeter is proportional to the mean of $(B_{max.})^{1\cdot6}$. The ratio of the first of these expressions to the second is accordingly the correcting factor to be applied to the observed hysteresis loss.‡

As examples, I have in this way worked out the correcting factor for two actual rings, one of very low, and the other of high hysteresis constant (n = 0·00083 and n = 0·0042 respectively). Each ring (Fig. 7) had an inner radius of 6 cm. and an outer of 8·5 cm. For $B_{max.}$ = 10,000 the correcting factors come to 1·0008 and 1·002 respectively, showing that, for a mean diameter of 14·5 cm., in each case the error in hysteresis is negligible with a radial width of 2·5 cm. If the permeability had been assumed constant the correcting factor would have been about 1·011 in both cases. It must be remembered, however, that for lower values of $B_{max.}$ (*e.g.*, 5,000) the variation in permeability would often make the correcting factor *greater* than for constant permeability.

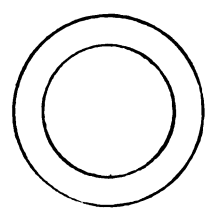

FIG. 7.

We have investigated in various ways the effect of stamping, but it will be enough to describe one experiment. From a batch of carefully annealed sheets two sets (1) and (2) of ring stampings were made, having radial widths of 1·5 and 2·5 cm. respectively. On testing each set the ratio of their hysteresis losses was found to be 1·076. If we assume that the same width of edge is hardened in (1) and (2), then it is easy to show that the ratio of the loss for 2·5 cm. width to that for infinite width is 1·126. Thus we see that even with a width of 2·5 cm. the stamping has increased the mean hysteresis loss by over 12%. Some experiments show less and some more than the above (according to material), but it is clear that for widths of the order of 3 cm. the effect of stamping is considerable, and some allowance would have to be made for it if absolute, and not merely comparative results are to be considered. The effect on the total loss will not be so great, as the eddy current part is not so much influenced.

In conclusion, I have to express my best thanks to Messrs. J. Lysaght, Ltd., for kind permission to publish results obtained on samples of their materials (*e.g.*, those in § 5); my thanks are also due to Messrs. H. C. H. Booth and T. L. Eckersley, whose skilful assistance was invaluable both in the experiments and in the reduction of results; and, finally, to Dr. R. T. Glazebrook, for his valued help and advice.

* *Elektrotechnische Zeitschrift*, vol. xxiv., p. 710, 1903.
† *Bulletin Bureau of Standards*, vol. v., p. 435, 1909.
‡ The index 1·6, though not necessarily the true value for some specimens, is near enough to indicate the magnitude of the correction. The method was pointed out to me several years ago by Mr. G. F. C. Searle.

COLLECTIVE HYDRO-ELECTRIC PLANT.

An interesting hydro-electric system has been installed for the Peerless Electric Co., of Warren, Ohio. The scheme embodied the uniting of a number of water-powers of various heads, and at widely scattered points, into a single system, and delivering the energy at Warren, where a steam-engine and a gas-engine auxiliary are used on the same system, all operating in parallel. These works, of which we give some details, abstracted from a lengthy description in the New York *Electrical World*, were built for the Peerless Electric Co., of Warren, Ohio, and are controlled by the Hydro-Electric & Gas Co., of Warren. The steam-engine plant is at the factory of the Peerless Electric Co., and the gas-engine at the gas works. Leavittsburg, on the Mahoning River, is the nearest water-power plant to Warren, and at a distance of three miles from the Warren sub-station. Formerly a small grist mill was operated at this point, the power being derived from a 7 ft. dam. The new dam was built about 200 ft. below the old dam, and gives a maximum head of 9 ft. It is of the reinforced concrete gravity type, is 200 ft. long, and stands on a soft shale bottom. Directly in line with the dam at the east end stands the power-house. The wheel pits are of reinforced concrete and three in number, each containing a 54 in. American turbine, all being geared to a single horizontal line shaft running at 118 r.p.m. As the back water frequently rises above the level of the dam's crest, each turbine has a different gear ratio, so that each wheel has an efficient speed for its own particular stage of back water. In the governor mechanism there is but one coupling pin, thus eliminating the usual danger of the operator leaving in one pin and inserting the second, thereby breaking off the levers or stripping the gears. The turbine gates are of the balanced wicket type, connected to the vertical shaft by means of a ring mounted on ball bearings, and a link and lever motion. It was guaranteed that a governor exerting 12,000 lb. through a distance of 1 ft. in one second would easily handle the gates, and a Sturgess governor was installed, and is reported as working successfully. Owing to the low speed of the line shaft, 118 r.p.m., a pulley 165 in. in diameter is required to drive the 300 kw. generator at 514 r.p.m.

The East Branch plant is situated on the East Branch of the Mahoning, at Newton Falls, and about 10 miles up the river from Leavittsburg. At this point there had been a grist and roller mill for over 30 years. The East Branch has about two-thirds the flow of the Mahoning River at Leavittsburg, but the head secured at the East Branch power-house is 16 ft. The dam is similar to that at Leavittsburg, except that it is provided with a movable crest and has a passage-way underneath. The movable crest has an up-and-down movement of 2 ft., and was built more especially for legal reasons.

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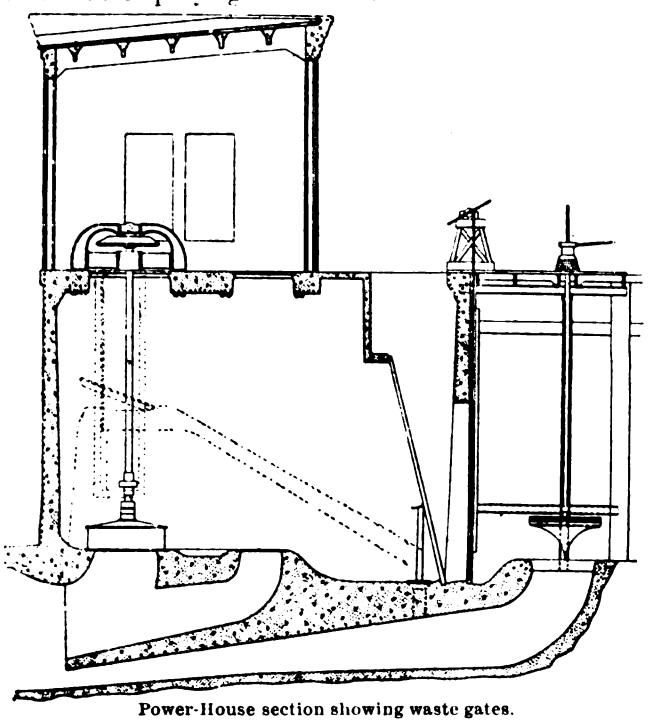
The power-house is built entirely of reinforced concrete. It at present contains three water-wheel units, geared to a horizontal shaft driving a 300 kw. generator at 300 r.p.m., and there is provision made for the future installation of a second line of turbines. Each of the three wheel pits is provided with head gates and steel racks, so that any wheel may be inspected at will. The wheel pits open up stream into a forebay, which is protected from coarse trash by a rack 50 ft. long and 12 ft. deep. This trash rack is parallel with the river's flow and flush with the river side of the power-house, and, therefore, a large proportion of the drift does not lodge upon it, but passes over the dam. In order to diminish the maximum depth of flood water on the dam, three waste gates were built, as shown in the accompanying illustration. Each of these has a



Power-House section showing waste gates.

capacity of about 30,000 cubic ft. per minute. It is also expected that built in this way there would be a material increase of power at such times, on account of the ejector effect. The water passing through these waste ways will have nearly twice the velocity of the discharge from the turbines, and mixing with, or picking up, the latter, will increase the velocity, and, therefore, the effective head on the turbine. The hydraulic equipment consists of three vertical 49-in. improved American turbines geared to a line shaft in a manner similar to that at Leavittsburg.

A third plant is located in the same village but on the West Branch of the Mahoning. The normal working head is 20 ft., and the minimum about 12 ft. This, therefore, is the only one of the three plants that can carry its full load under all flood conditions. The power-house stands at the west end of the dam, which is similar to the Leavittsburg dam. There are three wheel pits, each containing a turbine. One of the turbines is a 34-in. improved New American, and the other two are 49-in. New Americans having higher gear raters. All three turbines are geared to a horizontal shaft, which is directly connected to a 300 r.p.m., 300 kw. generator. The electrical engineer was Mr. Byron T. Mottinger, of the Hydro-Electric & Gas Co.

The East Forks station contains one 300 kw. Electric Machine Co. generator rated at 300 r.p.m., 2,300 volts, three-phase, 60-cycle, with a guaranteed regulation from full load to no load of 7%. The efficiencies at one-half, three-quarter and full loads are 93·5, 94 and 94·5, respectively. The fields of the machine are excited by a 7·5 kw., 125-volt Colonial belt-driven exciter. This station is electrically connected with the East Forks plant, which is located at a distance of about a mile by a 2,300-volt line. The line between the two plants is virtually an extension of busbars. In the West Forks station there is a 300 kw. Electric Machine Co. 2,300-volt, three-phase, 60-cycle generator. The exciter used in this case, however, is of somewhat larger size, being a 25 kw. Peerless machine, belt-driven. The generator is connected to the bus by a Westinghouse oil switch, and the transformer through a Westinghouse automatic oil breaker. This plant is equipped with a Tirrill regulator. There are at present installed six 100 kw. Enterprise Electric 2,300-volt to 23,000-volt, single-phase transformers connected in delta between the 2,300-volt bus and the 23,000-volt bus. The 23,000-volt bus is connected to the transmission line through three fused type Westinghouse circuit-breakers. Between the high-tension busbars and the fused breakers are located three Wagner 60,000-volt oil type series transformers connected to the three Wagner ammeters.

The Newton Falls plant is connected to the Leavittsburg plant by means of a 23,000-volt three-phase line on Thomas insulators. The line between Newton Falls and Leavittsburg is a No. 3 medium hard-drawn copper.

The equipment in the Leavittsburg plant comprises one 300 kw., belted-type Electric Machine Co. generator rated at 2,300 volts, three-phase, 60-cycle, 514 r.p.m. This machine is driven by a two-ply Shultz belt 32 in. wide. The exciter is a 7·5 kw. 1,200 r.p.m. belted Colonial machine.

The Warren transmission line is identical with the Newton Falls line in general construction, except that the transmission copper is No. 1. This large size of wire is used with special reference to contingencies. The sub-station at North Park Avenue, in Warren, is equipped with six 100 kw. Enterprise transformers. These transformers are connected on the high-tension side through disconnecting switches, to a 23,000-volt bus, to which are also connected the Warren transmission line and the gas-electric power-plant line, the latter lines being provided with Westinghouse fused-type circuit-breakers, choke coils and lightning arresters. The station is large enough to house 1,800 kw. in transforming apparatus.

The Peerless electric steam plant contains one 250 kw., belt-driven Electric Machine Co. generator, and a 7·5 kw. belted Peerless exciter. The switchboard consists of a combination exciter and generator panel and a combination transformer and distributing panel. The transformers are located in a transformer-house, and are connected on the high-tension side to the Warren transmission line by means of fused-type circuit-breakers. The equipment in the gas-electric power plant consists of one Olds 350 h.p., two-cylinder, four-stroke-cycle, horizontal gas-engine. The gas-engine is belted to a 250 kw. Burke generator. The plant is built to accommodate four engines and generators of the same rating as the unit already installed, and to accommodate 1,200 kw. in transformers. At present the switchboard consists of three panels. The high-tension side of the transformers is connected by dis-connecting switches to a 23,000-volt transformer bus. This second bus is located in a cupola on the top of the station, and to it are connected the lines leading from the sub-station to the gas plant, a line from the Peerless Electric steam plant to the gas plant, and a transmission line leading to Niles. Under a 20-year contract to furnish the city of Niles with electrical energy for lamps and motors, the company has built a transformer house on the grounds of the municipal lighting plant.

AN INGENIOUS ELECTRIC SIGN.

A very ingenious electric sign is being placed on the market by Messrs. Rashleigh, Phipps & Co., Oxford-street, London, W. Simple in design, it is automatic in action, and may be had in a variety of sizes for various styles of advertising. It has the charm of being kaleidoscopic in effect, flashing 500 different combinations of pretty designs in various colours at a speed of over 3,000 an hour. The average sign is about 3 ft. in diameter and of similar height, and fitted with about 50 lamps, consuming ½ unit per hour. Adaptable for window display or for fixing outside buildings, the sign is neatness itself, and when illuminated at dusk the novel and charming effects can scarcely fail to attract attention.

ELECTRICAL ENGINEERS TERRITORIALS (London Div.). Orders for the week ending October 2:—Monday, September 27, "A" Coy. Technical Drill, 7 to 9.30 p.m.; Tuesday, September 28, "B" Coy. Technical Drill, 7 to 9.30 p.m.; Wednesday, September 29, Gymnasium, 6.30 to 9.30 p.m.; Thursday, September 30, "C" Coy. Technical Drill, 7 to 9.30 p.m.; Friday, October 1, "D" Coy. Technical Drill, 7 to 9.30 p.m.—Officer Commanding, Col. R. E. B. Crompton, C.B. (Signed) P. H. Campbell, Capt. R.E. and Adj. for O.C. E.E. L.D.

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NOTES ON LONG DISTANCE TRANSMISSIONS.

By E. KILBURN SCOTT, A.M.Inst.C.E., M.Inst.C.E.

When power transmission work first began in California, the various companies which harnessed the high fall mountain streams had no idea of becoming linked together, and so each engineered its proposition in its own way.

The importance of the industry has, however, grown to such an extent that a few years ago some far-sighted engineers and financiers saw the advisability of linking up, so that each station could help the others in emergency and also for the purpose of economising establishment charges. This has now been done.

The result is that stoppages of power are very seldom heard of, and even when 11 miles of steel tower line is blown down a way round is found in a few hours.

California is now practically a huge switchboard, with over 1,000 miles of high tension bus-bars criss-crossing it in all directions. For the present the voltage is 60,000, but everything now going in is being erected with a view to changing over to 100,000 volts.

Such big figures might well make young engineers in this little England of ours long to get out to a country where deeds as well as the talk are so big. But they needn't leave the shadow of the Union Jack to get into transmission work. In Canada and in India there are some big transmissions already, and more being erected and proposed. Some day, also that country of magnificent distances—Australia—will have its long distance transmission lines, and it and New Zealand will fairly hum with engineers.

Patrol Men for Transmission Lines.

The development of long distance power has been the means of enhancing the importance of the occupations of patrol men and extra high tension line repairers. These men have an adventurous life, for they live most of the time away from their fellows and have to ride many miles a day over rough country and in all weathers. If need be, they must be prepared to camp out where darkness finds them and forage for their food as they go along. They can speak with the power house, but a telephone line running parallel to a transmission line is not a nice thing to talk through, however much the two may be barrelled.

Those young men who are fond of an adventurous outdoor life might do worse than make a bid for the position of patrol man on a long distance transmission line. It is something like to boundary riding on an Australian sheep station, and many English public school men are doing that to-day.

Live Line Repairers.

When the patrol man has discovered a fault, he rings up the power station or sub-station, and a gang of extra high tension line repairers come out. These men literally take their lives in their hands, for it is becoming the custom to execute all repairs by daylight, when current is on the line. It can be done quicker that way, and there is no loss of revenue due to the line being stopped.

Some of the feats of line repairers are quite remarkable, and anyone who wishes for details cannot do better than read an article on "Repairing high-voltage Lines Whilst in Service," by J. S. Jenks and W. H. Acker, in the *Electrical World* for August 5. It isn't often that an electrical technical article gives one the creepy feeling of a "shilling shocker," but to read how the wires are fixed to new insulators comes very near it.

It is with a feeling of relief that one reads that special *clamps* have been invented to fasten high tension wires to insulators, so that winding 30 inches of the wire with sticks 3 ft. long will not be necessary. In the preceding note the suggestion was made that young men might take up patrol work, but this journal doesn't care to take the responsibility of advising them to become extra high tension live line repairers. No doubt there will always be plenty of men prepared to undertake the work, just as there is no lack of men prepared to shovel coal in a torpedo boat destroyer and go to sea in submarines. The writer takes off his hat to them.

Some Large Transmissions.

The table* herewith is interesting, because it gives data of some very large power transmissions. The longest transmission—169 miles—is in Mexico, and no less than 37,500 h.p. passes over it. If ever advocates of unfettered private enterprise want an example of what it can do, they have only to refer to Mexico. Within two generations and under the leadership of an enlightened statesman—President Diaz—that country has risen from barbarism to be one of the most progressive in the world.

TABLE SHOWING ELEMENTS OF SEVERAL HIGH-VOLTAGE, LONG-DISTANCE TRANSMISSION LINES.

Power Co. and year designed.	Location.	Length of transmission.	Voltage.	Kilowatts transmitted.	Phase and No. of circuits.	Conductor.	Spacing of conductors.	Height of standard tower and span.	Width of tower at right angle to line.	Distance nearest tower member to line.	Type and Number of insulators.	Highest and lowest wires from ground.	Weight of complete tower.	Coating of metal in tower.
Great Western Power Company, 1907.	Northern Central California.	160 miles. Big Bend to Oakland.	100,000.	40,000 with first development.	3 phase. 2 circuits.	No. 000 copper strand cable, 6 wires and hemp core to a strand.	10 ft. vertically.	76 ft. in height. 750 ft. span.	17 ft.	6½ ft.	4-50,000 vt. suspended Lock type for each conductor.	66 ft. 46 ft.	3,800 lbs.	Galvanized.
Stanislaus Electric Power Co. 1907.	Central California.	92 miles to Mission San Jose. 140 miles to San Francisco.	100,000.	5,500 at present. To be increased shortly to 10,000.	3 phase. 1 circuit.	No. 00-6 strand copper cable with hemp centre.	8 ft.	65 ft. in height. 800 ft. span.	15 ft.	3 ft.	Suspended type—Lock and G. E.	58 ft. 35 ft.	3,400 lbs.	Galvanized.
Edison Electric Co. Kern River No. 1. 1906.	Southern California.	117 miles.	60,000 now. Intend to raise to 80,000.	30,000, including 50% over load at peak.	3 phase. 3 circuits.	No. 0000 hard drawn copper 7 strand. Elastic limit 35,000 lbs. Ult. strength 62,400 lbs. 2,500,000 lbs. of cable used in the line.	6 ft. between wires.	30 ft. to 60 ft. 1,140 towers in 117 miles av. span is $\frac{117 \times 5280}{1140} = 542$ ft.	12 ft.	3 ft.	Pin type, C. I. pin, 3 petticoats, 9 to the tower.	61 ft. 55 ft.	4,250 lbs. average.	Galvanized, portions below ground asphalted.
Necaxa Light and Power Co. 1906.	Mexico.	169 miles.	60,000.	37,500 at peak.	3 phase. 4 circuits. 2 tower line.	No. 000-½ in. diam. hemp centre copper strand cable, 40,000 lbs. Elastic limit, 60,000 lbs. Ult. strength, 168,000 circular mills section.	Circuits carried on 6 ft. triangles.	58 ft. in height. Span not given.	14 ft.	2 ft.	Pin type, porcelain petticoats, 14 in. diam. 120,000 vt. test.	46 ft. 40 ft.	.....	Galvanized.
Winnipeg Power Co.	Canada.	65 miles.	60,000.	.....	3 phase. 2 circuits.	No. 00 hemp core cable No. 7 wires.	6 ft.	Span 400-500 ft.	.....	.....	Pin type.	60 ft. 40 ft.	2,240 lbs.	.....

*Table from *Engineering News*.

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Two transmissions in the table work at 100,000 volts and the tendency is all in that direction, the wires being carried by suspended insulators instead of the upright pin type. Practically all long distance transmissions have two or more circuits, and in some of them the circuits are run over separate rights of way so as to tap more country and give greater safety in case of an accident.

Although aluminium has been used for many transmissions, all those in the table are copper, and now that the price has come down, the tendency is to use the harder metal. The wires are carried on steel towers, this being the most up-to-date construction, and, indeed, practically compulsory in hot countries where white ants give trouble. The towers run about 65 ft. high, with the cross-bars about 8 ft. apart. All the metal of the towers is galvanised, which is something new in lattice pole construction.

High Tension Apparatus for Outside.

In our moist climate it seems odd to read that the tendency at the present time in Canada and the United States is to put all high tension transformers and switch work, out in the open. Yet such is the fact, and last April an important paper was read by K. C. Randall before the American Institution of Electrical Engineers, detailing the precautions which had to be taken.

Of course, the transformers are very large, say, 1,500 kw., oil-cooled, and the voltages are in the nature of 60,000 down to 6,000, and so on. It is quaint to read that the oil must be non freezing, and in very severe weather the transformers not in use, are left in the circuit to make sure the oil shall not thicken, and so reduce its insulation.

Also in summer the transformers are kept cooler by a simple fence built high enough to throw a shadow over them during the hottest hours of the day. At night the heat accumulated in the oil during the day is discharged, so that the transformer starts fair with cool oil next morning. Then there are the terminals where the high tension wires enter the transformer. These are built with layers of tinfoil in the insulation on the lines of a graded high tension cable, so as to reduce the electric stress. The wires run down vertically into the top of the transformers, and each layer of tinfoil is provided with a water shed; but for particulars of these the reader is referred to another paper read at the same time before the Institute by A. B. Reynders. Both papers are good solid reading.

Failure of Great Western Transmission Line.

In January of this year about 11 miles of the transmission line of the Great Western Power Co., near Sacramento, were blown down. As the wires were carried on the latest approved manner on steel towers 70 ft. high, spaced 750 ft. apart, the failure of this line was serious especially as the old wooden pole lines weathered the storm.

Two firms of consulting engineers practising in San Francisco were called in, and their reports, which have recently been published, are interesting reading.

The failure of the towers was due to the foundations under the legs giving way. It appears that when the 92 towers which failed were erected, the ground was very hard, due to a dry summer, and most of the holes were opened out by blasting the clay. When the towers were up, this hard, lumpy stuff was hastily shovelled back, and no attempt made to properly compact it. In January there were heavy floods over the country, and the water getting into these holes softened the loose refilled material and destroyed its vertical supporting power as well as its holding down power. The result was that a heavy wind storm going up to 48 miles an hour found out the weak spot and overturned 92 of the towers.

Fortunately, comparatively little interruption to the power was caused, because one of the largest customers was the Gas and Electric Corporation, and the tap to their line was merely changed from Oakland to a point—Oroville—between the break-down and the power-house.

The investigation into the foundations was made by Messrs. Duryea, Hachl and Gilman, and their recommendations will no doubt prevent any such accident ever happening again, and fortunately so. A few like that, and long distance power transmission practice would receive a severe set-back.

Factor of Safety in Steel Tower Construction.

One result of the failure of the above transmission was that an investigation was also made by Galloway & Markwart into the design of the steel tower. Two towers which had been firmly anchored down were tested to destruction by pulling on the three cross arms horizontally and at right angles to the direction of the transmission. The first tower failed with 8,400 lbs., and the second, which had been strengthened, gave way with 11,250 lbs. The experts then assumed wind velocity of 77 miles per hour, which is equal to 30 lbs. per sq. ft., and from the area presented to the wind they worked out the total pressure as follows:

One steel cable	527 lbs.
Six copper cables	4,218 ,,
Force on tower..	2,100 ,,
Total	6,845 ,,

This force is not exactly comparable with the test force applied, because in the test there was lacking the weight of the transmission cables which produces a moment that counteracts the moment of the wind. It was estimated that 345 lbs. applied at the top of the tower would be equal to this, so that the total wind would be 6,500 lbs.

Therefore, the factor of safety works out at

$$\frac{8,400}{6,500} = 1{\cdot}3 \text{ to } 1 \text{ in first test,}$$

and

$$\frac{11,250}{6,500} = 1{\cdot}73 \text{ to } 1 \text{ in second test.}$$

The factors are too small when one considers the immense importance of keeping power on the line. A failure means loss of prestige and standing with power consumers, besides the money loss. In bridges it is common to allow four or five, and in buildings four to one.

Scamped Work and Scrip Payments.

In the above story about the Great Western Power Co. the writer detects the rotten system of ineffectual supervision payment by scrip. The contractor who blasted out the clay and merely shovelled it back without compacting it knew he was doing bad work, and the designers of the steel tower could have arrived at all the data that the experts, Galloway and Markwart did, but instead of skimping the design to a miserable factor of safety of 1·3 to 1.

It is usual in technical journalism not to speak out even when one knows that there is every cause, but this fashion has had too long an innings. Technical papers have a service to perform to the public, just as daily papers have.

It is to be hoped that in future American contractors will be thorough in their work, and the designers more liberal in their factors of safety. It might be said, what has it got to do with us in England? The reply is—*everything*. Any failure of electric supply in any part of the world is everybody's business, for it discredits the profession generally. The echoes of a failure in California will be heard by financiers in London, and a shut down on a Christmas Eve at Bristol gave opportunity for gas advocates in Australia to talk.

Good work and good money payment for it is the ideal; not scamped work and scrip payments. We haven't done much of the latter in England, as has been the case in the States, but there has been quite enough. Let us keep on in the good old English way of money down for good work, and the world will continue to look up to us as patterns of commercial morality and sound construction.

GOVERNMENT AND WIRELESS TELEGRAPHY.

In an interview, Mr. Marconi, before leaving Liverpool for America, stated that the agreement with the Post Office, whereby six Marconi stations would be taken over, was not yet complete. When it was it would be advantageous both to the Government and to his Company. The Company would retain the Transatlantic stations. He considered it quite feasible, as had been suggested, for the wireless system to be adopted for the purposes of communication during Captain Scott's attempt to reach the South Pole, as, with an apparatus weighing half a hundredweight and the use of kites to elevate the wires, messages could be sent or received over a distance of 200 miles.

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THE

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CONTENTS.

	PAGE
Notes	405
Tramway Problems in the Future	407
Central Repair Depôt, L.C.C. Tramways	407
Magnetic Testing of Iron with Alternating Current	410
Collective Hydro-Electric Plant	413
An Ingenious Electric Sign	414
Notes on Long Distance Transmissions	415
Government and Wireless Telegraphy	416
Reduction of Waste	417
Correspondence	418
Submarine Sound Signals	418
Locating Fault in Armature	420
"Gathering" Mine Locomotive	420
Hope's Patent Unit System	421
Impulse Type Steam Turbine	421
Tungsten Lamps	422
Improved Switches and Fittings	422
Illustrations as Samples of Leather Belting	423
Municipal Electric Light and Trams	425
Electrification for Trunk Lines	426
Watt-Hour or Ampere-Hour Meters	430
Wireless Signalling for Airships	430
Electric Ticket Issuing Machines	430
Parliamentary	430
Technical Problems, with Solutions by Practical Men	431
Tyneside Notes	433
American Notes	435
Companies' Meetings and Reports	435
Companies Registered	436
Contracts Open	436
Some Contracts	436
Lighting & General Notes	437
Traction Notes	438
Personal	438
Book Reviews	439
Educational	439
New Catalogues	439
Patents	440
Companies' Stock & Share List	442

REDUCTION OF WASTE.

A reasoned plea in favour of co-operation in power production was put forward recently by Mr. A. B. Gridley when addressing the Cleveland and Durham Engineering Society. He pointed out that in industrial centres, but more especially where manufacturing is carried on in scattered factories, there is inevitably a great amount of loss entailed in exhaust steam, waste heat or combustible gas, owing to the absence of any organisation for their utilisation. It is quite true that, unless we are dealing with some huge business, running a whole series of departments, where working can be dovetailed, as it were, in order to secure economy, there must be a considerable amount of waste, when steam has to be raised for engine driving, and there is no immediate useful outlet for the exhaust steam. With co-operation in the matter of power-raising, such waste can be largely avoided, and for this purpose certainly electricity offers the ideal service. It has been calculated that if all our factories and mines used power derived from central stations half of the present consumption of coal, put at some sixty million tons per annum, could be saved; that is, at a moderate computation, quite £11,000,000 a year to the good. This is a very substantial benefit, leaving altogether out of account the greater efficiency and the improvement as regards hygiene, for at central stations properly worked smoke prevention is one of the ends to economy. Mr. Gridley also claims, and rightly so, that such centralisation would ensure an enormous saving of water, and those who have even the most elementary knowledge of municipal administration know what this means, the planning for an adequate supply of water being one of the most troublesome problems before us. That the truth of this is being at least partially realised in the North is certain. At least one great central organisation up North is within

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sight of a 100% load factor, owing to widespread ramifications and the multiplicity of all kinds of customers. And, of course, the customer shares in the benefits of this economical working. A concrete example of this is the case of Messrs. Musgrove, of Bolton, which was cited. This firm is now taking over a million and a half units per annum from the Corporation, and as a result of the change that this involved, three-quarters of an acre formerly occupied by the generating plant has been made available for factory extension—a practical demonstration of that duality of power service which we recently discussed in these columns. In the typical illustration set before the Engineering Society, we find a network of mains stretching from Blyth, in Northumberland, to Loftus-in-Cleveland, through the Northumberland coalfields and Tyneside, with a double line across the Tyne, running through the East Durham coalfields to the iron mines district, with sundry branches and connections with active centres. This involves the operation of eight power stations (and others are being added), the main coalfield regulating stations being at Carville and Grangetown, while waste heat stations are at Blaydon, Weardale, Newport, Bankfoot and Tees Bridge. These waste heat stations are a great boon to the locality, taking up what was formerly a dead loss and converting it into electricity, which is readily absorbed by local industries, so that the stations are nearly all working at full capacity. It is an illustration which is, no doubt, familiar enough to most of our readers, but it is one with which the manufacturers of this country are not sufficiently familiar. A point of considerable importance raised by Mr. Gridley was that of the price of electrical energy. It is unfortunate that both producers and consumers have drifted into the habit of reducing their calculations to cost per unit. It is unsatisfactory, because it gives no definite idea unless accompanied by a statement as to load factor, total annual consumption, etc. Quotation of flat rates being misleading, are generally unfair to both parties. But a charge which is framed to cover the capital and fixed costs, and the running or variable costs of giving the supply, is now scientific. For after all capital cost is of paramount importance. Now, the varying conditions are met by a tariff based on a fixed charge per kw. or e.h.p. demanded —which demand should not be "peak," but rather an average taken over half-hourly periods—plus a running charge per unit consumed, as, for example, £1 per quarter per e.h.p. demanded, plus ·3d. or ·25d. per unit. In this way, the "undertakers," to use the phraseology of the Board of Trade, get a fair return on their capital, and the consumer derives the benefit of the central production and of his own contribution towards economical production by his increasing demand for power, which tends to level up the load factor.

FLUXITE SOLDERING PASTE.

After exhaustive tests, Fluxite Soldering Paste has now been adopted in the Chatham Royal Dockyards. The Auto-Controller & Switch Co., the sole proprietors and manufacturers, have been favoured with an order from this quarter for a large consignment of the flux. The merits of Fluxite are being appreciated by a rapidly increasing number of users.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

ENGINEERS AND GOVERNMENT.

Sir,—Considering that engineers and scientists are the most progressive and highly trained members of any community, it seems strange that the constitution of our Government should have evolved in such a way as to leave them quite outside.

Take the present British Parliament, for example: there are practically no distinguished scientists in the House of Commons, and very few engineers. Although some of the Labour Members have been mechanics, they have not the broad view of qualified engineers. In the House of Lords there are Lord Rayleigh, Lord Ross, and Earl Russell.

On the Privy Council the Right Hon. John Burns is the sole member, and even his engineering experience was cut short at the mechanic stage.

Now, a very large number of matters which come before Parliament concern engineers intimately, and even purely political questions are generally matters on which the cold reasoning, scientifically-trained brain is likely to give the soundest and most far-seeing judgment.

How, then, are engineers and scientists to take that part in the government of the country which their position in the community warrants? It is foreign to them to speak platitudes and inexactitudes at a General Election, and the House of Lords is closed except to, say, one giant of a generation, such as Lord Kelvin.

Clearly, if their services are to be utilised at all, they must be co-opted, and the only body to which they can be elected in that way is the Privy Council.

The writer, therefore, suggests that the Presidents of the principal learned societies be recognised as being specially eligible to become members of the Privy Council. A few elections from engineering ranks to that Council would raise the whole status of the profession.—Yours, etc.,

"M.I.E.E."

SUBMARINE SOUND SIGNALS.

We hear from the London office of the Submarine Signal Co. (Boston, U.S.A.) that vessels equipped with their receiving apparatus now number 515. Lloyds' Register now contains a list showing those vessels on their Register that are equipped with this apparatus, and attaches a note to the name of each ship so equipped. The Trinity House authorities have issued a notice to mariners stating that the Company's electric signal bell off the North Stack, Holyhead, will be ringing from October 14 next. This bell is now in position.

A monograph issued by the United States Hydrographic Office states that the Company's method of submarine sound signalling has been officially recognised as supplying an important aid in navigation. As early as 1903 the United States Lighthouse Establishment had furnished the light-vessels at Boston, Nantucket, Fire Island, and Sandy Hook with submarine fog bells. The equipment consisted of a bell with striking mechanism actuated by compressed air, suspended at a depth of 30 ft. or so beneath the surface of the sea from a davit at the side of the vessel; a small and compact air compressor, driven by a kerosene engine or by steam from the boilers of the light-vessel, for the purpose of furnishing power to operate the bell; and a code ringer also connected with the compressor engine, and adapted automatically to control the strokes of the bell, so as to cause its ringing to send out the code number of the light-vessel. The sound waves going out from the light-vessels below the surface of the sea could be heard for a distance of some miles by passing ships equipped with microphones to receive submarine sound signals. These sound receivers are located inside of the hulls of ships below the water line, and connected with the chart room or bridge by a telephone circuit. On either side of the forehold there is fitted a small tank on the inside of the

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skin of the ship, without cutting the plating or making any alteration whatever in the hull of the vessel. A small opening in the top permits the introduction into the tank of a dense liquid in which the receiving microphones are suspended. By listening at the telephone, whose circuit includes both the port and starboard microphones, and switching the instrument from the starboard to the port microphone and back again, the tones of the light-vessel's submarine bell could be heard on coming in range of it. If the tone was louder on the starboard side than on the port, the mariner would know that the light-vessel was on his starboard side, and if the tone was exactly the same in both microphones, he would know that the light-vessel was dead ahead. It was found that, even in the case of vessels to which the sound-receiving microphones had not been fitted, a listener, putting his ear to the inner surface of the plating, say in the empty forepeak below the water line, could hear the sound proceeding from a submarine bell several miles away; but under such circumstances no information is derived as to the direction from which the sound proceeds, and hence a vessel encompassed in fog could not be steered by bell, and must suffer a denial of those advantages that come from the knowledge of direction that is derivable on board of vessels in which suitable instruments have been installed to receive the sounds.

The substantial service rendered to shipping by the submarine bells first established decided the United States Lighthouse Board to extend their installation, from time to time, to other light-vessels until, at present, 46 of the light-vessels in the waters of the United States are thus equipped, and the signals which they send out are of undoubted aid to deep-water navigation. Equally effective as aids to navigation are the submarine bells that have been fitted to buoys, where they are worked by the motion of the sea, and those that have been suspended from tripods on the sea bottom, where they are controlled electrically from shore stations, and serve to give warning of dangers or to mark turning points along the routes of commerce. Many of the light-vessels and buoys in European waters have been similarly furnished with these bells, and they have been likewise established in the region of the Gulf of St. Lawrence. The effective range of the submarine bell far exceeds that of aerial sound signals, having been known to exceed 15 miles, and their bearing can be determined with sufficient accuracy for safe navigation in fog, if a vessel is equipped with receivers

Stations sending submarine signals are located as follow: Canada, 5 light-vessels, 4 electric shore stations, and 3 bell buoys; United States, 46 light-vessels, 1 electric shore station; England, 8 light-vessels, 1 shore station, and 1 bell buoy; Germany, 12 light-vessels; Holland, 7 light-vessels, 1 shore (hand-bell) station, and 1 bell buoy; France 1 light-vessel, 1 shore station, 1 bell buoy, and 1 tender; Sweden, 1 light-vessel; and Denmark, 1 light-vessel.

Remarkable endurance tests have been applied to some of these submarine signalling installations. From a cottage at Point Allerton, near Boston, in which a 2½ h.p. oil engine operated an electric generator, a submarine cable was laid to the shore, and thence 2 miles out into the harbour along the sea bottom. At the end of the cable was an iron tripod standing on the bottom of the ocean, 70 ft. below the surface of the water, and on the tripod was a bell weighing 220 lbs., the clapper of which was actuated by powerful magnets. On March 30, 1907, the current was turned on, and the bell began to strike at the rate of about 22 blows a minute, and continued until May 16, when the total number of strokes had reached 1,032,930 in a duration of 789½ hours.

The pneumatic bells on five light-vessels were also required to be rung continuously, night and day, for 61 days, making a period equal to 2½ years of service, according to the highest demands made in past years upon the fog whistle on the light-vessel at Sandy Hook. Submarine bell buoys have also been tested. The fact that the bearing of the buoy can be found in fog or at night makes them advantageous to shipping when they are placed in exposed positions in water of sufficient depth to give the vessels steering for them sufficient space to manœuvre for the purpose of locating the origin of the sound. It is noted that in restricted waters, or when the bell is located near steep banks or rocky shores, an echo may be expected; and this fact requires that the proposed location should, in each case, be thoroughly investigated by experiment, because there are possible situations where the echo may be heard instead of the direct sound, and thus lead to an erroneous determination of the place of the danger which the bell is intended to mark.

The mechanism for submarine bell buoys is dependent on wave motion for its power, and, therefore, differs from that of the electrically-controlled tripod bell, and also from the pneumatic bell employed in connection with light-vessels. On the trunk or stem of the buoy is a float or "sea anchor," free to move up and down for a short distance, and ballasted so as to have, as nearly as may be, the same weight as sea water. It is the design that this shall remain practically stationary as the buoy rises and falls. The pull rod of the clapper is connected to a crank on a toothed wheel, which is turned by a ratchet-and-pawl gear operated by two arms attached to the sea anchor. Of special interest in connection with submarine signal buoys are the gas buoys, which have been experimentally fitted with bells that are rung through mechanism actuated by the pressure of the gas supplied for the light, and are thus independent of the action of the waves as an agency for ringing the bell, and, consequently, free of the liability to irregularity in the intervals between the strokes of the clapper, which precludes the successful ringing of a code signal.

Communications between Vessels at Sea.

Beside their usefulness in warning vessels of their approach to the land and to dangers, submarine sound signals may be used as a means of communication between vessels at sea. For this purpose the sound-producing bell, immersed in water held in a tank, is installed in the forepeak of the vessel, inside of the hull, and may be operated automatically or by hand. As a means of communication between submarine boats in a state of submergence, this method of signalling has a special field of utility. During the tests of submarine boats in May, 1907, communication was, in this manner, kept up between the *Octopus* and the tender *Starling*. Signals were communicated from the *Starling* to the *Octopus*, telling when the latter had crossed the finish lines and when to come to the surface, and distinct messages were received in return from the submerged vessel.

While careful listening at the telephone is always a requirement that must not be underrated nor overlooked, it is found that vessels of deep immersion have an advantage in the range of distance at which submarine sound signals may be detected, and this is accentuated in cases where they are moving at a slow rate of speed. Indeed, on the Great Lakes, where the forepeaks of vessels are frequently above the water line, special provision was necessary for the proper submergence of the tanks containing the sound receivers.

There appears to be no failure to hear and recognise the sounds of the submarine signal bells at distances between 3 and 5 miles, und on the average these distances are considerably exceeded.

What range of submarine transmission of sound waves will ultimately be set as the limit of practical audibility of such signal bells is not now known, but the possibility of a comparatively extended range, under special conditions, is foreshadowed in the observations that have been lately made between the light-vessel *Gabelsflasch*, located at the entrance to Kiel, Germany, and the light-vessel *Fehmarnbelt*, situated nearly 27 nautical miles away. On different occasions the ringing of the submarine bell on the latter light-vessel was heard by the unaided ear through the naked walls of the carpenter's storeroom on the *Gabelsflasch* vessel.

BOOK NOTES.

"An Introduction to the Science of Radio-Activity." By C. W. Raffety, London: Longmans, Green & Co. Price, 4s. 6d. net.

A new edition of the standard work on the subject of "The Dynamo, its Theory, Design and Manufacture," by C. C. Hawkins and F. Wallis, will be published immediately by Messrs. Whittaker & Co. This book has been thoroughly revised and considerably enlarged, and deals exhaustively with recent practice in this important branch of electrical engineering.

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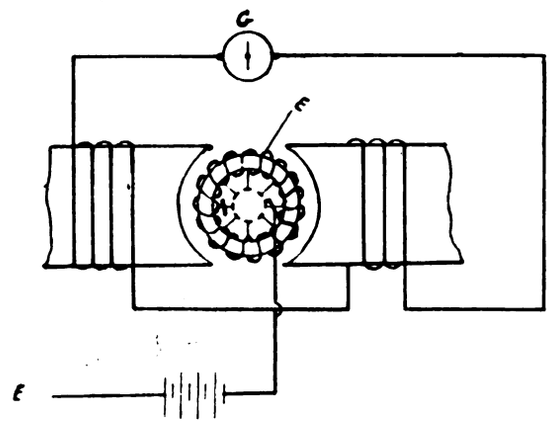
LOCATING FAULT IN ARMATURE.

By A. R. WOODHALL, Assoc. M.I.E.E.

There is only one test necessary for locating an earth in the armature of a direct current motor or dynamo. This may be carried out as follows: Disconnect the field magnet winding, and close the circuit with an ordinary galvanometer, as shown in the figure. Rock the brushes backwards approximately to the position shown, raise one, and connect the other to a few cells earthed on the other poll. On closing the circuit, a current will flow through the armature winding to earth, inducing a magnetic field in the armature, and, of course, a momentary current in the field winding, which will cause a throw of the galvanometer. Turn the armature round, making and breaking the circuit as each commutator segment comes under the brush, and it will be found that when the faulty coil is reached, the galvanometer will show little or no deflection.



According to its sensitiveness, and the amount of current passed through the armature. When the armature is in this position the earth cuts out the winding, with the consequence that no magnetic field is generated; therefore, no current is induced in the field circuit. The object of rocking the brushes back is to get the consequent armature poles in the centre of the field, thus shortening the magnetic circuit, and enhancing the effect on the galvanometer. This test is applicable to all kinds of direct current armature windings.

"GATHERING" MINE LOCOMOTIVE.

The Westinghouse Electric & Manufacturing Co. of America—the parent company—and the Baldwin Locomotive Works, are manufacturing, to patents of Mr. J. M. Roan, the General Manager of a large coal mine, an improved electric mining locomotive. It is of the "gathering" type, but is peculiar in this, that a single motor performs the functions of both propulsion and the operation of gathering the reel. In this locomotive the single motor used to drive the wheels is arranged to be detached and connected to the wire-rope gathering reel. The wheels or the reel may be operated either independently or simultaneously, winding up the rope while the locomotive is moving. This arrangement secures flexibility, compactness, and reduced amount and cost of electrical apparatus.

When loaded cars are to be hauled from the working face to the butt heading on which the locomotive stands, the rope is paid out and attached to the cars. The main driving motor is then unclutched from the axle and connected to the reel which winds up the rope, drawing the car toward the locomotive which stands, with its brakes set, on the heading track. The provision for propelling the locomotive at the same time the reel is in operation enables the cars to be swung on to the heading without sawing the rope on the rib at the room neck.

The motor transmits its power through a single spur gear directly to one axle. The two axles are connected together by side-rods spaced 90° apart, and the wheel base is short, though the wheels are of full size. The locomotive frame is of steel angles and plates, to secure the maximum strength for a given weight, and spring suspension is adapted to the frame and motor.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

HOPE'S PATENT UNIT SYSTEM.

We note that Messrs. Parmiter, Hope & Sugden, of Manchester, are introducing a new and improved system for Ironclad Distribution Fuse Boxes. Of recent years Ironclad distribution boxes have been almost universally adopted for power work, in place of the older forms of teak case boxes. The use of cast-iron cases for distribution fuse boxes has, however, always been open to one great objection—the extensions were a matter of serious difficulty and expense. In the design of a large power installation it has been necessary to provide spare ways on all distribution boards to cover future extensions, or where any extensions required to be made, to take down the existing board and refix one of a larger capacity,

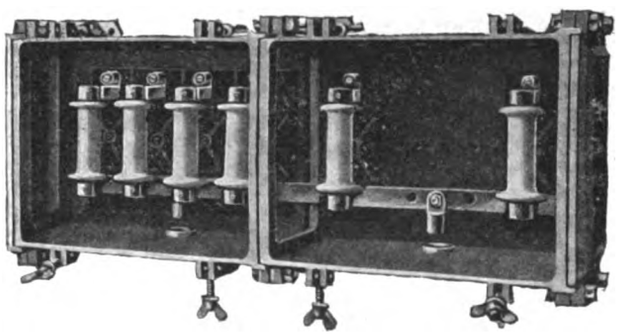

Fig 1. Interior of coupled unit.

thereby disarranging the supply of a number of motors and delaying and upsetting works. The Hope's Patent Unit System overcomes this difficulty entirely, and should be in great demand. The cases are of cast-iron, built up in such a way as to allow of either end being removed and an additional case unit being added, the box remaining perfectly water-tight and gas-tight. One end of the case is a "male" and the other a "female"; therefore, extra sections of case can be added at either end. Four strong set screws hold the case, or end plates, as may be together, so that additions can be made in a few moments. All the parts are "jig" made throughout, and it is guaran-

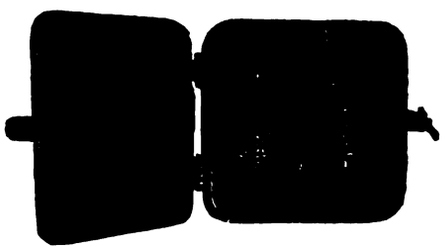

Fig 2. Three-phase single-pole fuse box.

teed that all extension pieces will go together without any filing or fitting. With regard to the interior, each fuse way is a separate unit complete in itself; the fixing of the cases and coupling up of the same to the busbars is done entirely from the front of the board, and extra fuse ways can be coupled up whilst the board is "live" and from the front of the case.

Fig. 1 illustrates the coupled unit with lids removed, showing a six-line board ready for two extra ways to be added later. All bases are of black china, and the insulation test of any complete board is guaranteed to be at least 50 megohms.

In Fig. 2 we illustrate a new form of three-phase single-pole fuse box, with the firm's well-known C type fuse sections in a water-tight cast-iron box. The three-pole boxes are made in large quantities, and are offered at very tempting prices.

Fig. 3 illustrates their new spring-on switch fuse, showing the method of construction.

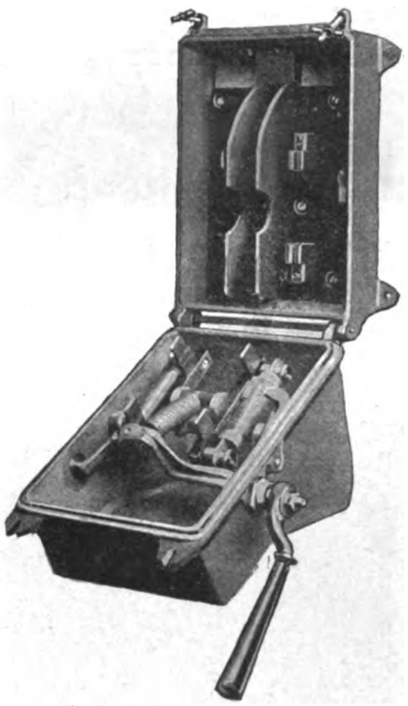

Fig. 3. Spring-on switch fuse.

This switch is an ideal one for hired-out motors, and the movement of the switch is independent of the person operating it. The switch is quick make and quick break, and cannot be tampered with.

IMPULSE TYPE STEAM TURBINE.

We note that Messrs. Willans & Robinson, Ltd., Victoria Works, Rugby, after prolonged experiments, are placing on the market a Steam Turbine of the Impulse type, intended to meet those cases in which a speed of as high as 3,000 r.p.m. is admissible. This will provide for a capacity up to 1,500 k.w.

The Turbine has been designed with a view to efficiency as well as simplicity. The Rotating Element consists of two wheels only, but the economy realised compares favourably with that of any other turbine. In future, therefore, Messrs. Willans & Robinson, Ltd., will be in a position to supply either turbines of the Parsons or of the Impulse type, and will, we understand, be glad to put forward the type most suitable for the conditions to be met.

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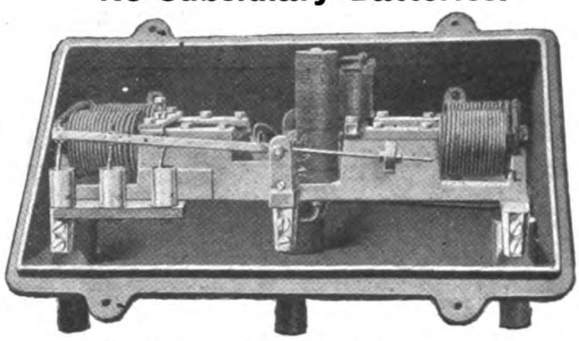

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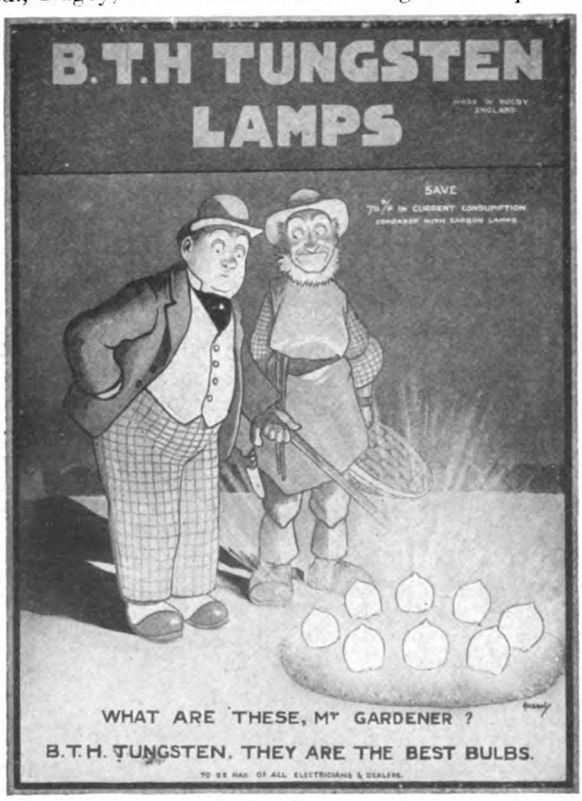
TUNGSTEN LAMPS.

We reproduce below the design of a striking showcard now being issued by the British Thomson-Houston Co., Ltd., Rugby, to advertise B.T.H. Tungsten Lamps.



These lamps are becoming increasingly popular, and the manufacturers claim that they save 70% in current consumption compared with carbon lamps. Many who have seen the design of the latest show-card believe that Hassell has outdone himself, and by designing it has added one more to his long list of successes.

IMPROVED SWITCHES AND FITTINGS.

Contractors and users will no doubt welcome anything which tends to simplify and facilitate the work of wiring up. The new lines of iron-cased switches now being made by Messrs. Dorman & Smith, of Ordsal Electrical Works, Salford, have been specially designed with this object in view. As illustrated in Fig. 1, a bevelled inlet is employed instead of the ordinary method of bringing the pipes or cables immediately to the box itself.

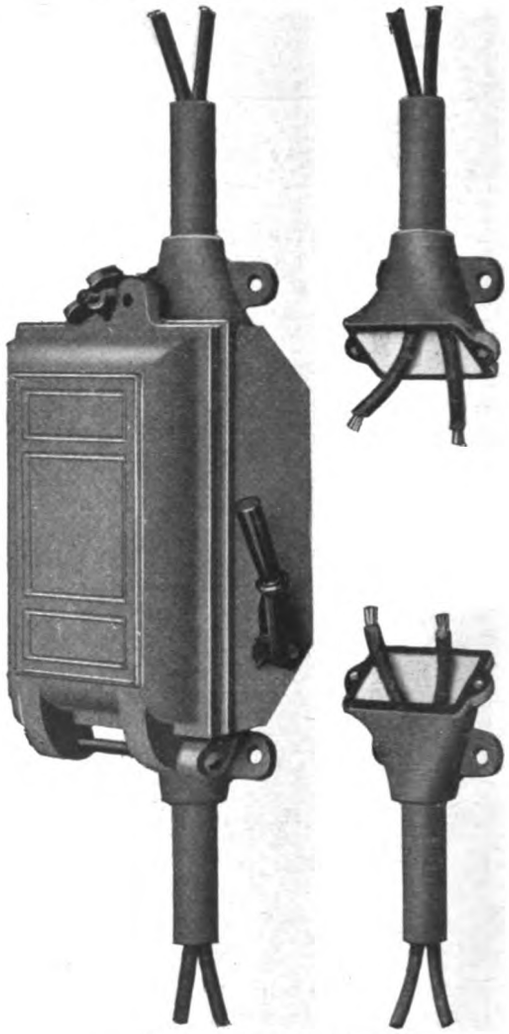


Fig. 1. Iron-cased switches.

The inlet being easily detached from, or fixed to the switch box, the wiring is facilitated, and the arrangement possesses the further important advantage that, in the event of it being necessary to remove the switch box, this can be done without disturbing the pipes or wires. The switches are specially applicable to alternating current installations, where it is desirable for lead and return to be carried in the same pipe. The firm are supplying this new pattern in both their water-tight and non-water-tight iron-cased switches.

They have also placed on the market a new patented type of strong iron well glass fitting (Fig. 2), which, as in

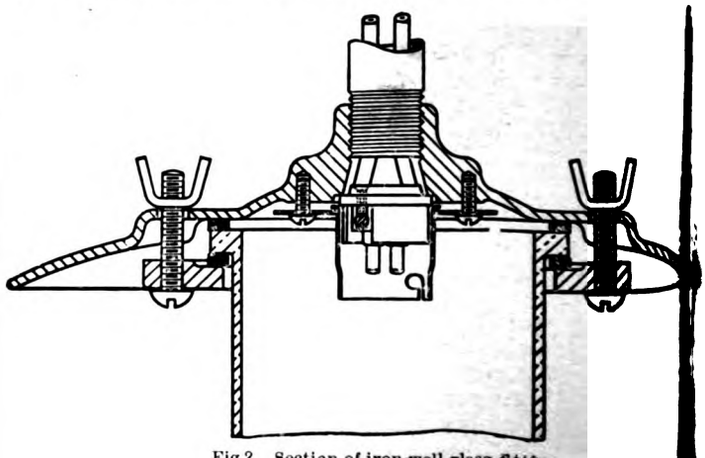


Fig 2. Section of iron well glass fitting.

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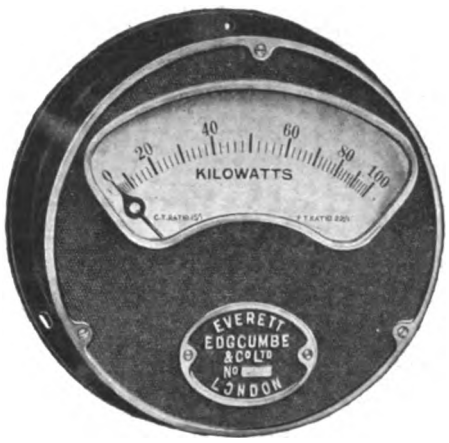
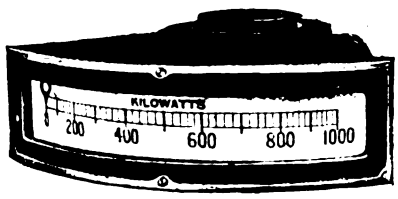
The Student's Guide to Knowledge.—*Chap. III.*

"WATTMETERS" Indicating, Round, Sector & Edgewise Patterns.



Round Pattern, 6-in. and 8-in. Dials.

These instruments are of the **Electro-dynamomoter** type, and are suitable for use on D.C. or A.C. circuits, single or polyphase. They are supplied either with a **single element** for use on A.C. **single** or **polyphase balanced loads** or with a **double element** for use on A.C. **polyphase unbalanced loads** or of the **astatic pattern** for use when there are large stray fields. The accuracy is **unaffected** by variations in **wave-form** or **frequency** and on circuits having the **power-factors** usually met with in practice.



Edgewise Pattern.—Horizontal Form.

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the case of the switches, has been designed primarily with the object of facilitating the wiring up of the fittings, and at the same time effecting some economy by reducing the number of parts. In these fittings the usual lampholder nipple is dispensed with, and the wires have consequently a straight run through from the tube in to the lampholder insulator, eliminating the usual dangerous bends in the insulated wires at this point.

A TORONTO BUSINESS.

The Consolidated Electric Co., Ltd., announce that they are now permanently located at 129, Queen-street, East, Toronto.

ILLUSTRATIONS AS SAMPLES OF LEATHER BELTING.

One of the best realistically illustrated catalogues we have yet seen is the new copyright catalogue which is being sent out by Mr. James Hendry, the laminated leather belting manufacturer, of Glasgow. The illustrations are first-rate substitutes for samples of the articles, and they show more than is possible with samples. The letterpress is a monograph on the use of leather belting, which should be of much practical interest to users. For a copy of this publication, "From a Single Strand," write to the Laminated Leather Works, Bridgeton, Glasgow.

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NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

COUNTY BOROUGH OF BELFAST.

TO ELECTRICIANS.

The COMMITTEE of MANAGEMENT of BELFAST DISTRICT ASYLUM invite TENDERS for ELECTRIC LIGHTING INSTALLATIONS in NEW ASYLUM BUILDINGS on the PURDYSBURN ESTATE.

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Sealed Tenders, endorsed "Tenders for Electric Installations," addressed to the Chairman Belfast Asylum Committee, must be delivered in my Office not later than TWELVE noon on MONDAY, 27th September, 1909.

The lowest or any Tender not necessarily accepted.

R. MEYER, Town Clerk.

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TO MAKERS OF ELECTRICAL HEATING APPLIANCES.—The PROPRIETOR of PATENT No. 14256/05 for "Electric Heating Cartridges" is desirous of having the same manufactured under licence or otherwise in this country in accordance with the terms of the Patent Act, 1907.

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WANTED for an Electrical Power Station in the Federated Malay States, a Chief Electrical Engineer. Must be accustomed to high tension, turbine generator, transformer, electrical winding plant, ordinary motors, and lighting.—Write, stating qualifications to "MALAYA," c/o. of Messrs. Deacon, Leadenhall Street, London, E.C.

ENGINEER, A.M.I.E.E., expert, with large valuable connection; capable organizer and designer, desires important position.—Apply Box No. 16, "The Electrical Engineer," 149, Fleet Street, London, E.C.

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THE CHINNERY SIGNS, LTD., 23, Old Street, London, Manufacturers of illuminated and other signs of all descriptions, are open to appoint provincial Agents where not represented. Correspondence invited only from firms of established reputation possessing showrooms and travellers.

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ADVERTISER, 22, three years technical training, 2½ years central station experience, desires post in central station or large colliery. Good references; disengaged.—J. FLETCHER, Mapperley, Derbyshire.

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WANTED, to APPRENTICE boy of 14, just left school, to Electrical Engineering in London; no premium.—H. B., 106, Station Road, Westcliff-on-Sea.

MUNICIPAL ELECTRIC LIGHT AND TRAMS.

The second part of the Home Office return relating to municipal undertakings gives some interesting statistics as to electrical and tramway undertakings in certain cities and towns. For the year 1905–6 the income over outlay in respect of the Liverpool Electricity Works was £53,484, of which £20,827 was contributed to the relief of the rates. The surplus on the tramways amounted to £84,420, the contribution to the rates being £27,586. At Manchester the electricity works' surplus was £60,933, and the trams surplus £120,172 (£46,000 to the rates). At Salford £10,000 out of a profit of £14,891 on the electric light and £13,000 out of £22,302 derived from the trams went to the rates. Bolton's Electricity Works, with a surplus of £9,243, contributed £6,000 to the rates, while the tramway, showing a surplus of £20,006, provided £4,058 for the relief of the rates. The electricity undertaking at Oldham had a deficit of £451, while the Blackburn tramway undertaking showed an adverse balance of £683. The trams at Preston showed a surplus of £2,764, and at Birkenhead the electricity works and trams yielded favourable balances of £2,210 and £898 respectively.

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ELECTRIFICATION FOR TRUNK LINES*

By C. L. DE MURALT.

Trunk lines handle two distinct kinds of traffic—passengers and freight. Each kind can again be subdivided into through and local traffic. It is quite probable that in the final outcome we will try to eliminate the subdivisions more or less. Meanwhile, it will be best simply to substitute electric locomotives for the present steam locomotives, and operate all trains substantially as is done now. Suburban traffic in the large cities should preferably be handled by motor-car trains. This is a special kind of service, of relatively small importance when complete trunk-line electrification is considered, and, therefore, it may well be solved by a special method. The advantage of using motor cars for this kind of service lies principally in the high rate of acceleration made possible. By this method suburban trains can run on the same schedule speed as through trains, even though they make many more stops than the latter.

Any electric trunk-line equipment has three essential parts: power house, line equipment, and electric rolling stock. The last is, of course, the counterpart of the steam locomotives. The other two are not present with steam operation.

In the present state of the art four electric systems are suitable for electric trunk line purposes: 1. The direct current system. 2. The single-phase alternating current system. 3. The three-phase alternating current system. 4. The combination system, which uses single-phase alternating current on the line, converting on the locomotive into direct current for use in the motors.

It is probably easiest to compare the systems after investigating the relative merits of their separate parts. Starting with the power house, we find that all four systems use three-phase alternating current generators. For the direct current and the three-phase alternating current systems this is literally true. The two single-phase alternating current systems could use single-phase generators, but even they operate best if three-phase alternating current is generated in the power house and the three phases are used separately. There is thus no real difference in the type of generator used, nor need there be any difference in the cost per kilowatt of power house capacity. The difference lies in the size of the power house required. All four systems will have to exert substantially the same power at the driving axles of the trains, but the losses between driving axles and power house vary with the different systems. The single-phase systems have the greatest losses and, therefore, require the largest power house capacity for the same service. The three-phase system is the most efficient, and, therefore, requires the least power house capacity. Roughly speaking, for each 100 kw. in power house capacity, which the direct current system requires, the single-phase systems require about 180 kw. and the three-phase system about 70 kw.

As to the line equipment, we would better distinguish between the transmission line which carries the high-pressure current along the right-of-way; the sub-stations which transform the high pressure to medium pressure; and the contact line by means of which the medium pressure current is transmitted to the locomotives. It is, of course, possible to combine all these three items into one by using the transmission line directly as a contact line, provided distances are not too great and traffic is not too heavy. With 10,000 volts, distances of 40 miles and even greater may thus be covered. The more locomotives on the road at the same time, the shorter would be this distance, due to the increased line drop.

But even with light traffic, I see no advantage in feeding the contact line direct from the power house, as it necessarily multiplies power houses. On a 150 mile division there would be at least two or three power houses, all of medium size, and, therefore, of low efficiency if compared with a single power house of a size suitable to feed the entire 150 mile division. There would also be more men required for the three small power houses than for the one large power house. Furthermore, it does not seem good practice to use the transmission line as a contact line, because the security of the service is thus undoubtedly

* Abstract of paper presented before the University of Michigan Branch, American Institute of Electrical Engineering, 1909.

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lower than if separate contact and transmission lines were used, both being thoroughly sectionalised, so that even in case of a breakdown current may be fed around the break and interruptions thus avoided. Everything considered, I believe that the use of an independent transmission line, with transformer sub-stations and an independent contact line, is by far the best arrangement.

With the transmission line we find essentially the same practice in all four systems. Here again, all preferably use three-phase alternating current, although for the two single-phase systems the three phases are used separately. In the sub-stations the two single-phase systems and the three-phase system use transformers for reducing the high pressure of, say, 60,000 volts, to the medium contact line pressure of, say, 3,000 to 15,000 volts. The direct current system has to transform the high-pressure alternating current into medium pressure direct current. This means that in addition to the transformers, the direct current system must use either synchronous converters or motor generators, entailing an increase in first cost of installation as well as in cost of operation.

For the contact line, we find that the most important point to be considered is the question of amount of current to be carried. An overhead contact line can be made to give off only limited amounts of current. Depending on the speed of the locomotives, the amounts may be said to range somewhere between about 300 amp. and 600 amp. A third rail can be used without difficulty for very much larger amounts of current. The locomotive power available is directly proportional to the product of amperes and volts. The higher the line pressure the lower the current for the same power. Whether or not an overhead contact line can be used thus depends directly on the line pressure.

The alternating current systems, with pressures of 3,000 volts and more, have no difficulty in collecting the current by means of an overhead line. The direct current system, which thus far has used 600 to 700 volts, and is now using 1,200 volts, is practically forced to use the third rail. If we go higher in direct current pressure and use 2,000 volts or more, as is now customary in Europe, we may come back to the overhead line. There has been a great deal of discussion as to which type of contact line is better from the general operating standpoint, considering accidents, work of track gangs, etc. In actual practice it has been demonstrated clearly that there is little difference between the two types of contact lines from these viewpoints.

Let us finally investigate the question of electric rolling stock. We find that the direct current motor was formerly considered to be the most desirable for trunk-line purposes. The principal reason for this belief was the fact that direct current apparatus had been thoroughly developed and standardised in street-railway service, and it was thus undoubtedly the most available when the first trunk-line electrifications were considered. Direct current motors are mostly of the series type. Quite early in the art, shunt-type direct current motors were experimented with. It was found, however, that for street-railway service—then the only kind of service considered—the shunt type was not advantageous. If direct current should be used extensively in trunk-line work, whether or not we may come back to the shunt type on account of its speed characteristics I do not know, but it is a possibility.

The single-phase alternating current motor is really a direct current motor, which by certain refinements of construction has been made suitable for operation on alternating current circuits. It is admittedly a makeshift, that is employed for the sole purpose of being able to use alternating currents in the contact line. Being a makeshift, it naturally possesses a good many faults. For instance, the single-phase motor must use a much smaller flux density; hence its speed characteristics are very unstable. If single-phase and direct current motors have the same current input for a certain speed, any increase in current due to greater power output will produce considerably more drop in speed in the single-phase motor than in the direct current motor.

Furthermore, the single-phase motor has much larger copper losses; hence, with a good starting torque a large amount of heat is produced. This is the explanation of the fact that single-phase motors cannot be used for starting heavy loads nor for starting light loads at frequent intervals. The single-phase motor is essentially a high-speed motor, and is not suitable for frequent stop service nor for heavy freight service. It can consistently be used for express work, since in this kind of service the trains can be started slowly, and will run long distances at high speed.

The three-phase alternating current motor is of a type quite different from either the direct current or the single-phase motor. It is a constant speed motor, and has all the characteristics of the shunt type. The field strength is independent of the current flowing through the armature, and, therefore, the motor will maintain practically constant speed, no matter what output it is called upon to give. This may be an advantage or a disadvantage, according to circumstances. Not only will the motor run at practically constant speed, but from zero to full speed the rate of acceleration will be practically constant. The three-phase motor is thus able to accelerate much faster than either the direct current or the single-phase alternating current motor. Now, this may be considered a disadvantage where the stops are frequent, as in street-railway service, because the high rate of acceleration means a high peak. It is an advantage wherever runs between stops are comparatively long, and, furthermore, where the highest schedule speed is desired. Constant speed in itself is an advantage, because it insures maintenance of train schedule, independently of the motorman's actions, of train weights, and of grades.

Perhaps the most important difference between the three types of motors lies in the ease with which they can get rid of the heat losses. The three-phase motor produces the greater part of its losses in the stationary or outside part of the motor. The losses in the direct current and the single-phase motor are produced chiefly in the armature or rotating part, and the heat must pass first through the field structure before it reaches the outside radiating surface of the motor. The winding of the three-phase motor, being evenly distributed, is much thinner than the winding of the direct current or the single-phase motor. Therefore, the heat from the losses in the three-phase motor will reach the outside surface more easily. Moreover, the losses in the three-phase motor are smaller. It is not difficult to obtain 90% efficiency in three-phase motors, while the efficiency of direct current motors is somewhere between 75 and 85%, and that of single-phase motors is hardly better than 60 to 70%.

For the foregoing reasons, if the motors are of the same size, the three-phase motor will run much cooler than the direct current motor, and the latter much cooler than the single-phase motor; or if the same amount of heating is allowed for the three types, the three-phase motor will be much smaller than the direct current motor and the latter much smaller than the single-phase motor for any given output. Of course, this is a well-known fact thoroughly exemplified by stationary motor practice.

The difference in motor weight introduces differences in locomotive weights all the way through. To support a heavier motor requires a heavier frame. Actual locomotives plainly show this. The New Haven single-phase locomotive weighs 102·5 tons and produces 1,000 h.p. at the usual 1 hour rating. The New York Central direct current locomotive weighs about 95 tons, and produces 2,200 h.p. on the 1 hour rating. The Simplon three-phase locomotive weighs about 70 tons, and produces 2,700 h.p. on the 1 hour rating. These figures correspond to about 200, 90, and 50 lb. per horse power respectively.

It is the weight question that principally acts against the use of the fourth kind of electric system above referred to, namely, the converter locomotive. If single-phase alternating current is converted on the locomotive into direct current, the weight of the locomotive is increased by the weight of the converter and by the extra weight of mechanical parts to support the converter. Whether or not these converter locomotives weigh much more than single-phase locomotives remains an open question.

After thus considering the three parts of electric trunk line equipment—the power house, the line equipment, and the rolling stock—we can put the three parts together and determine the comparative advantages and disadvantages of the various systems taken as a whole. First, let us establish the over-all efficiency for each system from power house to driving axle. Starting at the driving axle

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we find that the amounts of power required for hauling any given trailing load are different, following the differences in locomotive weights. The three-phase system, having the lightest locomotive will require the least total power, the direct current system will require more power, and the single-phase systems still more. Due to its higher motor efficiency, we again find the three-phase locomotive in the lead, with the direct current system second, and the single-phase systems in third place.

From the contact device to the sub-station it is not quite so easy to draw direct comparisons among the systems, because a great deal depends upon the amount of metal placed in the contact line. In actual practice maximum losses in third rails for direct current are generally limited to 50%, and in three-phase and single-phase overhead contact lines to 15%. Average losses will be smaller, but about in the same ratio. In the sub-stations we find that the efficiency of the transformers is considerably higher than the combined efficiency of the transformers and the converters. The main transmission lines being essentially the same in all cases, the transmission loss will be practically proportional to the amounts of power carried over the transmission line in each system. Combining all these efficiencies, we find the approximate relation already mentioned, namely, that for the same trailing loads the power-house output will be least for the three-phase system, more for the direct current system, and most for the single-phase systems, about in the proportion of 70 to 100 to 180. These are, of course, approximate figures only, subject to changes according to train weights, speeds, and metal used in line equipment. The amounts of energy consumed throughout the year are approximately in the same ratio.

To produce figures for first cost of installation so that they will be applicable to any general case is almost impossible. It is essential that each case be studied on its own merits, and a comparison of costs should be based on actual figures obtained after designs for the three systems have been decided upon.

Nevertheless, it is permissible to draw a few general conclusions. For instance, wherever traffic is dense and rolling stock plays a preponderant part as compared with line equipment, without question the single-phase systems will be most expensive. Whether the direct current or the three-phase system is more suitable in such a case is somewhat doubtful, with the odds in favour of the three-phase system. When a line is very long and the traffic light, rolling stock is less important compared with line equipment; in this case it is possible that the direct current system will be out of the question, due to the great cost of converter sub-stations. Whether the three-phase system or the single-phase system should be used in such a case must be carefully investigated. The single-phase line equipment may be cheaper, but the difference is small. The difference in rolling stock is always great. In most cases the three-phase system will be preferable. It requires a very long line combined with a very light traffic to show an advantage for the single-phase system. As a matter of fact, if the traffic dwindles to five or six trains a day, which is about the point where the single-phase system may show to advantage over the three-phase system, then it is generally found that steam operation is preferable to electric operation.

It is thus seen that for real trunk-line service the three-phase alternating current system will be found best in almost all cases. But there are some disadvantages connected with the three-phase system, and it is well to have those in mind before making a definite decision. First, we have two overhead wires on any railroad equipped for the three-phase system. Two overhead wires are undoubtedly more complicated and less desirable than one overhead wire. The question is, will this show itself in cost of operation. Fortunately it does not. It is more difficult to install two overhead wires, because at the switches it is necessary to have a short insulated portion, so that the two wires, which have a difference of potential between them, can be safely brought past each other. But this does not mean that current must be interrupted

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at the switches. Three-phase locomotives are usually equipped with two contact devices, one at each end, and one of them will always be able to draw current from both phases of the line. Once a double overhead-line equipment is suitably installed, it operates more easily than a single line, as the roller runs more steadily on two wires than on one. In Europe three-phase lines have been in use for more than 15 years, and not only was their operation thoroughly satisfactory, but the line expenses were actually less than for similar direct current or single-phase lines.

A second objection is the small air-gap used in three-phase motors. Years ago it was thought dangerous to use what is now considered quite standard in this respect. Air-gaps have been reduced in direct current motors also, and designers of single-phase motors are certainly showing that they are not really afraid of small air-gaps. The point is this. If a small air-gap is used between stationary and revolving parts, it is necessary to be sure that the gap will remain constant regardless of wear or vibration. This is a question of size of bearings. In direct current and single-phase motors the space available for bearings is limited, and, therefore, small air-gaps might be dangerous. In three-phase induction motors there is ample room for sufficient bearings, and with almost the entire length of the shaft available for bearing surface it would be easy to reduce the gap even below the $\frac{1}{16}$ in. now used.

As a third disadvantage, it is frequently claimed that the three-phase locomotive possesses only one efficient speed. Those who make this claim do not seem to realise that the direct current locomotive acts exactly like the three-phase locomotive in this respect. If either of these two locomotives have only one motor, then there is only one speed at which it can run without using resistances. No one has ever thought of calling the direct current locomotive ineffective on this account. Why, then, should the matter be counted against the three-phase locomotive? Most locomotives have two or more motors, and in that event, two, three, four, and more speeds can be obtained at which the motors can run without resistance. The advantage of the three-phase motor lies in the fact that, whatever speed is chosen, it is a constant speed. The superintendent of motive power can decide at what speed he wants his locomotive to run, and they will run at that speed no matter how heavy the train or how inexperienced the motorman.

We find, therefore, that the disadvantages claimed against the three-phase system are all negligible except that of two overhead wires. These remain a disadvantage from the designing engineer's standpoint, because it is somewhat more difficult to lay out a complicated track system with two overhead wires. From the operating engineer's standpoint the three-phase system possesses no disadvantages. It is well to bear this clearly in mind.

For real trunk-line work we can choose the three-phase alternating current system without hesitation. For the suburban traffic at the large city terminals of trunk lines we can use the three-phase system if we desire to do so, but the use of the direct current system for this particular service presents the advantage that the multiple-unit train control has undoubtedly been developed more for the direct-current system than for the three-phase system. Suburban traffic is generally so dense that rolling stock is by far the greater part of the equipment required, and it is quite feasible to pay somewhat more for line equipment without seriously affecting the total first cost of installation. Suburban zones may, therefore, be well provided with direct current equipment for multiple-unit train operation. Suburban trains will then draw their energy from a third rail, supplying direct current while the through or main trains will use a three-phase overhead line equipment. Both the third rail and the overhead line will be fed by common three-phase power houses, three-phase transmission lines, and three-phase transformers, the direct current for the third rail being obtained by adding converters to the sub-stations for this specific purpose. For the single-phase alternating current system I can find no suitable place in trunk line operation. It can, of course, be used as heretofore on long lines of the interurban railway character. But three of these, among them the first and most important lines, have just decided to go back to the direct current system. It would seem, therefore, that even for this purpose the single-phase system is not suitable.

DISCUSSION.

Advantages of Three-Phase.

(Professor G. W. Patterson.)

On roads with heavy grades both direct current and single-phase motors have to cut off power and use the brakes when going down hill, whereas the three-phase motor will automatically return power to the line, thus braking the train electrically, and not only saving wear and tear on brake shoes, but also directly economising energy. A shunt motor of the direct current type would also return power to the line, and it is not improbable that some day it may be sufficiently improved to take its place in trunk-line service.

Single-Phase Advantages.

(Mr. L. W. McOmber.)

Firstly, with the single-phase motor all one has to do is to "notch up" on the controller and increase the speed. The same process would apply for any voltage drop on the line. Secondly, as regards the use of single-phase motors with heavy trains, we all know of the Port Huron tunnel, where 1,000-ton trains are hauled through the tunnel and up a 2·5% grade. This has been going on for some time, and there has not been an hour's delay due to the breakdown of any motor. The locomotives have large starting torques for the power taken. The motors heat up, but this is taken care of by forced draft. The locomotives go up the grade at the slow speed of 10 miles an hour or less, and yet no burn-out or overheating has occurred. The commutation is now practically as good as for direct current machines. In starting a train with single-phase motors, a pulsating starting torque is obtained. Thus, when the wheels slip they have a chance to grip the track between the points of maximum torque.

Economy in Return of Energy.

(Mr. C. L. De Muralt.)

On all roads with heavy grades not only can the returned energy be made useful for hauling trains up the adjoining grades, but there is a material saving in wear and tear on brake shoes, and also a great reduction in wrecks, many of which are caused by overheated brake shoes and tyres, when heavy trains have to be let down long hills on the brakes. Mr. McOmber's remarks about making up speed should be carefully considered. In actual practice we find that any given track will allow running at a certain maximum speed. No matter how many notches there may be beyond that speed, they cannot be used. If they cannot be used, no better speed is available for the single-phase system as compared with the three-phase system. Indeed, the latter possesses the advantage that it takes away from the motorman the possibility of running at higher speeds than the tracks permit. As regards starting torque, there is no question that large torque can be obtained from the single-phase motor, but it requires twice as large a locomotive, which means useless weight and investment. The pulsating torque is a disadvantage. It does not allow fully the adhesion weight to be utilised, and if the single-phase motors allow a better grip on the track than three-phase or direct current motors, it is only at torques about one-third as large as the adhesion weight would otherwise allow. At best, large torque in single-phase motors can be obtained only by increased losses. The case of the Port Huron installation is an example. The 1,000-ton traint could be handled with considerably lighter locomotives if the three-phase system were used, and three-phase locomotives could start these trains on the grade, while the single-phase locomotives cannot do this. The Port Huron motormen are forbidden to start on the grades, because their single-phase motors would burn out if they attempted to do it. The New Haven installation is another example. The New Haven single-phase locomotives are not allowed to start at the maximum rate of acceleration which their weight could allow, because also in this case the motors would burn out. As to difference in weights, let me say that it is the heating limit which decides the weight of a railway motor. The three-phase motor is the most efficient electric motor. Its losses being smaller, the heat produced by these losses is in itself smaller. In addition to this, due to the construction of the motor, this heat can be very readily dissipated. The three-phase motor is lighter than the direct current motor, and the latter, as well as the single-phase motor, is also handicapped by the addition of a commutator, which still further increases its weight, thus making up the differences of weight stated in the paper. There has been brought out the very important point of the smallest feasible locomotive weight. It is principally a question of speed desired. To obtain a certain draw-bar pull, it is necessary to have a certain minimum weight on the drivers. To obtain a certain speed it is necessary to have sufficient motor capacity. Horse-power equals speed in miles per hour, multiplied by draw-bar pull in pounds, divided by 375. For low speeds it is possible with any electric system to give sufficient motor capacity within the maximum locomotive weight. As the speed goes higher and higher, a point will be reached where

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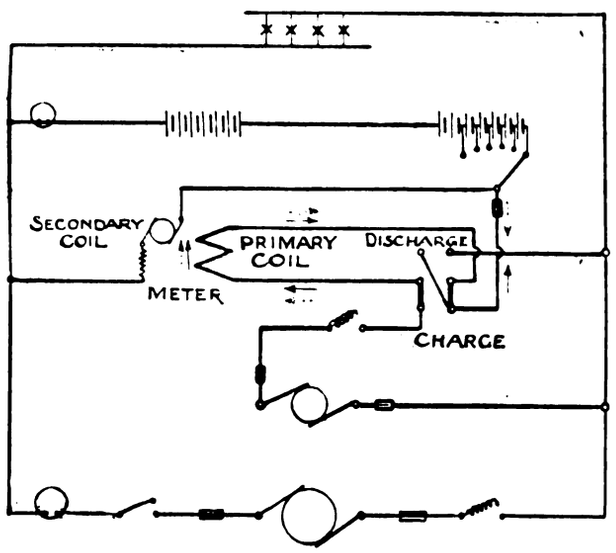
the increase in motor capacity will bring the locomotive weight above the minimum, and those systems having the heaviest motors will reach this point first. Taking figures mentioned in the paper for locomotive weights in pounds per horse-power output, it is possible to establish this limiting speed point for each one of the systems. So long as the speeds stay below the point, all systems are on the same basis. For higher speeds, first the single-phase and then the direct current system will be handicapped, because they will have to carry larger locomotive weights than the three-phase system.

WATT-HOUR OR AMPERE-HOUR METERS.

Small and medium-sized installations are often provided with single cell shunts. In this case, if the installation has an accessory machine, as is usually the case, current from the mains can be taken at once during the charging. Inasmuch as the action is purely mechanical, small variations in voltage are without effect. The consumption of current during a day's work is devoted almost entirely to the production of power.

If in such installations it is desired to measure the charging and discharging energy of the accumulator by means of a watt-hour meter, this can be done very simply and cheaply by replacing the usual unipolar shunt serving both for charging and discharging by a bipolar shunt, as shown in the direction of the annexed diagram. The line arrows show the direction of the current during charging, the dotted arrows the direction during discharging. It is clear that the chief coil of the meter is traversed by the current always in the same direction. On changing from charging to discharging, the connection with the chief coil



is changed at the same time, so that the meter runs in the same direction, whether the battery is charging or discharging. All the attendant has to do is to enter the reading of the meter before charging or discharging under the corresponding heading in his report book, when a glance at the page will show when recharging is necessary. The advantage of this arrangement is that no special meter with relays, etc., is required. An ordinary watt-hour meter, say, one for 150 volts, with a 110 volt installation is enough.

As there is no shunting arrangement within the branch circuit, there is no fear of bad contacts, and the intermediate resistances evoked in the main circuit by the switching have no effect on the indications of the meter.

WIRELESS SIGNALLING FOR AIRSHIPS.

A system of wireless signalling for airships has been invented by Dr. Friedrich Lux. The idea of the inventor, says a Berlin correspondent, is that all airships should be equipped with a receiving apparatus which will weigh only 6 lbs., and that wireless signalling stations should be equipped all over the country at about 50 kilos apart. At intervals of five minutes these signal stations should send out wireless messages by which they could be identified and aviators informed of their whereabouts. A combination of a few letters would be sufficient to distinguish one station from another; and by the increasing or decreasing strength of the electric impulse the aviator could tell whether he was approaching or receding from a particular station.

ELECTRIC TICKET ISSUING MACHINES.

TIME-SAVING DEVICES ON THE "UNDERGROUND."

Several interesting ticket-issuing machines have recently been installed on the London District and allied "Tube" railways. From 4,000 to 5,000 passengers frequently pass through a booking hall in an hour, the greater number of whom have to purchase tickets. These machines are the last development of attempts which have been made to deliver railway tickets automatically to the public. Some of the earlier machines were not fully automatic, the public having to pull a handle to work the machine, which was unlocked by the introduction of the coin. The new machine, which is worked electrically, is entirely automatic; all that is required is to insert the money in the slot provided for the purpose. The coins in their passage through the machine complete an electrical circuit. The current actuates a lever, which, carrying forward a selecting device, picks off one ticket from a pile placed in a reservoir; a hammer is brought into action to print the date, and the ticket is delivered through a slot in the front of the machine. As the coins fall into the till the circuit is broken, and the lever returns to its original position, but, in so doing, it automatically advances the inked ribbon used for dating, so that a fresh piece is always ready for printing the next ticket. In the earlier machines where a ticket of a greater value than a penny was required, a separate slot was provided for each coin, and mistakes were frequently made by putting two pennies in one slot instead of one in each. In this case the unfortunate passenger did not get a ticket. The new machines are made for fares of 1d., 2d., and 3d., but in all cases the whole of the money is placed in one slot, so that no such accident can occur. It has been found by experience that florins and other coins are frequently inserted in automatic machines by mistake and thus lost, but if coin other than a penny is placed in the new machines it is automatically returned. Iron discs, metal rings, and washers are frequently used for defrauding automatic machines, and a heavy loss is experienced.

The new type of machine is so constructed that such articles when introduced do not complete the circuit, and, what is more, do not block the action of the machine when correct coins are subsequently used.

Machines relying upon clockwork for their action, which were also fully automatic, were tried, but did not prove reliable on account of the possibility of delivering more than one ticket at a time. The principle in this new machine of making a single electrical contact for each insertion of the correct amount of money has rendered the delivery of more than one ticket to each passenger impossible. The machines with their brilliantly illuminated transparent signs present somewhat the appearance of a large safe. The patents for this country are controlled by the Sweetmeat Automatic Delivery Co. A polished brass plate in the centre has a slot for the insertion of coins, a slot through which the ticket is delivered, and an opening through which the rejected coins are returned.

PARLIAMENTARY.

NIGHT TELEPHONE SERVICE.

Mr. Lloyd Morgan asked the Postmaster-General, in view of the approaching taking over of the business of the National Telephone Co., whether the privileges at present enjoyed by the public of telephoning throughout the night would be in any way restricted when under the management of the Post Office, and whether it was proposed to make any change as to the use of the telephone on Sundays.

Mr. Buxton, the Postmaster-General, in a written reply, says: I do not anticipate that present facilities for night telephone service—so far as they meet an actual need on the part of the public—will be restricted after the transfer of the National Telephone Co.'s system to the State. The question of the extent of Sunday use will require careful consideration.

WIRELESS TELEGRAPHY ACT.

Mr. Buxton, in a written reply, answering Mr. Henniker Heaton, says: It is proposed to renew the Wireless Telegraphy Act to the end of next year by means of the Expiring Laws Continuance Bill. As the Act has hitherto been renewed once only it cannot be said that there is any recognised practice as to the manner of its renewal. There appears to be no need, therefore, at present to revise the Bill. No circumstances or question have yet arisen which necessitated any alteration in the Act.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

"If thou hast knowledge, let others light their candle at it."

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should be *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

Question No. 1,200.—At a certain works in the Midlands there is a steam pump working in connection with a hydraulic accumulation. This pump is a source of trouble, and is also very inefficient as regards steam consumption. There is within a few feet of it the main shaft of one of the machine shops, whose motor (a 50 h.p.) is but half loaded. It has been suggested that the steam pump, which absorbs 10 h.p. to 12 h.p., should be replaced by a three-throw belt-driven pump worked from the shop shaft, the belt being moved over the pulleys by means of a solenoid energised from a 220-volt circuit and brought into operation by means of a separate circuit connected with the pressure gauge. It is suggested that the solenoid should pull the belt on to the driving pulley against a spring, which, as soon as the solenoid is de-energised, draws the belt back on to the idle pulley. The above operation would be taking place about eight times per hour. Is the above idea workable? If so, give the best method of putting same into practice, with necessary sketches, and setting forth the calculations necessary for arriving at size of solenoid, and also particulars as to best size of belt, etc.

Answer to Question No. 1,200 (*awarded* 10s.).—The suggestions made are quite practicable, and below are outlined the main features of a suitable design: The exact dimensions of all parts cannot be given, (a) on account of space limitations (2) on account of the insufficiency of the data supplied, the most serious omission being that of the main shaft r.p.m. As no particulars of the actual useful work done by the present pump are given, no figures can be presented as showing the likely increase of efficiency accruing from the proposed arrangement; but it may be taken that the efficiency of pumping from the main shaft to the pump delivery will vary from 45 to 70% according to the efficiency of the belt transmission: probably 60% will be a reasonable mean.

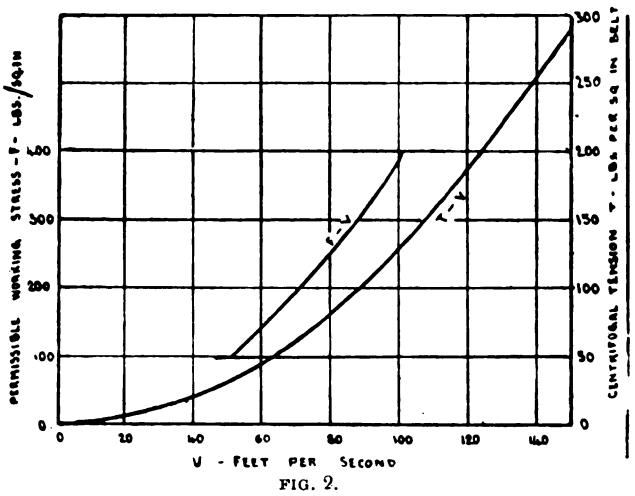

FIG. 2.

The general arrangement proposed is shown in Fig. 1. The fast and loose pulleys are on the main shaft, the pump pulley being of twice their width. The belt is shifted from pulley to pulley by the usual type of *u* fork acting on the advancing side of the belt. This prong is mounted on a rectangular slide bar T moved by the slotted T lever shown (L, M). In place of two hand ropes, one on each limb of the T, a solenoid is arranged to act on one of the T ends and a suitable spring on the other end. Solenoid and spring are hung from a stout wooden block W hung in turn from a convenient roof beam as indicated (in many cases direct suspension from the roof beam is possible). The roof member also carries guides H for the sliding bar T. H may be webbed for stiffness. To show the arrangement of the solenoid more clearly, the right hand member H is only dotted in the side view. As shown in the end view BB, the T lever is best made in two parts, otherwise the compact disposal of the solenoid and spring offers difficulty. The spindle carrying L, M is held in bearings slung from *w*, it being preferable for rigidity to extend the bearing as shown dotted.

The sketches of Fig. 1 are not to scale, but indicate the general arrangement proposed with sufficient clearness. The methods of determining the dimensions of the chief parts of the design are as below:—

Belt Design.—Assuming a main shaft r.p.m. of 300 r.p.m. and a pulley diameter of 12 in. the belt velocity = 15·75 ft. per second. At this speed, as shown by Fig. 2, there will be no difficulty from centrifugal stresses, for with a permissible belt working stress of 300 lbs. per sq. in., the velocity may rise to 88 ft per second (see Fig. 2). Assuming 15 h.p. to be transmitted (probably less power will actually be required under the improved conditions), and assuming a ⅜ in. belt, the sq. feet of belt surface that must pass

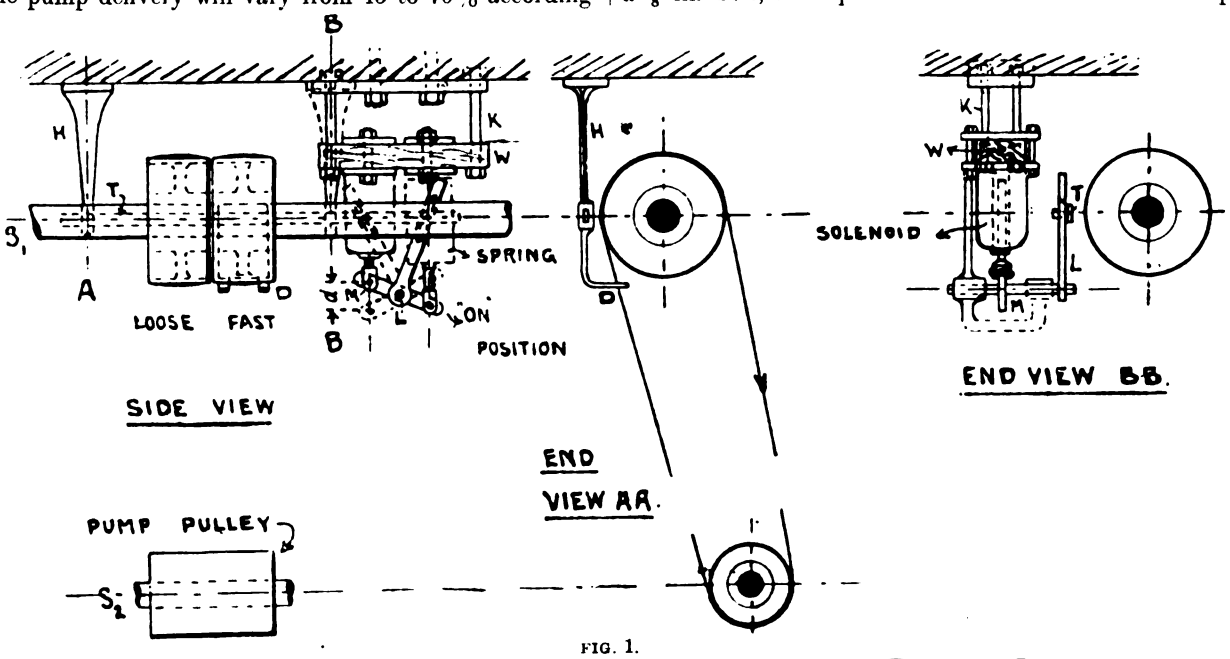

FIG. 1.

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over the pulley per minute is equal to about 39 × 15 sq. ft. (taking u = 0·3 and single laced joints = see Table I.). This necessitates a belt width of about ·62 ft., or, say, 7 in. Clearly, if the belt be run faster, a less width will suffice, and the writer would prefer a belt 4·5 in. wide ($\frac{3}{8}$ in. thick), this corresponding to a velocity of 22 to 27·5 ft. per second. The curves (Fig. 3) show the working tensions permissible per inch width of belts of various thicknesses and different modes of jointing (Unwin). The "factor" curve gives the factor by which the belt width,

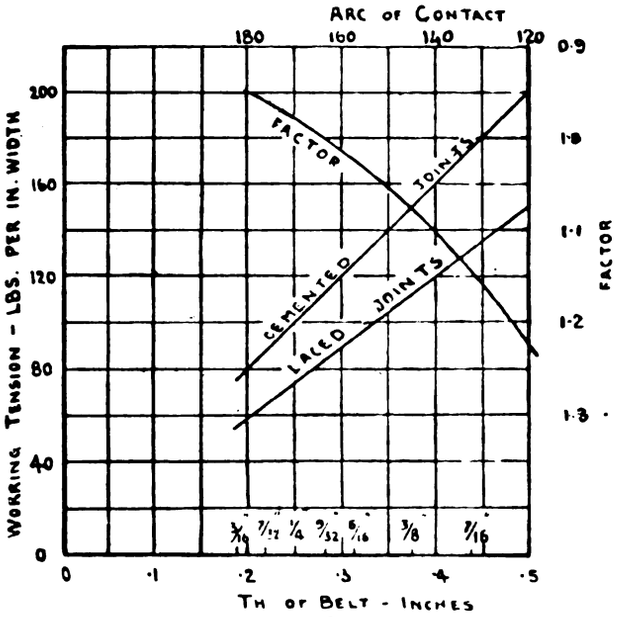

FIG. 3.

as designed from Table I., has to be multiplied, if the angle of span be different from 165°, which is taken as the basis of this table.

Table I.—sq. ft. per min. per h.p. (Unwin.)

Laced single belt, $\frac{7}{32}$ in. ..	A = 61	A = 72
Cemented ditto	= 46	= 54
Laced double belt, $\frac{3}{8}$ in. ..	= 36	= 43
Cemented ditto	= 27	= 32
	u = 0·4	u = 0·3

Pulley Design.—If the main and pump shafts be very close together, a guide or jockey pulley may be necessary to keep the belt to its work and to avoid too frequent stoppage for adjustment. For the fast, loose and pump pulley the following rules may be employed (Unwin's):—

Width of rim = $B = \frac{9}{8}(B + 0{\cdot}4)$ (B = belt width).

In the present case, therefore, $B = \frac{9}{8} \times 7{\cdot}4 = 8\frac{1}{4}$ in., say, so that, allowing for clearance, etc., the belt must be moved $8\frac{1}{2}$ in. from pulley to pulley. The thickness of the pulley rim at the edges is given by

$t = 0{\cdot}78 + 0{\cdot}005\ D$, where

D = pulley diameter: S = belt thickness.

The thickness of rim at the centre is 2 t; the outside surface of the pulley rim is struck to a radius = 3B to 5B, and the inner surface is conical in section. Pulley diameters should not be less than 6 to 8 times the diameter of W. I. shaft necessary to transmit the power in question, and the smaller pulley should be of diameter < 18 times belt thickness. By these rules the pulley dimensions assumed above for purposes of demonstration may be corrected to suit the actual conditions.

The number of pulley arms = $V = 3 + \frac{BD}{150}$ and their section, and the design of the pulley nave, etc., proceed along the usual lines, as set out in any handbook on Machine Design.

Electrical Connections and Solenoid.—The electrical connections are indicated in Fig. 4. The pressure gauge relay is represented diagrammatically at P, the exact arrangement of this apparatus being of course quite optional. The solenoid operated switch, controlled by P, closes the circuit of the main solenoid, which is run in series with resistance if necessary. The contacts of P should be shunted by a condenser to minimise sparking.

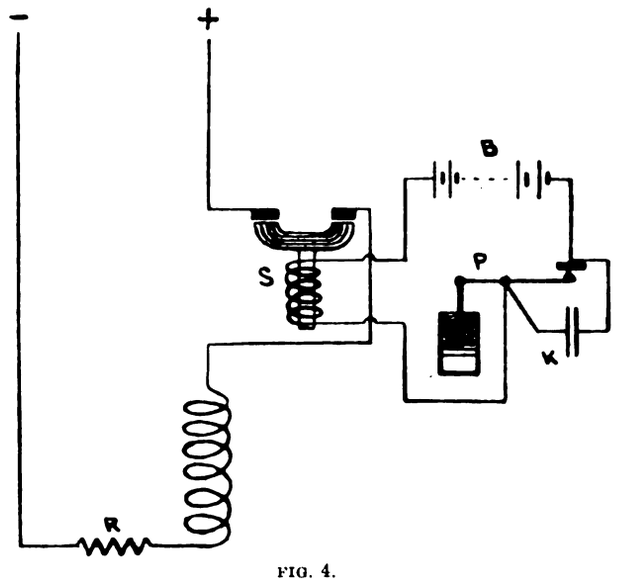

FIG. 4.

The solenoid used should be a suitable standard solenoid as put on the market at present by various firms (chiefly for operating crane brakes, etc.). The use of such a solenoid is preferable to attempting to design and construct a "home-made" one. In Fig. 5 are shown the characteristics of a certain make of brake solenoid; from this curve the usual lift available for various pulls is obtainable. These figures are not the only ones obtainable in standard equipment, but are quite typical; short lift is an unfortunate characteristic of all solenoids. With a lift of about $3\frac{1}{2}$ in., a pull of 90 lbs. is obtainable. The belt has to be shifted about $8\frac{1}{2}$ in., hence, by making each arm of M (centre to centre) about 0·40, the effective arm of L, the requisite motion will be obtainable by use of the above solenoid. Allowing a spring, giving 40 lbs. pull with $3\frac{1}{2}$ in. extension, the available axial force pushing the belt *on* to the fast pulley = $(90 - 40)\frac{3{\cdot}5}{8{\cdot}5} = 20{\cdot}6$ lbs., and pulling it *off* on de-energising the solenoid = $40 \times \frac{3{\cdot}5}{8{\cdot}5} = 16{\cdot}5$ lbs.

These forces are on the low side, and it would be safer to purchase a stronger solenoid for the same lift, or one of the same, or, possibly, rather less pull out greater lift. In any case, the spring should always give less than half

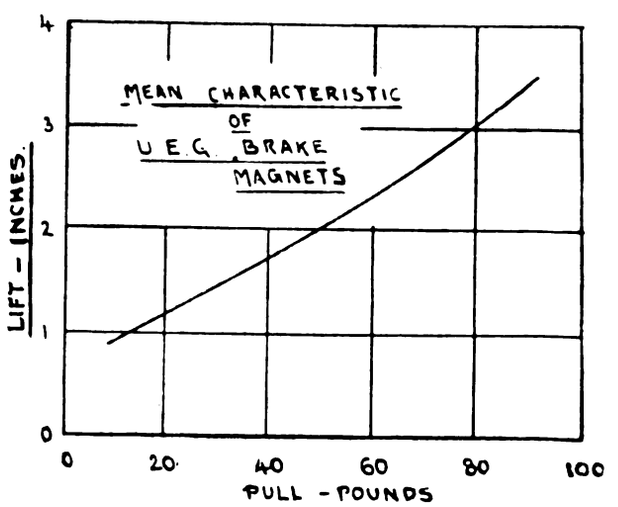

FIG. 5.

the solenoid pull when extended to the full extent required. A greater force is then available to push the stationary belt on to the moving pulley than to shift the moving belt after the desired hydraulic pressure has been restored.

The energy consumed by the solenoid is not an important point under these conditions, since all standard solenoids of suitable power for the present work are reasonably economical of energy, and the service is here very intermittent. The number of cells required in the battery B (Fig. 4) is best determined by experiment, depending, as it does, on the type of switch S employed. The allowance should be liberal to ensure reliability.

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Spring Design.—To illustrate the formulæ given below, assume that the spring referred to above is adopted, *i.e.*, 40 lbs. pull is required with 3½ in. extension.

Assume circular steel wire to be wound to a spring of 3 in. mean diameter, and allow 10,000 lbs. per sq. in. working stress = q, and let C = 5,000 tons per sq. in. Then

$i = \frac{d}{a}$ where i = radians of twist of section of bottom spring turn.
d = extension of spring.
a = mean radius of spring.

$\therefore$ i here $= \frac{3{\cdot}5}{1{\cdot}5} = 2{\cdot}34$

Now torque = 40 lbs. × 1½ in. = 60 in., lbs.

And $T = \frac{q}{r} \cdot I_p$ (q = working stress; r = radius of wire; I_p = polar mt. inertia of spring)

$\therefore r^3$ here = 0·00382 and $\therefore r = 0{\cdot}1{,}565$ in. ($\frac{5}{32}$ in.)

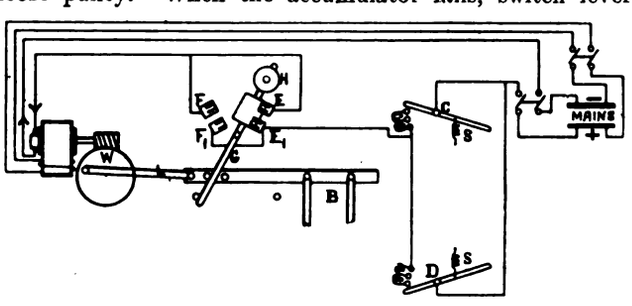
And length of wire required:

$= l = \frac{i.C.I_p}{T}$ here $= 410$ in.

i.e., No. of turns, assuming spring initially *close* $= \frac{410}{\pi \times 3} = 43{\cdot}5$

Hence the spring may be of $\frac{5}{16}$ in. steel wire wound to 3 in. mean diameter; 44 turns would be required, and the length of the finished spring closed = 11 in. (say 28 cms.).—"MULTUM."

Answer to Question No. 1,200 (*awarded* 5*s.*).—An electric drive for the pump would certainly be better than the present arrangement, both from the point of view of convenience and also from economical considerations. It would, of course, be possible to move the belt by means of a solenoid, or by an electro-magnet, but it is doubtful if either of these would give satisfaction. Both solenoid and magnet give a snatch when energised, while what is wanted is a slow, steady motion. It is almost impossible to shift a belt suddenly, but a comparatively small force steadily applied will move even a large belt without difficulty. Another point against the employment of a solenoid is that it would have to be powerful enough to overcome the spring as well as move the belt. A suggested automatic arrangement is shown in the accompanying diagrammatic sketch. A ¼ h.p. motor drives, by means of a worm, the wheel W. This wheel actuates the sliding rod carrying belt forks B by means of the link L. Considering the small amount of energy, about 50 watts, required to energise the field magnets of such a motor, the magnets may with convenience be kept always excited. C and D are two starting switches; these switches are actuated by a tappet fixed on the rising and falling part of the accumulator. As shown in the figure, the belt is supposed to be on the loose pulley. When the accumulator falls, switch lever



of D will be moved across its contacts and current will flow through the motor, as shown by the full arrow, and from motor back to negative main. The small motor then turns W through 180°, and the sliding bar with belt fork is pushed to the right, the belt being thus shifted on to the fast pulley. As this takes place, the lever G is moved from its contacts at EE, to those at FF_1. H is a balance weight attached to lever G. The belt is now driving pump and filling accumulator. When accumulator weight rises, switch C comes into play, motor rotates and turns W through another 180°; belt is now shifted from the fast back to the loose pulley. Such a combination appears to be a more satisfactory arrangement than the employment of a solenoid. To avoid the snatch with solenoid or magnet, a dash-pot could be fitted, but there would still be the difficulty of securing sufficient stroke. A method worth consideration would be to have one pulley only, and fit it with a magnetic clutch.

The size of belt required will depend on speed of pump and dimensions of pulley. Suppose pulley on pump is 1 foot in diameter, and that it runs at 240 r.p.m. As the belt has to run between forks, it will be best to have it made of leather; for a double belt, a fair allowance will be 90 lbs. pull per in. of width. Thus to transmit 12 h.p. the belt should be:

$$\frac{7 \times 12 \times 33{,}000}{22 \times 240 \times 90} = 5{\cdot}83,$$

say, a 6 in. belt.—M. M.

TYNESIDE NOTES.

(From our Correspondent.)

NEWCASTLE.

With the somewhat unusual course taken by the Chairman of the Newcastle-upon-Tyne Corporation Tramways Committee in communicating to the Press what was practically a disclaimer of a certain portion of the report officially issued by the General Manager of the Tramways undertaking, it was anticipated that a certain amount of public discussion would have been created, and for this reason opinion was reserved in my communication last week. Apparently, however, it appears to have been left alone by the general public, and this is perhaps as well, as the position now admits of discussion from a technical standpoint. The matter can be recapitulated as follows. Mr. Hatton said in his report that concessions to the public in the way of increased facilities, lower fares and increased services of cars, together with concessions to employés in the way of shorter hours and increased pay, are rarely considered in the light as to how and in what manner they affect the revenues, and he drew a comparison between the gas undertaking, which in periods of dear coal could make, say, a 5% additional charge on the price of their commodity without raising an outcry, and that of a tramway undertaking, which had no intermediate charge between 1d. and 1½d. units. The latter was, therefore, compelled, if the working charges lay within the limits of the 1d. and 1½d., either to suffer a deficit to be paid for out of the rates by taking the lower unit, or to lay by a surplus for relief of rates by charging the higher unit. Mr. Hatton suggested an eminently practical idea, which is to make a minimum fare stage of 1½d., this being the fixed price charged on the cars to casual fares and paid for in the usual way to the tram conductor.

A Minimum Fare Stage.

In order, however, to impart flexibility tothe system and to cater for the regular supporters of the Tramway undertaking, he proposes that in a system, not necessarily Newcastle, where such conditions exist, books of tickets, each of the nominal value of 1½d., should be issued at discounts so proportioned as to make the revenue fit the expenses for the current year. In this way it will be seen whatever real or supposed benefits to the community or the employés may be advocated by the Committee we have here an automatic means of regulating the income to the expenditure, and, by making the supporters of the undertaking directly feel the cost of any concession, putting an automatic regulator on the cost conferred. It was suggested in my last week's letter that the disclaimer on this question arose rather from a misunderstanding as to the above premises rather than total disagreement with the policy involved, and Sir Joseph Baxter Ellis points out that Mr. Hatton's suggestion, that it might become necessary to resort to a minimum fare of 1½d., and to revert from some of the concessions as to fare stages, merely expressed the private opinion of the General Manager, and has not been considered by the Committee. In Sir Ellis' opinion there is no necessity for such consideration, especially at a time when, on the advice of the Tramways Manager himself, the Committee had agreed to reduce the fares and increase the fare stages. So far as the local position is concerned, the matter remains at this point in the eyes of the public.

The Carville Power Station.

During the present week the 20th annual general meeting of the Institution of Mining Engineers has been held in Newcastle, and, although there was in the papers and discussions nothing of electrical interest, a very interesting series of visits was arranged. By the courtesy of the Secretary of the Institution, I am allowed to quote from the Handbook of Excursions, which was issued to the members and visitors in connection with these visits. The first one was to the Carville Power Station of the Newcastle-upon-Tyne Electric Supply Co., Ltd., but as this has been so frequently discussed in the technical press there is no further contribution to the description which can be usefully made except that the whole system is now operated and controlled from the control room by the system engineer, who is in direct telephonic communication with each sub station in the area, which now covers some 700 square miles. The control room contains a large diagram of the whole system, and upon it a record is kept of the position of the switches. Adjacent to the

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control room are the operation offices and telephone exchange, from which the large private telephone system of the company is operated. This feature of separating the control room from the actual switchboard is, I believe, one of the first of its kind in Europe.

Electric Colliery System.

The visit to the Harton Colliery of the Harton Coal Co., Ltd., is, however, of very great interest, as this company has probably one of the most largely electrified colliery systems in Great Britain. The whole of the appliances of the colliery are worked entirely by electricity, no steam power being used for any purpose. The existing shaft is 14 ft. in diameter, and is sunk to the Bensham seam to a depth of 1,284 ft. from the surface. The new shaft is to have a finished diameter of 16 ft., and will be sunk to the same seam. The output of the colliery is about 1,200 tons per day of 10 hours. The electrical winding engine, which has just been erected, is, however, designed to deal with an output of 240 tons per hour. The motor is of 800 b.h.p. normal capacity, with a maximum output when starting of 1,700 h.p. at 5,500 volts. The motor works at a speed of 5·18 r.p.m., and is coupled direct to the winding drum, which is 14 ft. in diameter by 8 ft. in width. The brakes of the drum are operated by means of compressed air at a pressure of 60 lbs., and can be applied in three ways, namely:—(1) By the winding engineman, by means of an operating lever; (2) automatically by a depth indicator, in the event of an overwind; and (3) by an auxiliary magnet, in case of failure of the electrical energy. Round winding ropes are used, $5\frac{7}{8}$ in. in circumference, made of the best extra improved plough steel, with a breaking strain of about 145 tons. The balance rope of flat, $8\frac{1}{2}$ in. in width, weighs about $4\frac{3}{4}$ tons, which is $1\frac{1}{4}$ tons heavier than the winding rope. The engine draws coals from the Bensham seam level. The cages in use have four decks and carry two tubs on each deck; each deck is fitted with the Winter patent tub stopping device. The total weight on the loaded rope at starting, including the rope, cage, tubs, coal, etc., is $14\frac{3}{4}$ tons; the net weight of the coal raised at each wind is $4\frac{1}{4}$ tons. The time occupied per wind is 48 sec. The guides are of pitchpine.

The Haulage Engines.

There are two principal haulage engines, both electrically driven, and one in the Hutton seam, also driven electrically, all of which are worked on the main-and-tail system. Each is driven by a 250/600 h.p. motor working under 2,600 volts at 230 r.p.m. The drums of the engines are each 6 ft. in diameter on the trod, and are geared $4\frac{1}{4}$ to 1. The speed of the set is about 10 miles per hour. The sidings for these haulages are situated 1,050 ft. from the shafts, and two small haulage gears are used to bring the coal from them to the onsetting station. There are also several auxiliary haulages; one in the Hutton seam is driven by a 60 h.p. electric motor at 2,700 volts. It is placed $\frac{3}{8}$th of a mile from the shaft, and brings tubs from the different flats to the main hauler; the speed of the set is 6 miles per hour. In the New Hutton seam, there is a small endless rope gear, driven by a 15 h.p. motor at 600 volts; the speed of this set is $1\frac{1}{2}$ miles per hour. At the top of the staple is a small main-and-tail haulage gear, the motor being of 15 h.p. at 600 volts, and the speed of the set is 5 miles per hour. In the Hutton seam, south-east district, is a main-and-tail haulage gear, driven by a 60 h.p. motor at 2,600 volts. It is situated $1\frac{3}{4}$ miles from the shaft, and runs at a speed of 6 miles per hour. There are exactly similar haulage gears in the South Winnings and Holder House in the Bensham seam districts. In the south-west cross cuts district is a small endless rope haulage gear, driven by a 15 h.p. motor at 600 volts, the speed of this set being $1\frac{1}{2}$ miles per hour, and in the North drift district a small main drum gear is installed, the motor being of 15 h.p. at 600 volts. These auxiliary haulages haul the coals from the flats to the main hauling engine roads so as to avoid the use of driving ponies. There are only four driving ponies employed in the pit. A small electrical winding gear is installed, winding coals from the new Hutton seam to the Bensham seam level, a distance of 132 ft. This is worked by a 35 h.p. motor at 600 volts and winds one tub at each lift.

Pumping Water by Electricity.

The whole of the water is pumped from the face by means of small electrically driven pumps and is raised from the Bensham seam to bank by a Sulzer four-stage high lift centrifugal pump of a capacity of 1,000 gallons per minute, against a head of 1,380 ft. when working at 2,300 r.p.m. The pump is direct coupled to a Brown-Boveri motor, working at 2,700 volts. A spare and stand-by pumping plant is also installed, consisting of a motor of 140 h.p., working at 480 r.p.m. at 2,600 volts, and a horizontal three-throw pump, with three ram, each 9 in. in diameter with 18 in. stroke, making 24 r.p.m. and capable of pumping 300 gallons per minute against a vertical head of 1,300 ft. The head gears and pulley frames are constructed of steel, being of the lattice girder pattern, and have been recently erected. The pulleys are made of cast iron and are 16 ft. in diameter, the pulley centres being 102 ft. from the surface. Creepers and gravitation roads are employed on the surface to conduct the tubs from the shaft mouth to the tipplers leading to the screens; the empty tubs afterwards gravitate back to the cage. A similar arrangement is in operation at the bottom of each shaft. The tubs on all four decks of the cage are simultaneously discharged, no movement of the cage being necessary when it has been brought to a standstill. The motors driving the creepers are of $7\frac{1}{2}$ h.p., and work at 1,120 r.p.m. at 600 volts. The coal cleaning belts consist of three main belts, 5 ft. wide, formed of steel plates, varying in length from $48\frac{1}{2}$ to $63\frac{1}{2}$ ft. by 4 ft. The subsidiary belts for nuts and small coal are 3 ft. wide by 52 ft. and 46 ft. in length respectively. The two motors driving the screening appliances are each of 35 h.p. and work at 480 r.p.m. at 600 volts. The lamp room is of suitable capacity for cleaning, examining, repairing and storing upwards of 850 safety-lamps; these are electrically lighted and magnetically locked by means of patent devices. The motor driving the granary plant is of 15 h.p., and the horse food for the whole of the company's collieries is suitably crushed, chopped, mixed and cleaned at Harton Colliery.

Electrical Sinking Engine.

Particulars of the electrical sinking engine and plant at the Harton sinking are as follows:—Weight of kibble and stones, 3 tons; weight of rope (1,300 ft.), 15 cwt.; maximum speed of rope, 1,000 ft. per minute. The drum is 6 ft. in diameter over the barrel, $5\frac{1}{2}$ ft. wide, and runs at 51 r.p.m. when at full speed. The rope is $2\frac{3}{4}$ in. in circumference, and is of best plough steel. The brakes are of the best post type and are operated by compressed air at a pressure of 50 to 60 lbs. They are applied by the driven by means of a lever, act automatically in case of failure of supply, and can also be operated by the driver by means of a foot lever. The drum is geared at $7\frac{1}{2}$ to 1; the gearing is steel and the teeth are machine cut and double helical in shape. The pinion wheel has 18 teeth of 2 in. pitch, and a 12 in. face; the spur wheel has 134 teeth, and has the some pitch and face. The motor is wound for 2,600 volts at 40 cycles and 390 r.p.m.; it developes 240 b.h.p. normally and 450 b.h.p. in starting. The gear and motor are mounted on the same bedplate. The controller is of the liquid type, with circulating pump and electrically controlled reversing-switch. The total horse-power of the motors installed is 1,645, exclusive of the winding engine, which is 800 b.h.p., but capable of exerting 1,700 h.p.

Description of Other Machinery.

The colliery is at present ventilated by means of a Capell fan 11 ft. in diameter by 7 ft. in width (erected at St. Hilda Colliery) which is direct driven by means of a 300 h.p. Siemens-Schuckert motor, wound for 5,500 volts at 260 r.p.m. With the fan running at that speed, 210,760 cubic ft. or air per minute are produced at a water gauge of 5 in. A motor of the same make is installed on the other side of the fan shaft as a standby in case of breakdown. this motor being rated at 400 h.p. and running at 295 r.p.m. At this speed the fan will give 250,000 cubic ft. of air at a water gauge of $6\frac{1}{4}$ in. An additional ventilating plant is also provided, consisting of a Walker indestructible fan, 26 ft. in diameter by 8 ft. in width, which is driven by compound horizontal engines, having a high pressure cylinder 22 in. in diameter and a low pressure cylinder 38 in. in diameter, with a stroke of 48 in. Eleven cotton ropes connect the engine with the fan pulley. With the engine running at 45 r.p.m. and the fan at 110 revolutions, 207,000 cubic ft. of air per minute are produced at a water gauge of 5 in. The total horse-power installed at the collieries of the Harton Coal Co. is as follows:—Boldon Colliery, 1,892 h.p.; Harton Colliery, 2,445 h.p.; St. Hilda Colliery, 1,820 h.p., and Whitburn Colliery, 2,413 h.p., making an aggregate of 8,570 h.p.

Electricity in Mines.

A further proof of the necessity of dealing strongly with the present position with regard to electricity in mines is furnished by a report in the *Newcastle Evening Chronicle* of September 17 regarding a pump attendant's death at Shildon Lodge Colliery, owned by Messrs. Balekow, Vaughan & Co. This man was found dead behind the electrical switchboard. From the report of the inquest it appeared that the deceased's duties were to attend to the pump, and he had nothing to do with the repairing of the pump or the electrical gear. He had, apparently, however, gone within the fences to adjust one of the terminals which had been sparking. The only thing he had to do with the electrical plant was to turn the switch on or off. The report of the Workmen's Inspectors was to the effect that they found the plant in order and the occurrence was simply an accident. The Coroner, however, in his address to the jury, thought it showed that electric current, which was being increasingly used in mines, was a very dangerous thing to deal with, and the greatest possible care should be taken by the men who had to use it. While this is undoubtedly true so long as the non-technical type of men has to be in charge of any piece of electrical apparatus, it may be suggested that the emphasis should rather be laid on the necessity of providing a higher standard of attendance with reference to electrical plant in mines, and the efforts of the Institution of Mining Electrical Engineers will in this respect do very much to meet the case by raising the status of engineers, both mechanical and electrical, who have anything to do with this new power agent in colliery work.

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AMERICAN NOTES.

[From Our Correspondent.]

NEW YORK.

Though the small trader is as keen as the big storekeeper to recognise the value of a good electric light installation in attracting customers, he is, as a rule, rather chary of incurring the initial expenditure. In Chicago the Commonwealth Edison Co. has stepped in to the assistance of the small retailer in this matter. The company instals the complete wiring for shop-window illumination at a cost of five shillings (not dollars) per lamp, inclusive of reflectors, and also inclusive of the City Inspection fee of ten cents. per lamp. All the customer has to do is to guarantee to consume a shillingsworth of electricity per lamp per month for one year; and in addition to his installation he is provided without charge with an illuminated sign bearing his name and business. My Chicago correspondent tells me that the company is doing a big business in this way, and the small retailers are simply delighted at being able to increase the attractions of their stores on such eminently economical terms.

The Great Advertising Campaign.

I mentioned in my notes last week that the September issues of most of the popular magazines were to carry whole page advertisements of the General Electric Co.'s Tungsten Lamps. They have made a beginning with *Harper's Magazine*, *Everybody's Magazine*, the *Review of Reviews*, *McClure's*, *Munsey's*, *Scribner's*, *System*, *Popular Electricity*, the *Saturday Evening Post*, and the *Associated Sunday Magazines*. In addition to this the leading electrical trade journals carry either whole or double page advertisements directing the attention of central stations and electrical dealers to this colossal advertising campaign, by means of which the General Electric's announcements will be brought to the notice of something like 20,000,000 people. And this is only the beginning of what promises to be the most extensive advertising campaign in the whole history of the electrical industry in this country.

A Note to the Trade.

In the special advertisement addressed to central station engineers and the electrical trade generally, the company points out that less than half the people who can afford it are now using electric light. "To YOU," the company adds, "this should be a significant fact. It means you are not getting all the business you might easily get," and they urge that with the new General Electric lamps "you can interest many people who never before thought they could afford electric light." The magazine advertisements are carefully worked out and form very attractive pages, which should add very materially to the demand for electricity for purposes other than lighting. They undoubtedly mean a big boom for everybody concerned with electricity.

Long Island Railway.

It is announced that in another nine months the Pennsylvania tunnels will be ready for operation, and that as the majority of the contractors are ahead of their schedules, the opening may even be earlier. The total expenditure will reach more than $100,000,000 before the work is complete. The progress of the work on the Long Island section of the road is fully as far advanced as on the main terminal, and the President of the Long Island Railroad is quoted as saying that operation from many points on the western division of the system to Manhattan would be under electricity through the tunnels before the end of this year. Already the ties for the tracks in the East River tunnels have been stored in Long Island City. The first division of the road from Long Island City to Jamaica will probably be ready within a few months, and the double tracking of the North Shore line to Port Washington will be completed before the end of the year.

Transformer for Direct Current.

There would seem to be a promising future for an invention which has recently been perfected by Mr. L. A. Hawkins. It is described in the *Electrical World* as a method for converting direct current from one voltage to another in a machine passing only one armature winding and a single commutator. The field structure is provided with double the number of pole cores ordinarily required, there being four pole cores for a two-pole machine. There are two sets of brushes, one of which is connected to the supply circuit and the other to the delivery circuit. The voltage between one set of brushes bears to the voltage of the other set the increase ratio of the sums of the magnetic fluxes interposed between the brush sets. Since the resultant flux between one set of brushes can be altered without changing the flux between the other set, merely by increasing the magnetism in two of the pole cores and decreasing the magnetism in the other two cores by an equal amount, it follows that the ratio between the supplied and the delivered E.M.F. is variable throughout a wide range. This variation is obtained by means of the rheostat and reversing switch in the magnetising circuit of two of the field cores.

The Ignorance of the Consumer.

Mr. Harold Almert, of Messrs. Byllesby & Co., a well-known firm of consulting engineers in Chicago, has been saying some very noteworthy things on advertising. Ignorance on the part of the consumer, he declares, is the principal retarding element which prevents a much more extended use of public-utility service. If the public understood all the varied uses, economies, comforts and conveniences obtainable from the intelligent use of gas, electric light and electric power service, the output of central stations and gas companies of the country would be three times what it is to-day. "The connecting link between the prospective consumer, who does not understand the varied uses, and public utility or producer who does, is advertising. Such advertising, to be eagerly read, must be in the form of a campaign of education, setting forth step by step the whole truth and nothing but the truth, in simple language, devoid of technical terms so that the reader can readily comprehend it."

The Electric Vehicle.

Some eminently sensible remarks on the share of the central station in the popularisation of electric vehicles are made by Mr. J. H. Vail in the course of an article in the *Electrical World*. He points out that if the development of the electric vehicle has been somewhat slow, it has been sure, and it must now be recognised that whether for pleasure or business or for commercial purposes, it has come to stay. "Its field of usefulness is too large and its economy of service too great to be ignored any longer," and the conclusion seems obvious, the writer declares, that within a reasonable time nearly as much current will be sold to serve electric vehicles as for other motive power. He cites the case of central stations which, understanding the value of this new business, are proving their faith by using vehicles in their own service; co-operating with vehicle manufacturers in developing new business, and already beginning to reap their reward, which recent statistics show aggregates upwards of $500,000 per annum of new revenue.

"The Note of Distinction."

"The use of an electric pleasure vehicle," says Mr. Vail, "is an accepted mark of social distinction, and the use of commercial electrics is likewise viewed as a distinct economic advance in business enterprise. The central station company and the manufacturer have each their product to sell, and cordial co-operation should serve to promote the business to their mutual advantage," and he urges with emphasis that the "surest method of getting the public more deeply interested in electric vehicles is for each central station company to adopt a vehicle equipment for its own service. This is the master-key to the secret of success in developing the sale of energy in this comparatively new field. The central station company should always be in 'the firing line.' With regard to commercial electric vehicles he points out that the speed and radius of service exceed more than twice the ability of horses. Actual practice proves that the ability of a two or three-ton electric truck in express service to make from 125 to 200 delivery stops in 10 to 12 hours, over a route of 35 to 45 miles, crowds the working capacity of operators. In other words, the capacity of the truck exceeds the ability of the man to handle the merchandise. The delivery wagons having a capacity of 1,000 lb. and 2,000 lb. prove capable of exceeding 40 miles daily service and 200 delivery stops. This work is frequently done between 8.30 a.m. and 4.30 p.m.

COMPANIES' MEETINGS AND REPORTS.

BRITISH THOMSON-HOUSTON CO.

At the 14th ordinary general meeting of the British Thomson-Houston Co., Ltd., held at the offices, 83, Cannon-street, London, E.C., Mr. G. Franklin presided. In moving the adoption of the report, the Chairman said their works at Rugby had been well maintained during the year, and they had made a number of improvements, the most important being an extension of the steam plant at a cost of £8,766. The Company now owned all the patents for the United Kingdom of the Curtis steam turbine, and 12 turbine engines had been sold. With regard to industrial developments, the volume of business done had not been so satisfactory, owing to the depressed state of trade; but the Company had received its fair share of traction work. Satisfactory progress had been made in the development of metallic filament lamps.

UNITED ELECTRIC CAR CO.

At a meeting of the shareholders of the United Electric Car Co., Ltd., at Preston, the Chairman reported an improvement on the previous year, but owing to continued slackness in their special business the output had been considerably below the capacity of the works and plant. In spite of these circumstances, the net profit was £1,800 more than last year. After charging debenture interest, depreciation, and all charges, there was a net profit of £8,896, with which, with the amount brought forward, the directors felt justified in declaring a dividend on the Ordinary shares of 2½% for the year. Their financial position

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was very strong. Their total liabilities to creditors at June 30 was only £15,364, whereas their bank balance was £59,000, and debtors, all perfectly good, nearly £48,000. The reserve for depreciation amounting to £34,500 had been increased since last year by £4,500. The directors believed this a very ample reserve. The buildings were in an excellent state of repair, the machinery was as good as new, and there was nothing of an obsolete character. He regretted he could not see any immediate prospect of improvement in their line of business, but when the improvement did take place they were in a most satisfactory position to meet it. Replying to a shareholder, the Chairman said with regard to the Hadley and Trafford Park Works, they had tried to dispose of them, but trade had been so bad they had had no offer equal to their expectation. They hoped as soon as trade improved to dispose of them.

YORKSHIRE ELECTRIC POWER CO.

The directors of the Yorkshire Electric Power Co., in their report, state that the receipts from the sale of energy and for work charged out to consumers, etc., for the half-year to June 30, amount to £11,169, against for the half-year to June 30, 1908, £8,698, and for the half-year to June 30, 1907, £4,700. The gross profit on the revenue account for the half-year is £2,598, against a gross profit for the half-year to June 30, 1908, of £1,249, and a gross loss for the half-year to June 30, 1907, of £403. After payment of mortgage interest, the net revenue account shows a profit on the half-year just ended of £1,069, compared with a profit for the corresponding half-year in 1908 of £363, and a loss for the half-year to June 30, 1907, of £1,211. The demand for energy per h.p. connected has been low, owing to the depressed state of nearly all the industries in the company's area; notwithstanding the adverse conditions of trade, there has been a steady increase in the use of the company's supply.

HALIFAX AND BERMUDAS CABLE CO.

The report of the Halifax and Bermudas Cable Co., Ltd., for the year ended June 30 last, as submitted to the meeting, showed that the net result of the year's working is an available balance of £3,312, as compared with £3,095 for the previous year. An interim dividend of 2½%, free of income-tax, has already been paid, and it is now proposed to make a further equal payment, free of income-tax, which will leave £812 to be carried forward. Opportunity was taken of a cable ship being in the vicinity of Bermuda to engage her to thoroughly overhaul and renew where necessary the harbour cable and the shore end of the main section, at the cost of £817. The balance to credit of revenue account, which was last year increased to £18,443, has been debited with £1,250 applied to dividend and with £817 expended in renewals during the year, and credited with £812 surplus revenue for the past year, and it now stands at £17,189. During the year Debentures have been paid off to the amount of £9,600, leaving £10,000 outstanding.

DIRECT WEST INDIA CABLE.

The report of the Direct West India Cable Co., Ltd., for the year ended June 30 last, as submitted to the meeting, stated that the net result of the year's working is an available balance of £5,189, as compared with £6,149 for the previous year. An interim dividend of 3 %, free of income-tax, has already been paid, and it is now proposed to make a further equal payment, free of income-tax, which will leave £3,389 to be carried forward. The hurricane of September last year did very serious damage to the company's cable property, and the necessary repairs and renewals, together with work at Bermuda, involved an outlay of £3,820. The balance to credit of revenue account, which was last year increased to £34,396, has been debited with £900 applied to dividend, and with £3,820 expended in renewals and repairs during the year, and credited with £3,389 surplus revenue of the past year, and it now stands at £33,065. A licence to establish, instal and work a wireless coast station was granted to the company by the Jamaica Governemnt on February 16 last, and the cost to date has been taken to capital expenditure. During the year Debentures have been paid off to the amount of £7,400, leaving £43,500 outstanding.

FOLKESTONE ELECTRICITY SUPPLY.

The Directors of the Folkestone Electricity Supply Co., Ltd., have declared an interim dividend of 4% per annum (2s. per share) less income-tax, on the Ordinary shares for the past half-year, payable September 30.

RIO DE JANEIRO TRAMWAY LIGHT AND POWER.

The Board of the Rio de Janeiro Tramway Light and Power Co. has declared a dividend of 1% on the issued share capital, payable November 1 next to all shareholders of record on October 15.

UNDERGROUND ELECTRIC RAILWAYS OF LONDON.

At the half-yearly meeting of the Underground Electric Railways Co. of London, Ltd., held at Hamilton House, Victoria Embankment, E.C., Sir Edgar Speyer, Bart., Chairman of the Company, presided. The Chairman, in moving the adoption of the report and accounts for the half-year ended June 30 last, said he was glad again to be in a position to record material progress and to express unqualified satisfaction at the results submitted to the proprietors. With regard to the balance-sheet, the temporary loan on the debit side of £225,000 would be paid off on October 1 next on the redemption of the outstanding Four-and-a-Half per cent. Power House Debentures and Power House Second Debentures by an issue and sale of £1,000,000 Four per cent. Power House First Debentures. The company would then be free of all floating debt and would have a good cash balance in their treasury. As pointed out in the report, the net revenue for the half-year was insufficient by £16,240 4s. 10d. to meet the half-yearly charges. It would be remembered that the estimates published with the scheme assumed that for the year 1909—the entire year—there would be a deficit of £96,000, so that the result up to date was distinctly encouraging. This deficit, as compared with the first revenue account—if one figure were compared with the other—showed an increase, but, as had been explained in the report, that first revenue account included more than one half-yearly dividend on the company's holding of shares in the Tube companies, and a large part of the fixed charges was charged to capital under the scheme of readjustment. It was not necessary for him to go into the various other items as they had been fully explained in the report, and the tables given spoke for themselves. They showed a healthy increase in all the Tube railways, as well as in the District Railway, and a reduced working cost. In this connection he desired again to express his great appreciation to their general manager, Mr. Stanley, for his very efficient management and for the favourable results which he had achieved. The results of the tramways had again been satisfactory, but inasmuch as that company made up its accounts annually he would reserve any remarks on that subject until the next meeting.

COMPANIES REGISTERED.

National Electric Signs Co., Ltd.—Registered in Edinburgh September 8 by Oswald & Son, Edinburgh. Capital, £2,000, in £1 shares. Objects: To acquire the rights to erect and use in Great Britain the German invention, "Universal Licht-Reklame, and to carry on, in the United Kingdom or elsewhere, the business of general advertisers and contractors. The first directors (to number not less than three nor more than five) are: F. Land, J. Barr, and D. Graham. Registered office: 112, Bath-street, Glasgow.

CONTRACTS OPEN.

HOME.

Glasgow.—At the new Mitchell Library.—For supplying and fitting up the following lifts: (1) One electric passenger lift, (2) three electric book lifts, and (3) three handbook lifts, for the Corporation. Specifications and forms of tender obtainable at the office of Mr. W. B. Whitie, 219, St. Vincent-street. Sealed and endorsed tenders must be sent to Mr. A. W. Myles, Town Clerk, City-chambers, Glasgow, by October 4.

OVERSEAS.

Brazil.—At the Municipal Works Offices, Corumba.—To execute and construct a central electric station. October 5.

Jastrow.—Municipality.—Locomobile for electric service.

SOME CONTRACTS.

Chatham.—The Paterson Engineering Co., Ltd., London, has received from the Admiralty a repeat order for oil eliminating plant, with quartz sand filter, for H.M. Dockyard at Chatham, together with steel-carrying structure and pipe work. The total capacity of the Paterson purifying plant at this station will now be 10,000 gallons per hour.

Tewkesbury.—The Premier Accumulator Co., Northampton, has recently completed the battery for the Tewkesbury Electricity Works, and is now executing the order for a lighting battery for the Chippenham Electricity Works, and also a lighting battery for the North-Eastern Railway.

Winnipeg.—We note that the city of Winnipeg have awarded the contracts for electrical apparatus in connection with the power plant at Point du Bois, which shows a saving to the city of approximately $157,000 lower than the best tenders recommended in October, 1907. The total of the figures of contracts awarded is approximately $425,000, and the successful tenderers are as follows:—Turbines: Jens, Orten, Boving & Co., London, Eng., $97,150; includes $11,000 for erection. Generators and Exciters: Vickers, Sons & Maxim, Ltd., Sheffield, Eng., $93,080; this price includes erection. Transformers, Switching and Protective Apparatus: Canadian Westinghouse Co., Ltd., Hamilton, Ont., $150,800; including spare parts. Light, Heat and Power System, Generating Station: Canadian General Electric Co., Toronto, Ont., $11,600. Travelling Cranes: Canadian Fairbanks Co., Ltd., Winnipeg, Man. (Niles-Bement-Pond Co.), $14,900;

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including estimated cost of erection. Auxiliary Apparatus—Canadian Apparatus: Canada Foundry Co., Ltd., Toronto, $27,520; Canadian Fairbanks Co., Ltd., Winnipeg, Man., $6,901; allowance for contingencies and spare parts, say, $23,049.

BUSINESS NOTES.

LIGHTING AND GENERAL—Home.

AMBLE.—A poll has been taken on the lighting question. In favour of the electric scheme were 251 papers, and against 129, showing a majority in favour of 122. The Council have decided to obtain the report of an expert on electric lighting.

BARROW.—The Council has decided to spend £108 10s. on the laying of new mains in connection with the electricity undertaking.

BATH.—The Local Government Board has decided to comply with the application by the Council so far as it relates to the borrowing of £1,773 in respect of the expenditure on the electricity undertaking up to March 31 last; £775 for new works at the generating station; £4,000 on mains from April 1 last; £1,500 on services from April 1 last; £500 on transformers from April 1 last; and £140 to defray expenditure already incurred on meters since April 1 last. The Board declined sanction in respect of the borrowing of £450 2s. 1d. in respect of certain items, and deferred their decision on part of the application as regards £350 required for water softening plant, it being understood that before installing the latter plant the Council would try the effect of graphite paint in the boilers.

BEXHILL.—The Local Government Board has complied with the Council's application for loan of £2,120 in respect of condensing plant, cooling tower, for the electricity undertaking, etc., so far as it related to the borrowing of £1,990, to be repaid within 21 years. The Council has decided to apply for sanction to a loan of £197 for small extensions carried out since the last public lighting application.

BRADFORD.—To the City Council it was reported that the total income on the electricity account was £110,242, and the working expenses £52,131, making a trade profit of £58,111. Interest and sinking fund charges amounted to £55,964, leaving a net profit of £2,147. The unappropriated profit at the beginning of the year was £3,223, to which had been added the net profit of £2,147, making £5,370. Against this there had been charged £1,200, which had been allowed for rebate to tramways for electricity supplied for traction purposes. With regard to the tramways, the income from traffic revenue was £231,475, and from other sources £12,760, making a total income of £244,235. The working and management expenses were £170,196 making a trade profit, exclusive of allowances for renewal of permanent way, of £74,039. The balance to credit of renewals fund at the beginning of the year was £52,229, and at the end of the year £44,461. Out of this sum the Council had voted £20,000 towards relief of the rates during the current year, leaving a balance to credit of £24.461. Mr. J. Lund attributed the deficit of £5,000 on the gas department to bad trade and the competition of electricity.

BRIGHTON.—The Town Council have urged upon the Shoreham Harbour Trustees the need of immediate attention being given to the lock gates, so as to avoid possible danger to the Corporation's electricity undertaking.

BUCKFASTLEIGH.—At the Urban Council meeting the Clerk stated that he was informed that the Electric Light Co. had sold the undertaking. It was decided to ascertain if the owner will enter into a new lease with the Council for public lighting on a seven years' term.

BURY.—The Electricity Supply Committee was asked to undertake the wiring, etc., of the Town Hall and offices. An amendment in favour of giving outside electricians an opportunity to tender for the work was negatived by the Council.

DARLINGTON.—At a meeting of the Darlington Tram and Light Railways Committee the report with respect to the electric lighting undertaking showed further progress. During August there were generated for lighting and power purposes 77,939 units, an increase of 5,997 upon the corresponding period last year, and equivalent to 8·4 %. The revenue from the trams for the four weeks ending August 28 was £770 2s. 1d., compared with £817 18s. 5d. for the corresponding period last year, a decrease of £46 15s. 8d. The number of passengers carried was 239,833, compared with 209,150, and the revenue per car mile 6·42d. against 6·83d.

DUNDEE.—The damage caused by the recent fire in the electricity station has been assessed at £1,588 16s. 11d., exclusive of the damage done to 23 transformers belonging to the British Thomson-Houston Co. The Electricity Committee have agreed to sell four old boilers and two generating sets, which were scorched in the fire. The purchasers are Messrs. William Kerr & Co., Glasgow, whose offer of £550 was the highest received by the Committee.—At a meeting of the Electricity Committee of the Town Council a claim was intimated from Messrs. J. & A. D. Grimond, Ltd., Dundee, against the Corporation. The amount of damages claimed is approximately £2,200, and the ground of the claim is that the Corporation failed to implement a contract they entered into to supply the firm with electric power, and that the firm thus incurred damage by loss of production and disorganisation of plant. The Committee unanimously agreed to repudiate liability.

FRINTON.—The Electrical Co., Ltd., has now finished the extensions to the Electric Light and Power Co.'s generating plant. The newly-installed generating set consists of a 150 kw. dynamo direct coupled to a vertical four-cylinder Hindley gas engine, and running at a speed of 450 r.p.m. The engine is fitted with forced lubrication, both low tension magneto and high tension accumulator ignition, and a gear pump for circulating the cooling water through the cylinder jackets and over a cooling tower.

GOSPORT.—The Gosport and Alverstone Urban Council have approved of an agreement with the National Telephone Co. for laying underground cables in Elmhurst-road.

HORSHAM.—The accounts of the Urban Council's electric lighting undertaking for the year ended March 31 last show that the total revenue amounted to £4,019 0s. 7d., and the aggregate costs to £1,977 15s. 10d. The balance carried to net revenue account is £2,041 4s. 9d., of which £2,031 3s. is absorbed by interest and capital charges. The quantity of electricity supplied to private customers by meter appears at 130,823 units, at charges varying from 1½d. to 7d. per unit, while the supply for public lighting totalled 77,790 units at 4d. per unit.

HOVE.—The directors of the Electric Lighting Co., Ltd., have declared an interim dividend on the ordinary shares of the company, at the rate of 8% per annum for the half-year ended June 30 last, payable on October 15 next.

LOCHEE.—A sub-committee has been appointed by the Dundee Electricity Committee to consider a proposal with a view to the improving of the electric lighting of Lochee. At present there is a generating plant at Lochee Baths which provides the current for the illuminating of the streets, and it is proposed that this should in future be done from the city mains.

LOWESTOFT.—The Electrical Engineer reported to the Town Council that there were connected to the mains 1,151 customers, representing 53,061 8-c.p. lamps. In consequence of the pressure of supply at the station, it was decided to provide another feeder at an estimated cost of £875.

ROSYTH.—Messrs. Easton, Gibb & Son, the Rosyth contractors' have decided to erect a private central power station for the distribution of electric light and power throughout the entire works at the Naval Base, and the National Gas Engine Co., Ltd., have been given the order for the installation of four gas engines and suction gas plants, with a maximum output of 1,100 brake h.p. The engines are to run day and night continuously, supplying electric current at 500 to 550 volts to the various motors spread over this large area, the work to be done including quarrying, stone crushing, concrete mixing, the driving of machine shop and sawmills, and pumping. The suction gas plants are to use gas coke for fuel, costing about 10s. per ton, obtainable from the Edinburgh Gas Works, and it is estimated that electricity will be obtained at a total cost of 3s. 8d. per b.o.t. unit, including all standing and working charges.

SHEFFIELD.—The District Council have received a letter from the Local Government Board sanctioning the borrowing by the Council of £3,986 for electric light purposes. The Council had applied for £4,700, and the amount sanctioned was made up of the following amounts: £441 excess of expenditure, £1,645 extension of generating station, £300 for public lighting, £1,300 expenditure on mains, and £300 on services. The Clerk was directed to write to the Board for an explanation of the £271 1s. 2d. for costs of the Provisional Order, referred to in the letter as deducted.

SHOREDITCH.—For the year ended March 31 last the Borough Electricity Department made a gross profit of £21,335 4s. 8d., as against £19,547 17s. 6d. shown by the previous year's accounts, and this improvement has been obtained in spite of a reduction in the total income of £644 3s. 2d. The smaller income is attributed chiefly to the reduction in the number of lighting units sold, through the increased use of metallic filament lamps by consumers in the borough. After meeting interest on loan capital £10,973 12s. 6d., and repaying capital to the extent of £5,951 19s. 4d., also paying bank interest, etc., the net profit on the year's working is £4,117 15s. 2d., which is used to wipe off the deficiency brought forward last year and the annual contribution to change of pressure account, leaving a small deficiency of £328 8s. The costs of working have been reduced under every head during the year. At the refuse destructor the total tonnage dealt with during the year was 41,369 tons, against 35,531 tons during the previous year, an increase of 5,838 tons. The borough refuse amounted to 28,905 tons, as compared with 29,434 in 1907-8, the cost being £5,896 4s. 8d., including loan charges, as against £6,331 3s. 3d.

SOUTH SHIELDS.—The result of last year's working of the electricity undertaking must be considered as very satisfactory considering trade depression and the effect of the advent of the

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metallic filament lamp. In the 12th annual report of the Electrical Engineer (Mr. J. H. Cathra) the capital expenditure at the year end appears at £182,268 5s. 5d., being an increase of £4,830 9s. 7d. The revenue for the year ended March 31 last was £25,559 6s. 6d., as compared with £25,607 19s. 5d. of the previous year, a decrease of £48 12s. 11d. The total costs chargeable against revenue for the year were £13,003 12s. 4d., against £13,537 14s. 10d., a decrease of £534 2s. 6d. compared with the previous 12 months. The gross profits were £12,555 14s. 2d., against £12,070 4s. 7d., an increase of £485 9s. 7d. The amount required this year for interest and sinking fund was £11,371 11s., compared with £10,711 9s. 2d. The surplus, after meeting all charges, was £1,184 3s. 2d., which, together with the net profit of £25 from the quay, made a total of £1,209 3s. 2d., as against £1,402 12s. 1d. The total number of units sold was 3,127,039, being 172,049 more than the previous year, which was equivalent to 5%. The number of premises connected to the mains was 1,366, compared with 1,313 12 months ago.

Mr. F. H. Tulloch, M.Inst.C.E., conducted a Local Government Board inquiry at the Town Hall, South Shields, into an application by the Corporation to borrow the sum of £3,735 for the purposes of the Corporation electricity undertaking. It was explained that £2,600 of the amount was intended to be used for the duplication of power mains, in order to prevent any stoppage in the supply of current to docks, shipyards, and other industries, and £135 was to provide two 1,000 ampere traction feeder panels to the existing board. Of the amount asked for £1,000 was required to connect up new consumers.

The Finance Committee have decided to recommend the Council to reduce the salary of the Electrical Engineer from £650 to £500. Other reductions are also suggested.

ST. PANCRAS.—The question as to the disposal of £7,126 17s. 2d. standing to the credit of the Borough Council Electricity net revenue account on March 31 last has been considered by the Finance Committee. Having regard to the increased demands which are again made in respect of the ensuing half-year by the central authorities, and to the heavy extra expenditure for repaving work which the Borough has been put to in connection with the reconstruction of tramways, they came to the conclusion that the whole of the sum available from the electricity profits should be allotted to the relief of rates. The revenue from the Electricity undertaking for the half-year ending March 31 next is estimated at £46,100, and the expenditure £37,714, as compared with £48,170 and £36,700 for the corresponding period of the previous year. The cost of public lighting is placed at £13,327 (against £14,320), of which £7,800 is for electric current and £1,982 for carbons, trimmings and repairs to arc lamps.

SWINDON.—During the quarter ended August 15 last the supply for lighting and power purposes amounted to 86,134 units, as compared with 87,913 for the corresponding period of last year. The figures in respect of traction were 72,976 against 78,756 units. The number of customers connected to date appears at 771 against 693.

WEST HAM.—The annual accounts of the Electricity Department show a credit balance of £3,854 on the year's working. The Consulting Electrical Engineer (Mr. A. H. Seabrook) reports that the improvement as compared with last year is £8,522, mainly due to the increased power business of four million to eight million units, and to the fact that the sales department has had a complete year under proper organization, with successful results. The reorganization of the generating station has been completed, and the best illustration of its improved efficiency is the fact that five and a half million units more have been generated than for the previous year, at an additional cost of only £700. Another important factor in the difference in the year's results has been that of capital charges. For the two previous years they have been laying the foundation of a big power business, involving heavy capital expenditure in generating plant and extensions to mains. The total expenditure amounted to £39,123, as compared with £39,326 for the previous year, and at the same time over four million units more have been sold.

LIGHTING AND GENERAL—Overseas.

BRITISH COLUMBIA.—Approval has been given to the by-law ratifying the agreement with the British Columbia Electric Railway Co., under which the city of Victoria agrees not to enter the power business without first offering to buy the company's plant, has been carried. The company in return agrees to spend $1,500,000 in installing a power plant at Cordar River.

BUENOS AYRES.—A measure has been passed by the Chamber sanctioning the construction of an underground electric railway from east to west across the city.

COREA.—The authorities have decided to construct new telephone lines in Corea to the length of 500 miles, at a cost of 70,000 yen (about £7,150).

JOHANNESBURG.—The annual accounts of the Electricity Supply Department show a surplus of £52,000. The cost of generation has been decreased from 1·07d. to ·677d. per unit. Extra plant is to be installed to meet the increasing demand for current. The working of the tramways resulted in a profit of £44,100. It is proposed to spend £67,000 on power station improvements and £60,000 on extensions to the tramway route.

PARIS.—The Compagnie Générale Electrique have received sanction to experiment on the canal from the Marne to the Rhine with a new system of vessel propulsion on a principle similar to that of the funicular railways.

TORONTO (Ontario).—Good progress is being recorded in connection with the establishment of the city's new electrical distribution plant for which Golden & Lansing, of Troy, N.J., secured the contract. The laying of conduits is to cost $65,800. Rapid progress is being made by the McGuigan Construction Co. with the work of erecting the steel towers for the high pressure power transmission line between Glánford and Ancaster townships, where a line of steel towers five miles long greets the eye. So far 85 towers have been put in place and the work is proceeding at the rate of eight towers per day. The completed system will involve the longest transmission line in the world. With branches it will be 297 miles in length, and will carry a current of 110,000 volts.

TRACTION—Home.

CARDIFF.—The traffic receipts for the city electric tramways for the year ended March 31 last amounted to £110,489 10s. 5d., as against £109,979 10s. 7d. for the previous year, an increase of £509 19s. 10d. The revenue derived from advertising on cars during the year was £1,094 15s. 10d. The energy supplied to the electric lighting account represents a revenue of £12,120 7s. 1d. as against £11,951 10s. 11d. for the previous year, an increase of £168 16s. 2d., the total income being £123,851 1s. 10d., or £349 6s. in excess of the year ended March 31, 1908. The net revenue surplus for the past year appears at £5,954 11s. 11d., a decrease of £2,853 1s. 1d. as compared with the previous year.

TAUNTON.—The Rowbarton extension of the trams has been opened.

TRACTION—Overseas.

ITALY.—The terms have been published of a contract granting to the Società Elettrica Comense "A Volta" a concession for the construction and working of an electric tramway from Camerlata to Appiano and Mozzate. The concession is for sixty years, and will carry with it, for a period of fifty years from the date of the opening of the line, a state subsidy of 1,400 lire (£56) per kilometre yearly.

MONTEVIDEO.—The Commercial Tramway Co. of Montevideo intends increasing the output of its power house by the addition of a new unit of 1,500 kw.

SPAIN.—The Compañía del Tranvía Urbano, Bilbao, have been authorised to convert their present horse tramways into electric tramways, and to widen the gauge of certain lines. The Compañia Vizcaina de Electricidad have applied to the Dirección General de Obras Públicas, Madrid, for a concession for the construction and working of an electric tramway from a point called Avanzada to Algorta.

SWITZERLAND.—A decree has been issued granting to the Compagnie du Chemin de Fer du Birsigtal, of Bâle, a concession for the construction and working of a metre gauge, single track, electric railway from Bâle to Rodersdorf *viâ* Flühen. The line must be completed within 12 months from the date of the commencement of the work.

VENEZUELA.—The *Gaceta Oficial* of August 10 publishes a resolution authorising the Compañía Anónima Tranvías Eléctricos de Caracas to extend their tramway system from Palo Grande to the Nuevo Matadero.

PERSONAL.

Mr. E. J. Cochrane, of Ballarat, has been appointed by the Sydney City Council, Chief Assistant Electrical Engineer.

The Council of the Institute of Marine Engineers have decided to award Mr. Wm. P. Durtnall, M.I.Mar.E., M.I.Auto.E., the Denny Gold Medal, for his paper on "The Generation and Electrical Transmission of Power for Main Marine Propulsion and Speed Regulation," read at the Franco-British Exhibition on July 18, 1908, which was considered to be the best of the papers submitted in competition for the medal during the session 1908-1909.

Mr. B. G. Nicholl, electrical engineer, formerly with Messrs. Siemens Bros.' Dynamo Works, is in charge of J. W. Glover's gold recovery plant at Christmastown, in the Chiltern district, Vic.

Mr. E. G. Fleming, representative of Messrs. Siemens Bros. in Australasia, has been transferred to India. Mr. W. M. Arnot, formerly engineer for the Allegemeine Electric Co. in Melbourne, has been appointed to succeed Mr. Fleming. Mr. Arnot is a brother of Mr. A. J. Arnot, Australasian manager for Messrs. Babcock & Wilcox.

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We hear that Mr. William Buchanan, B.Sc., Assoc.R.C.S., Whitworth Scholar, M.I.E.E., has been appointed lecturer on electro-technics and the design of electrical machinery to Faraday House, London. Mr. Buchanan had a most distinguished career at the Royal College of Science, London, and afterwards at Glasgow University, where he was "Thomson Experimental Scholar" in Lord Kelvin's laboratory. He has been for 15 years with the Electric Construction Co., Wolverhampton, first as designer of alternating current machines, and subsequently as chief engineer.

Mr. W. Western, Chairman of the River Plate Electricity Co. and Rosario Electric Co., is at present in that country visiting the various interests he represents.

During the absence of Mr. J. Hampden Wall, General Manager of the Port and City of Buenos Aires Tramway Co., the management will be in the hands of the local Director, Mr. F. H. Chevallier Boutell.

Mr. C. E. Smith, of the Rosario Electric Co., has left for a short holiday in England.

The Council of the Association of Engineers-in-Charge have unanimously elected Mr. Henry Adams, M.Inst.C.E., M.I.Mech.E., etc., as their President, in succession to Mr. James Swinburne. F.R.S., M.Inst.C.E. An attractive programme has been drawn up for the new Session, including some good papers and several social functions. Among the members of the Association Mr. Adams is one of the oldest of the Engineers-in-Charge, having so far back as 1865 been in responsible charge in the outdoor department of Sir W. G. Armstrong & Co., of Elswick Works.

BOOK REVIEWS.

"Continuous Current Dynamos and Motors and their Control." By W. R. Kelsey, B.Sc., A.M.I.E.E. 2nd edition. London: Technical Publishing Co., Ltd. Price, 7s. 6d. net.

This second edition is practically a new book, for although it retains its old form and certain sections, for the rest it has been almost entirely re-written. It is thus quite up to date. Although largely intended for students, the book appeals to a wider circle, for apart from the descriptions, which are very well done, the author is often suggestive. The last chapter, dealing mainly with testing, is admirable, containing many hints likely to be of use even to trained men. The numerous illustrations and diagrams are excellent.

"The Apprentices' Course of Experimental Physics and Mechanics." By J. L. Maxim, B.Sc. (Vict.), and G. S. (Lond.) London: Longmans, Green & Co. Price, 1s. 6d.

Mr. Maxim, owing to his experience in the educational world, is well equipped to compile a little book of this kind, which is a useful guide designed to meet the needs of students and teachers interested in the examinations connected with technical institutes, secondary schools, and the Board of Education. The author first gives some practical instructions to students. Next section 1 comprises ten lessons on the measurement of length, area and volume. Section 2, ten lessons on the measurement of density and relative density. Section 3, eleven lessons on the measurement of forces and of gaseous pressures. Section 4, seven lessons on the methods of measuring temperature and heat. Each section is followed by a test paper examination. The appendix contains tables of useful numbers and formulæ, which is a valuable feature of the book. The text is illustrated by a number of diagrams. It should be understood that this is more a cramming book than one for imparting knowledge, or teaching how to gain knowledge. But for those whose immediate concern is the wriggling through barriers erected by examiners, the book will serve its purpose well.

"Proceedings of the Incorporated Municipal Electrical Association, 1909." (London: Wyman & Sons, Ltd., Fetter Lane, E.C., and Reading.) Price 5s. The volume contains a full report of the Presidential Address by Mr. S. L. Pearce (Chief Electrical Engineer, Manchester) at the 14th annual convention at Manchester, together with the papers on "Cheap Units," by Councillor A. Sinclair (Swansea); "The Influence of Metallic Filament-Lamps on the Electrical Industry and on Street Lighting," by Mr. E. E. Hoadley (Chief Electrical Engineer, Maidstone); "Modern Cable Systems," by Mr. E. M. Hollingsworth (Chief Electrical Engineer, St. Helen's, Lancs.); "Steam Turbines from the user's point of view," by Mr. A. S. Blackman (Chief Electrical Engineer, Sunderland); and "Notes on Condensing and Water-cooling Plants" (Travelling Studentship Prize paper, 1909), by Mr. E. Lunn (Assistant Electrical Engineer, Huddersfield). Summarised reports are given, and the discussions, in addition to details of the annual meeting, the Council's report and balance-sheet, Mr. E. Lunn's Travelling Studentship Report, a list of members, etc.

NEW CATALOGUES.

Messrs. Bruce Peebles & Co., Ltd., have brought out a pamphlet dealing with their continuous current, self-contained dynamos and motors, which are manufactured in all standard sizes and types conforming to the Home Office and fire insurance rules. The pamphlet gives very fully the approximate dimensions of all the machines listed, as well as complete details of technical data for protected, semi-enclosed, and totally-enclosed machines.

The Electric and Ordnance Accessories Co., Ltd. (V. S. & M., Ltd.), have sent us a catalogue of the new "Timken" Patent Roller Bearing, of which they have the sole manufacturing and selling rights for the United Kingdom, and all Europe, and throughout the British Colonies and Possessions (except Canada). The firm advise us that they are immediately starting to make these bearings in their extensive Works at Aston, Birmingham.

We have received from Messrs. Smithson, Sharpe & Co., Hulme, Manchester, a new illustrated list of Manchester Arc Lamps and Accessories. Quotations are given for vertical differential arc lamps, inverted differential arc lamps, alternating arc lamp transformers, choking coils for alternating arc lamps, vertical single-enclosure arc lamps, twin carbon arc lamps, etc.

EDUCATIONAL.

CITY AND GUILDS OF LONDON INSTITUTE.

Mr. T. Mather, F.R.S., has been appointed by the Executive Committee of the City and Guilds of London Institute Professor of Electrical Engineering at the City and Guilds Central Technical College in succession to Professor Ayrton. Professor Mather was Professor Ayrton's chief assistant for many years, and was appointed Acting Professor during last session.

GLASGOW UNIVERSITY.

At the University of Glasgow the session commences on October 11 and extends to March 17 next. Courses are given in electrical engineering, the lecturer on this subject being Mr. John S. Nicholson, B.Sc., Whit.Sch., A.M.I.E.E.

HANLEY.

In connection with the evening classes at the Hanley Municipal Secondary School, Mr. C. H. Yeaman (Borough Electrical Engineer) is giving a course of lectures on "Electrical Engineering" on Fridays, commencing this evening. The course is intended to prepare for the examination in the elementary grade, and opportunity will be given to the students for laboratory work in connection with the various subjects.

KING'S COLLEGE, LONDON.

The course for Electrical Engineering at King's College, London (University of London), for the session 1909–10 opens on October 6. Evening classes will also be held for mechanical and electrical engineering.

LEEDS UNIVERSITY.

The next session at the University of Leeds begins on October 5, and the entrance examination is arranged for the same day. There is a department for electrical engineering, and the building is specially equipped for systematic instruction.

NEWCASTLE-UPON-TYNE.

Armstrong College, Newcastle-upon-Tyne, Calendar, 1909–10. Published by Andrew Reid & Co., Ltd., London and Newcastle, at 1s. The volume contains exhaustive particulars of the syllabus, as well as lists of the Governors and Council, the Board and Professors, Professors and Lecturers, the College Regulations, Scholarships, prizes, etc. The course for the degree of B.Sc. in Electrical Engineering extends over three years. There will be two courses of lectures throughout the session, one suitable for second year students who have attended the Junior Physics Course; the other more advanced and required for the third year of the Degree Course in Electrical Engineering. At the evening classes there will be an advanced course in Electricity and Magnetism, also for wireless telegraphy and electrical engineering (senior and junior sections). The Armstrong Electrical Laboratory is fitted up to enable students to go through full courses in electrical measurements, etc. The antenna supported from the College Towers is connected to a room in the Physical Department in which apparatus is provided for the sending and receiving of messages by radiotelegraphy.

CHANGE OF ADDRESS.

We are requested to notify that the Electrical League has changed its address to Bank Buildings, Kingsway, London, W.C. Mr. R. Borlase Matthews is hon. sec. to the Provisional Committee.

The Railway Passengers Assurance Co., originally established in Old Broad-street in 1849, but which has been housed at 64, Cornhill, for the past half-century, has determined to rebuild its premises, which will in future comprise 61, 62, 63 and 64, Cornhill, 124 and 126, Bishopsgate-street, and 1, White Lion-court. During the rebuilding the Company's address will be 81, Cornhill, E.C.

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PATENTS.

Wireless Electric Signalling Devices for Indicating the Relative Positions of Ships.

2845.—1909. A. Degener-Böning, Hanover. This invention relates to devices for indicating the positions of ships approaching each other. Fig. 1 is an elevation, Fig. 2 a plan, and Fig. 3 shows two ships approaching each other and equipped with the signalling device. A number of receiving aerials *b* with bent ends as shown on the drawing is arranged in a cricle on a plate *a*, in the centre of which is a transmitting aerial which has also a bent end and is continually revolved by a clockwork mechanism. The aerials are con-

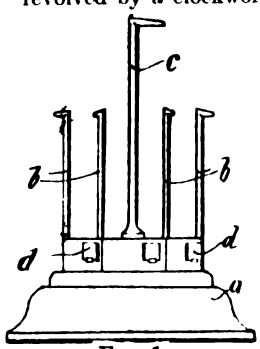

Fig. 1.

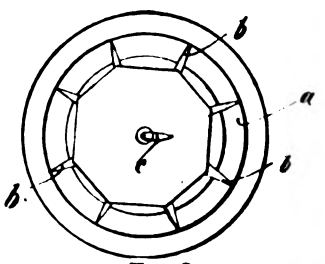

Fig. 2.

structed as directive, so that they are only capable of receiving waves arriving from a certain direction. Each aerial *b* is connected with a signalling device *d*, which indicates if a current passes through the aerial. This, for instance, may be in the form of a flap which falls down when the circuit is closed. If two ships provided with the device described above approach each other electric waves are sent from the

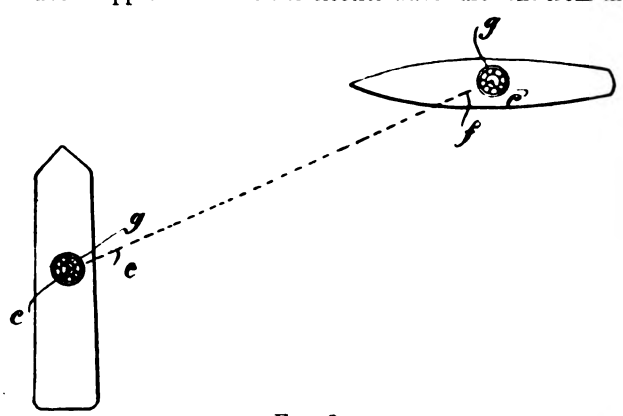

Fig. 3.

transmitter *c* of one ship to the receiver of the other ship; for instance, in the direction of a line from *e* to *f*, which connects two serials *gg*. If the point of the transmitter of one ship adjusts itself in this direction, the aerial of the other ship pointing in the same direction will receive the current and actuate its signalling device, thus indicating in which direction one ship lies relatively to the other.

Electric Ignition for Internal Combustion Engines.

26894.—1908. A. W. Bird, Birmingham. This includes improved means to adjust the time of the ignition to suit the speed of the engine and to enable multi-cylinder engines to be automatically started. Figs. 1 and 2 are sectional side and end

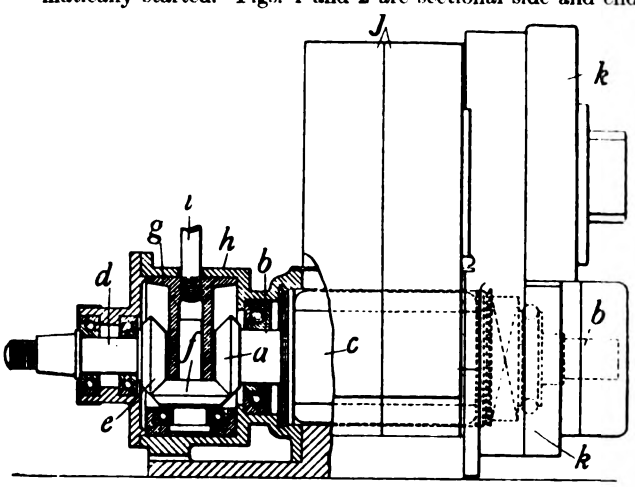

FIG. 1.

elevations illustrating the application of this invention to a magneto ignition device. A driven sun pinion *a* is secured to one end of the spindle *b* of the armature *c*, and on the adjacent end of a coaxial driving spindle *d* is secured a driving sun pinion *e*, both pinions being of the bevel type. Gearing with the same pinion is a planet pinion *f*, whose axis is at right angles to the axis of the sun pinions. The planet pinion carrier *g* comprises a cylindrical drum mounted in a cylindrical part *h* between the bearings of the sun pinion spindles. To a projecting extremity of the planet pinion spindle or to any convenient portion of the drum, means such as a lever *i* is connected to impart an angular movement to the planet pinion with respect to the axis of the mecanhism, these means being adapted for operation through linkage or a flexible cable either from the dashboard of the vehicle or the ordinary steering wheel. Normally, the planet pinion serves only as an idle pinion to transmit motion from the driving to the driven sun pinion. But to advance or retard the spark an appropriate angular movement is given to the planet pin carrier, and the instant at which the sparking is produced in the engine cylinder is correspondingly altered. With this arrangement no adjustment of the ordinary contact breaker is required, and the sparking is

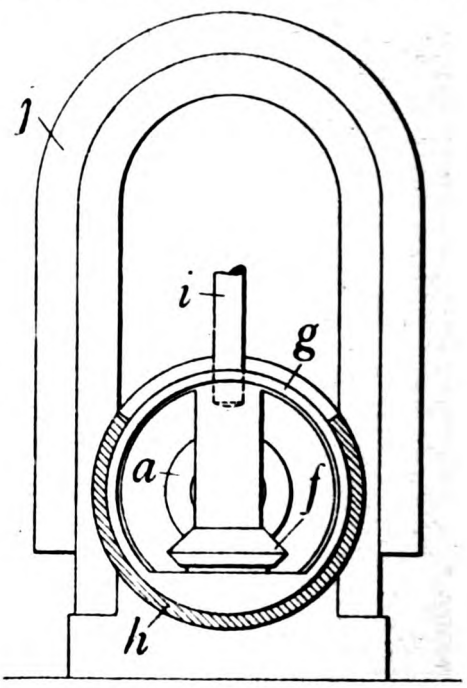

FIG. 2.

always produced when the armature is in the position to generate maximum current. From the foregoing it will be seen that by actuating the planet pinion carrier motion can be given to the armature when the driving pinion is stationary. Consequently, to start a multi-cylinder engine having one of its cylinders charged it is simply necessary to actuate the pinion carrier. In order that a rapid movement of the armature may be obtained, the movement in one direction may be effected by the ordinary adjusting mechanism above referred to, and the reverse movement effected instantaneously by means of a spring, suitable provision being made for the temporary disconnection of the carrier from its ordinary actuating mechanism. It is found, however, that a rapid to and fro movement of the lever through the medium of the ordinary actuating mechanism is sufficient to produce a spark, and the provision for spring actuation of the armature can usually be dispensed with.

Electroliers.

19183.—1908. R. S. Woods, Chorlton-on-Medlock, Manchester. Electroliers hanging from a ceiling in a dining-room are provided with shades over the bracket arms to which the electric lamps are attached, so that the light is directed principally on to the table. In drawing-rooms where the light is required to illuminate the whole of the room, these shades are not required. It has been necessary to have two forms of electroliers, one for the dining-room and one of different construction for the drawing-room; this invention enables an electrolier to be applicable for either a dining-room or a drawing-room, so that the light may either be directed principally to the part of the room directly under the electrolier, or may be diffused over the whole area of the room. Fig. 1 is a side view and Fig. 2 a plan of an electrolier; in these views the brackets are shown inside the ring of the electrolier; Figs. 3 and 4 are side and front views of the bracket to which the globes are attached shown in the same position, but drawn to an enlarged scale; Fig. 5 is a side view of part of an electrolier as in Fig. 1, showing the brackets to which the globes are attached projecting on the

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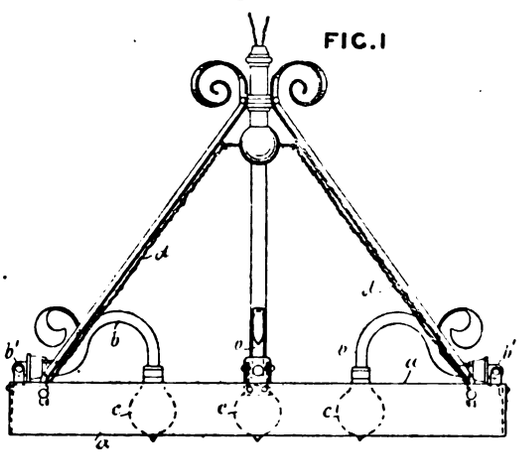
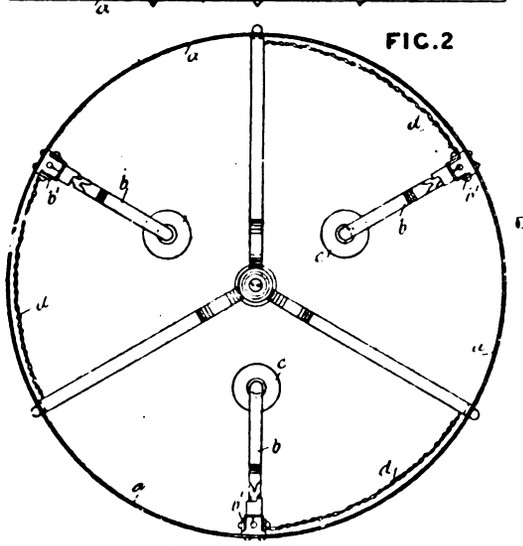
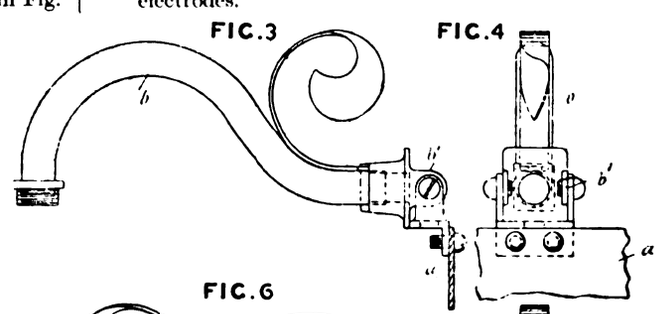
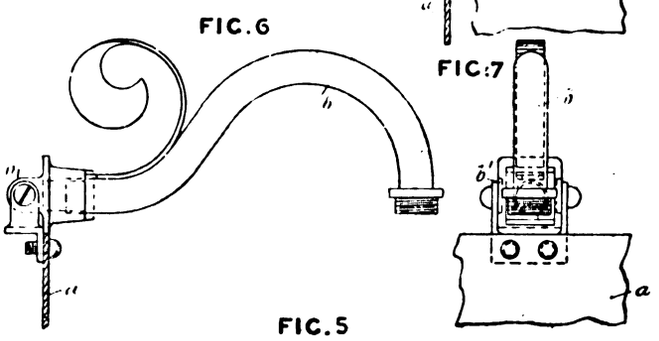
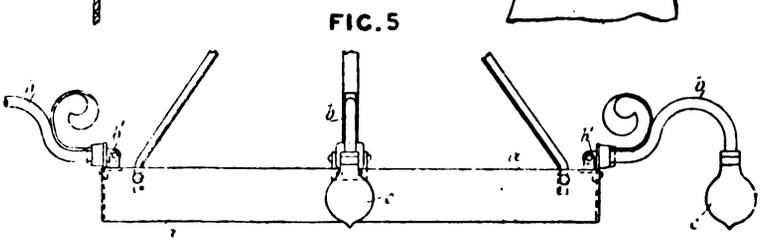
outside of the ring of the electrolier, and Figs. 6 and 7 are respectively side and front views of the bracket as in Figs. 3 and 4, and drawn to an enlarged scale projecting outwardly from the ring of the electrolier. A ring *a* is suspended in a horizontal position to the ordinary mechanism for raising and lowering the lights. The lamp brackets *b* are hinged to this ring in such a manner that they may either project inwardly from the ring as in Figs. 1 and 2, or lie horizontally in the same position outside the ring as in Fig. 5. The bracket *b* is hinged so that it may be placed either on the inside as shown in Fig. 1, or on the outside as shown in Fig.











5, and is formed so as to permit of partial rotation, and when turned over lies either within or on the outside of the ring *a*, the lamp *c* being dependent from it. The electric wires *d* are brought down from the ceiling and enter the brackets *b* at the base following the positions of the brackets. By these means the light may be diffused over a large area or restricted to a particular part of the room.

Controlling Electric Motors.

759.—1909. H. E. Dey, Jersey City, U.S.A. This is an improvement in the type of apparatus in which the speed of the load is controlled by a differential effect on two motors. The apparatus comprises a dynamo electric machine with one stationary and one rotary element, a second dynamo electric machine, both elements of which are rotary, and one of which elements is mechanically connected to the rotary element of the first dynamo electric machine, and a primary resistance whereby the relative strength of the field magnet of such machines is varied and controlled. The apparatus has a counter resistance operated by the load,

Retarding Mechanism for Electric Motor Starting Switches.

4317.—1909. Siemens Bros., & B. J. Payne, Stafford. The mechanism comprises a spring controlled disc rotatably mounted on a pivot attached to a moving lever on the apparatus. The disc has a slot in its periphery which engages consecutively with a series of pins whereby in the case of too rapid operation an unslotted part of the disc periphery engages itself with one of the pins and thereby throws the lever out of action until pressure has been relieved.

Electric Wire Supports.

7610.—1909. C. C. Gould, Philadelphia. The support comprises a post secured to a standard. A collar is connected to the inner side of the post and is open at its outer end. A sleeve consisting of a coil of resilient material encircles the post, and at its inner end enters the collar. The wire is pressed between the convolutions of the sleeve and wrapped around the post, whereby the convolutions are expanded and the inner end of the sleeve is forced against the wall of the collar so that the sleeve and wire are held tightly.

Electric Ignition Device.

17159.—1908. A. J. Postans, Brentford. One of the features of the invention is the arrangement of a cup-shaped member of large internal diameter attached to the armature of an electromagnet, and into which the rocking electrode projects, so that on the electromagnet being energised the side walls of the cup-shaped member engage the electrode and rock it. The size of the cup-shaped member is such that lost motion is introduced for the purpose of allowing the electromagnet to become strongly energised before separating the electrodes.

Manufacture of Flat Incandescent Filaments for Metallic Filament Electric Lamps.

28554.—1908. W. Schaffer, Berlin. The threads are produced from a plastic mass, which loses its plasticity on drying. The newly-moulded round filament is pressed flat, whereby its length is increased, and at the same time is given an approximately rectangular cross section.

Regulators for Electric Circuits.

4882.—1909. General Electric Co., Schenectady, U.S.A. The regulator has a resistance which may be intermittently connected in the circuit. A protective device for the regulator operates automatically upon the occurrence of a break in the resistance.

Alternating Electric Current Machines.

6103.—1909. R. Moser, Charlottenburg. This is an improved arrangement for automatically regulating the tension of synchronous rotary current machines under any displacement of phase by means of rotary field excitation and commutator. According to the invention, the compounding ampere turns are produced in the rotor by the stator current, and the exciting ampere turns by a rotary current exciting machine positively coupled to the main machine. The rotors have but one winding wherein the exciting machine works with a straight line characteristic tension curve, and is connected up in parallel or in series with a compounding transformer and the rotor winding of the machine.

Starting Switches for Electric Motors.

18965.—1908. E. Garside, London. The switch arm is provided with a detent which is pivoted to a fixed support and engages the contact brush carrier so as to hold it stationary during the major portion of the movement of the switch arm. During the closing movement the switch arm reinforces the spring against the resistance of the stationary contact brush carrier. As the switch arm reaches the end of its travel, and just before the main switch is closed, the detent is tripped by the switch arm and the carrier with the brush contact follows the spring compressing device and moves over the resistance contacts, cutting out the resistance in its travel, its movement being controlled by a dash-pot arrangement

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Protective Device for Electrical Installation.

17890.—1908. British Thomson Houston Co., & E. B. Wedmore, Rugby. The device comprises a contact which assumes definite positions for different current values in the circuit with respect to a second contact which approaches the first at a predetermined rate on the occurrence of abnormal conditions. These contacts co-operate to engergise or de-energise the tripping circuit of a circuit breaking device.

Electric Apparatus for the Synchronous Working of a Cinematograph with one or more Gramophones.

10396.—1908. Dr. Pierimi, Rome. The synchronous movement of the cinematograph and the gramophones is obtained by means of an automatically and continuous working electro magnetic brake. This brake consists of a rotary part fitted to the shaft of the talking machine and of a fixed ring fitted with electrical current from an independent source through three or more separate windings connected up to the corresponding sections of a distributor mounted on or positively geared to the obturating shaft of the cinematograph. The brake serves to check the acceleration of the movement of the talking machines on that of the cinematograph.

Electrolytic Meters.

865.—1908. W. B. Thorpe, Balham. The movable piston between the electrolytic cell at one end of the tube and the opposite end is caused to make a gas-tight connection with the inner surface of the tube so as to prevent creeping of gas or electrolyte from one end portion of the tube to the other. The movable piston is formed by mercury and the gas-tight connection with the inner surface of the tube is caused by rings of platinum fused into the tube and with which the mercury is constantly in contact.

Signalling System.

21766.—1908. General Electric Co., Schenectady, U.S.A. This is an improvement in the block signalling system, and consists in the provision of a magnet which co-operates with the relays and renders the relay responsive to current from the source at the entrance to a block ineffective to operate the signal on the approach of a train until the train reaches a fixed point on the track.

Electric Conductors.

17283.—1908. R. H. Gray, London, E.C. This is an improvement in the type of conductors which consist of two or more wires or other elements of different metals. According to the invention the various wires have all their surfaces of the same metal surrounded by an outer sheath composed of wire of another metal. The various elements of the sheath have previously had deposited on them an outer coating of metal, which deposited metal is the same as that on the outside surface of the central core with which it is in mechanical contact. The object of the surface coating of each element is to minimise the possibility of one or more of the metals forming the elements of the compound conductor becoming corroded owing to the existence of moisture between the different elements..

Electrical Switches.

17315.—1908. H. W. Cox, Nottingham. The main part of the switch is comprised of two frames, that is, a lower fixed frame secured to the base of the casing provided with fixed contacts, to which the leads are connected, and an upper movable frame provided with moving contacts corresponding to and adapted to engage with the fixed contacts. The contacts on each frame are arranged in pairs. The upper frame is connected to the lower frame by means of arms. One of the arms is connected to a lever whereby the upper frame can be raised or lowered. In rising and falling the upper frame always remains parallel to the lower frame, and the whole of the contacts thus make and break simultaneously.

Protective Devices for Alternating Current Systems.

20498.—1908. British Thomson Houston Co., & E. B. Wedmore, Rugby. The invention consists mainly in the utilisation of the change in direction of currents in two parts of a system on the occurrence of a fault to cause movement in a reactive relay, having a pair of windings, each of which is excited by a series transformer.

Composition for Use in Electrical Resistances.

17340.—1908. W. A. Phillips & F. R. Bacon, St. Louis. The composition is made up of a mixture of fireclay blended with Portland cement and baked, and a metallic element. The fireclay is impregnated with the metallic element. The two elements combined have a neutralising effect with respect to one another so far as the degree of electrical resistance is concerned.

Electric Heating Apparatus.

17687.—1908. R. G. Pheysey, Ontario. The apparatus comprises an outer thin metal shell on one surface of which a housing rests to contain the ends of the heat-producing cores. A shield encloses a space in which are the ends of terminals for electric conductors. A substance which is a non-conductor of heat is arranged within the shell and covers the housing and shield. The heat is confined to one surface of the appatatus.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last prices. £
Alliance Electrical Co., 5 p.c. Cum. Pref., Nos. 1-70,000	1 ..	¼-½
—— Ord., 1,125,000	1 ..	¼-½
Aron Electr'ty Meter, 6 p.c. Cum. Pref. Sh's, 1-125,000	1 ..	½-¾
—— Ordinary, Nos. 1-125,000	1 ..	½-¾
British Aluminium Co., Ordinary, 1-40,000	5 ..	¾-1
—— 7 p.c. Cum. Pref., 1-40,000	5 ..	1¼-2¼
—— "A" 6 p.c. Cum. Pref., 1-20,000	5 ..	3¼-3¾
—— 4 p.c. Funding Certificates, 1-20,000	5 ..	2¼-3¼
—— 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	73-78
—— 5½ p.c. Loch Leven Deb. (Reg.), Red., 1-3,000	100 ..	96-99
British Insulated and Helsby Cables, Ord. 1-100,000	5 ..	7¼-7¾
—— 6 p.c. Cum. Pref., 1-100,000	5 ..	6¼-6½
—— 4½ p.c. Mortgage Debentures	100 ..	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	89-94
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 275,001-475,000	3 ..	3/16-7/16
—— p.c. Mortgage Debenture Stock	100 ..	38-42
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	0-¼
—— Non. Cum., 6 p.c., Pref.	2 ..	0-¼
—— 4 p.c. 1st Debenture Stock	100 ..	41-46 xd
—— 4½ p.c. 2nd Debenture Stock	100 ..	27-31
Callender's Cable, Debentures	100 ..	105-107
—— Ordinary	5 ..	10-15 16
—— 5 p.c. Pref.	5 ..	5¼-5½
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	¼-½
Crompton and Co., Nos. 1-85,000	3 ..	¾-1¼
—— 5 p.c. 1st Mort. Reg. Debs., Nos. 1-900 of £100, and 901-11,100 of £50, Red.	— ..	90-93
Dick, Kerr, and Co., Ordinary, 1,260,000	1 ..	20/
—— 6 p.c. Cum. Pref., 1-305,000	1 ..	1¼-1½
—— 4½p.c. Debenture Stock.	100 ..	100-103
Edison and Swan United, "A" Shares, 1-99,261	3 ..	3/16-5 16
—— "A" Shares, 01-017,139	5 ..	1-1½
—— 4 p.c. Deb. Stock, Red.	100 ..	68-73
—— 5 p.c. Debentures	100 ..	84-87
Electric Construction, Nos. 1 to 112,100	2 ..	7 16-17 16
—— 7 p.c. Cumulative Pref.	2 ..	1 3/16-1 7/16
—— 4 p.c. Perp. 1st Mort. Deb.	100 ..	65-69
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	71-77
General Electric Company (1900) 5 p.c. Cum. Pref.	10 ..	7¾-8½
—— 4 p.c. 1st Mort. Deb. Stock	100 ..	85-88
W. T. Henley's Telegraph Works, Ordinary	5 ..	12¼-13¼
—— 4½ p.c. Preference	5 ..	5¼-5½
—— 4½ p.c. Debentures	100 ..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10 ..	14¾-15½
—— 4 p.c. Debentures	100 ..	100-102
National Electric Construction Co., 1-170,000	1 ..	¾-¾
Telegraph Construction and Maintenance	12 ..	34¼-36
—— 4 p.c. Bonds	100 ..	100¾-102¼
White, J. G., and Co., 6 p.c. Cum. Pref., 1-15,000	10 ..	10-11

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	5-5¼
Bournemouth and Poole, Ordinary	10 ..	9¼-10
—— 4½ p.c. Cum. Pref., 7,501-15,000	10 ..	9¼-10
—— 6 p.c. Cum. Second Pref., 15,001-22,500	10 ..	10-10¼
—— 4½ p.c. Debenture Stock, Red.	100 ..	100-104
Bromley (Kent) Electric Light and Power Co.	5 ..	4¼-4¾
—— 4½ p.c. 1st Debenture Stock, Red.	100 ..	93-96
Brompton and Kensington, Ordinary	5 ..	7¼-7½
—— 7 p.c. Preference	5 ..	7¼-8
Calcutta Electric Supply Corp., Ord., Nos. 1-100,000	5 ..	6¼-6¾
Cambridge Electric Supply Company, £10 Ord.	8 ..	12¼-13¼
Canadian General Electric Co., Common Shares	$100 ..	122-127
—— 7 p.c. Cum. Pref. Stock	$100 ..	120-122
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100 ..	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5 ..	82/6
—— 4½ p.c. Cum. Pref., 1-80,000	5 ..	4¼-5
—— 4 p.c. Debenture Stock, Red.	100 ..	96-99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5 ..	3¾-4¾
Chelsea Electricity Supply	5 ..	3¼-4
—— 4½ p.c. Debentures	100 ..	100-103 xd
City of London, Ordinary	10 ..	10¼
—— 6 p.c. Cumulative Pref.	10 ..	11¾-12¼
—— 5 p.c. Debenture Stock	100 ..	121-124
—— 4½ p.c. 2nd Deb. Stk., Red.	100 ..	100-103
Cordoba Light and Power Co., 1st Mt. Stl. 5 p.c. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	1¼-2
—— 5 p.c. Preference, 1-50,000	5 ..	3-3¼
County of London Elec. Supply, Ordinary	10 ..	7¾-8¼
—— 6 p.c. Cum. Pref.	10 ..	11
—— 4½ p.c. Debentures Prov. Certs. Al pd., Rd.	100 ..	104-107
—— 4½ p.c. 2nd Debentures Prov. Certs.	100 ..	100-103
Edmundson's Electricity Corporation, Ord., 1-80,000	5 ..	¼-5/16
—— 6 p.c. Cum. Pref.	5 ..	¼-¼
—— 4½ p.c. First Mort. Deb.	100 ..	58-61
Electrical Development Co. of Ontario, 5 p.c. 1st Mort. 30-year Gold Bonds, 10,751-15,750	— ..	84-86
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100 ..	91-94
Folkestone Electric Supply, Ord., Nos. 1-10,000	5 ..	4¼-5
—— 5 p.c. Cum. Pref., Nos. 1-10,000	5 ..	5-5¼
—— 4½ p.c. First Deb. Stock, Red.	100 ..	97-100
Hove Electric Lighting, Ord., 1-13,000	5 ..	7¼-7¾
Indian Electric Supply and Traction Co., 6 p.c. Construction Deb. Stock, Red.	5 ..	1¼-2
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100 ..	75-80
Kalgoorlie Electric Power and Lighting, 6 p.c. Cum. Pref., 1-150,000	1 ..	¾-27/32
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000.	5 ..	6¼-7¼
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100 ..	98-101

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Name.	Amount paid. £	Last price. £
London Electric Ordinary	3 ..	1¾-2¼
—— 6 p.c. Pref.	5 ..	5
—— 4 p.c. st Mortgage Debenture Stock, Red.	100 ..	93-97
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100 ..	76-80
Metropolitan Ordinary, 100,001-300,000	5 ..	82/6
—— 4½ p.c. First Mortgage Debenture Stock	100 ..	105-108
—— 4½ p.c. Cum. Pref.	5 ..	4¾-5
—— 3½ p.c. Mortgage Debenture, Red.	100 ..	83¼-86¼
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,000 ($500) M 1-4,400 ($1,000)	— ..	81¼-1
($500), 4,001-14,000 ($1,000)	— ..	84¼-3¾
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	96-99
Newcastle-upon-Tyne Electric Supply, Ord., 1-87,500	5 ..	85/
—— do. 87,501-137,500 (issued at £1 prem.). All paid (Prov. Certs.)	5 ..	4¼-4¾
—— do., 5 p.c. Pref., 1-87,500 (Prov. Certs.)	2 ..	4¼-5
—— 5 p.c. Pref., 87,501-137,500 (Prov. Certs.)	4 ..	4¾-5¼
Notting Hill Electric Lighting	10 ..	12-13
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6-6¼
—— 4 p.c. Debenture Stock	100 ..	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1 ..	1 5/16-1 7/16
—— 6 p.c. Non-Cum. Pref., 1-100,000	1 ..	1-1¼
—— 5 p.c. Debenture Stock, Red.	100 ..	103-106
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5 ..	5 7/16-5 11/16
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5 ..	5¼-6
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100 ..	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	— ..	105¼-107¼
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	¼-¼
South London, Ordinary	4 ..	2¾-3
South Metropolitan Electric Light and Power, Ord.	1 ..	5/16-9/16
—— 7 p.c. Cum. Pref.	1 ..	2 1/3
—— 4½ p.c. 1st Mort. Deb.	100 ..	102-105
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	8¾-9¼
—— 7 p.c. Pref.	5 ..	7-7¼
—— 3½ p.c. Deb.	100 ..	84-88
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	¼-1
—— 5 p.c. Cumulative Preference, 50,001-80,000	5 ..	1¼-1¾
—— 4½ p.c. First Mort. Debenture Stock, Red.	100 ..	77-81
Westminster, Ordinary	5 ..	8 9/16
—— 4½ p.c. Cum. Pref., 110,101-138,251	5 ..	5 1/16

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 10 p.c. Non-Cum. 2nd Pref., 260,008-280,007	5 ..	4¼-4¾
—— Permanent 6 p.c. Debenture Stock, 1888	100 ..	91-92
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	102-105
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	¼-¾
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1 ..	9/16-11/16
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100 ..	87-90
Blackpool and Fleetwood Tramroad	10 ..	13¾-13¾
Bombay Elec. Supply and Trams. Co., 6 p.c. Cum. Pref.	10 ..	9¾-10¼
—— 4½ p.c. Deb. Stock, Red.	100 ..	94-96
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	6¾-7
—— 5 p.c. Cum. Pref., Nos. 1-75,000	5 ..	5-5¼
—— 4½ p.c. Deb. Stk., Red., Prov. Certs., all pd.	100 ..	100-103
British Columbia Electric Railway Co., Ord. Def.	100 ..	146
—— Ord. Pref.	100 ..	117-122
—— 5 p.c. Cum. Perpetual Pref. Stock	100 ..	106-110
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	102-104
—— 4½ p.c. Vancouver Power Deb.	100 ..	102-105
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10 ..	12/6
—— 6 p.c. Cm. Pf., 30,001-60,000	10 ..	403/9
—— 5 p.c. Perpetual Debenture Stock	100 ..	84-87
—— 4½ p.c. 2nd Deb. Stock	100 ..	63-67
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	81-86
Buenos Ayres Gd. Nat. Trams. Co., 5½ p.c. Pref. Deb. Bonds, Red., 1-1,500	100 ..	102-107
—— 6 p.c. Deb. Bonds, Red., 1-2,275	100 ..	103-106
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	97¾
Calcutta Tramways, Ord., No. 1 137,610	5 ..	4¾-5¼
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5 ..	4¾-5
—— 4½ p.c. 1st Deb. Stock, Red.	100 ..	97-100
Cape Electric Tramways, Nos. 1-491,222	1 ..	3 16-7/16
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5 ..	4¾-5¼
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	97-101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5 ..	5¾-6
—— 4 p.c. Deb. Stock, Red. (1985)	100 ..	98-101 xd
Colombo Electric Tramways and Lighting, 5 p.c. 1st Mortgage Debenture Stock, Red.	100 ..	98-101
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 p.c. Cum. Pref.	10 ..	12¾-13¾
—— 4 p.c. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12¾-13¾
—— 6 p.c. Pref., Nos. within 1-60,000	10 ..	12¾-13¾
—— 3½ p.c. Mort. Debs., 1-3,000 Red.	100 ..	90-95
Hastings & Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	76-81
Havana Electric Railway Consolidated Mort. 5 p.c. 50-year Coupon Bonds of 1952, 1-6,957	$1,000 ..	92-96
Imperial Tramways, Ordinary	all ..	18-19
—— 6 p.c. Cum. Pref.	all ..	14-14¾
—— 4½ p.c. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 p.c. Cum. Pref., Nos. 30,001-60,000	5 ..	¾-1¼ xd
—— 4 p.c. 1st Mt. Db. Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/32-3/32
—— 5 p.c. "A" Deb. Stock	100 ..	92-95
—— 6 p.c. "B" Deb. Stock	100 ..	66-70
Kidderminster & District Lighting & Traction, Pref.	5	9 15/16-10 3/16
Lancashire United Tramways, Limited, 5 p.c Prior Lien Deb Stock, Red	100 ..	88¼-90¼
—— £296,500 2nd Mort Deb Stock	— ..	—
—— £83,330 Deferred Deb Stock (all fully paid)	— ..	—
Lisbon Elec Trams, Limited, Ord, Nos 1-594,188	1 ..	29/32-1 1/32
—— 6 p.c. Cum Pref, Nos. 1-425,553	1 ..	15/16-1 3/16
—— 5 p.c. Mort. Deb., 1-5,000, Red.	100 ..	98-102
London United Trys (1901) 5 p.c. Cum. Pref.	10 ..	2¼-2¾
—— 4 p.c. 1st Mt. Db. Stock, Red.	100 ..	67-70
Madras Elec. Trams. (1904) 5 p.c. Deb. Stk., Red.	100 ..	93-96
Manila Elec. R.R. & Ltg. Corp., 5 p.c. 1st Lien & Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000 .	95-97
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5 ..	4¼-5
—— 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	86-91
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	1/32-5/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1 ..	11/16-13/16
—— 4½ p.c. Deb. Stock, Red.	100 ..	94-96
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 p.c. Gold Bonds	— ..	92¼-¼-2
Milwaukee Electric Rail and Light, 5 p.c. 30-yr. Con. Mort. Bonds (1926) 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ p.c. Sterling Deb., 601-2,000 (1922)	100 ..	103-105
New General Traction, 6 p.c. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	¼-¾
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100 ..	100¼-103¼
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	¼-¾
—— 5 p.c. Cum. Pref., 300,001-545,000	1 ..	¼-¾
—— 4½ p.c. Debenture Stock	100 ..	86-89
Provincial Tramways Co., Ordinary, 1-24,912	10 ..	4-4¼
—— 6 p.c. Cum. Pref., 1-10,000	10 ..	9¼-10¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5 ..	5¼-5¾
—— 4½ p.c. 1st Mort. Deb. Stock, Red.	100 ..	99-101
San Paulo Tramway, Light, and Power Co.	$100 ..	149-152
—— 5 p.c. 1st Mort Deb., Red. (1929) 1-12,000	$500 ..	101-103
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	¾-¾
—— 4 p.c. Deb. Stock, Red. (1940)	100 ..	69-73
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red., 1-1,600	100 ..	81-85
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5 ..	¼-¼
—— 6 p.c. Cum. Pref., 1-46,261	5 ..	1¾-2¼
—— 4½ p.c. 1st Deb. Stock, Red.	100 ..	81-85

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100 ..	61-63
—— 4 p.c. Pref.	100 ..	85-87
—— ,, deferred	100 ..	44¾
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	101-103
City and South London, Consolidated Ordinary	100 ..	31¼-1
—— 4 p.c. Debenture Stock	100 ..	100-102
—— 5 p.c. Pref. Stock '91	100 ..	108-110
—— ,, ,, ,, '96	100 ..	104-107
—— ,, ,, ,, '01	100 ..	100-103
—— ,, ,, ,, '03	100 ..	96-100
Liverpool Overhead, 5 p.c. Pref.	10 ..	4¼-5
—— Ordinary, 1-50,000	10 ..	⅜-⅜
—— 4 p.c. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 p.c. 4½ p.c. Bds.	— ..	90-89¼

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10 ..	2¼-3¼
—— 5 p.c. Debs., Red., within 1-1,069	100 ..	97-99
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000 ..	96-98
Anglo-American Telegraph Co., Ordinary	100 ..	61¼-63¼
—— 6 p.c. Preferred Ordinary	100 ..	104¼-¼
—— Deferred Ordinary	100 ..	22-22¼
Anglo-Portuguese Telephone Co., 5 p.c. 1st Mort. Deb. Stock, Red.	100 ..	101-103
Chili Telephone Co., 1-44,000	5 ..	8-8¼
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100 ..	90-92
Cuba Submarine Telegraph Co., Ordinary, 1 16,000	10 ..	8¼-9¼
—— 10 p.c. Preference, 1-6,000	10 ..	17¼-18¼
Direct Spanish Telegraph Co., Ordinary	5 ..	3-3¼
—— 10 p.c. Cum. Preference	5 ..	8¼-8¾
—— 4½ p.c. Debs., 1-600	50 ..	100¼-102¼
Direct United States Cable Co.	20 ..	13¼-13¾
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100 ..	100-102
Eastern and South African, 4 p.c. Mort. Debs., within 1-3,000 (1909)	100 ..	100-100¼
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	25 ..	100-102
Eastern Extension, Australasia and China, 1-300,000	10 ..	11¾-12¼
—— 4 p.c. Mort. Deb. Stock, Perp.	100 ..	102-104
Eastern Telegraph Co., Ordinary Stock	100 ..	129-132
—— 3½ p.c. Preference Stock	100 ..	85-87
—— 4 p.c. Mortgage Debenture Stock	100 ..	104¼-106¼
Great Northern Telegraph Co. (of Copenhagen)	10 ..	26-27
Halifax and Bermudas Cable Co., 4½ p.c. 1st Mort. Debs., within 1-1,200, Red.	100 ..	100-102
Indo-European Telegraph Co.	25 ..	53¼
Marconi's Wireless Telegraph Co., Nos. 256,128-384,190	1 ..	16/6 15/6
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	¾-¾
—— 5 p.c. Preference, 1-86,492	1 ..	¾-¾
National Telephone, Preferred	100 ..	106½
—— Deferred Stock	100 ..	121¼
—— 6 p.c. Cum. First Pref.	10 ..	10¼-10¾
—— 6 p.c. Cum. Second Pref.	10 ..	10¼-10¾
—— 5 p.c. Non. Cum. Third Pref.	5 ..	5 7/16-5 11/16
—— 3½ p.c. Deb. Stock, Red.	100 ..	98-100
—— 4 p.c. Deb. Stock, Red.	100 ..	100-102
Oriental Telephone and Electric Company	1	1 15 32-1 19/32
—— 6 p.c. Cum. Pref.	1 ..	1 5/32-1 9/32
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100 ..	100-102
United River Plate Tele. Co., Ordinary, 1-100,000	— ..	6¾
—— 5 p.c. Cum. Pref., 1-40,000	5 ..	5¼-5¾
—— 4½ p.c. Debenture Stock, Red.	100 ..	104-106
Telephone Co. of Egypt, 4½ p.c. Deb. Stock, Red.	100 ..	100¼-102¼
West African Telegraph Co.	10 ..	12¾-13¼
West Coast of America, 1-30,000 and 53,001-53,008	2½ ..	1¼-1¾
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	100-102
West India and Panama Telegraph Co., Ordinary	10 ..	11/16-13/16
—— 6 p.c. Cum. 1st Preference	10 ..	8¼-9
—— 6 p.c. Cum. 2nd Preference	10 ..	8¼-9¼
—— 5 p.c. Debs., Red., 1-800	100 ..	101¼-103¼
Western Telegraph Co., 1-207,930	10 ..	13¾-13¾
—— 4 p.c. Debenture Stock, Red.	100 ..	103-105

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1909.	1908.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Sept. 15	1,393	1,437	— 44	— 558	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940,	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Aug. 7	2,770	2,650	+ 120	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Sept. 12	1,059	1,079	— 20	— 395	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Sept. 11	6,434	6,333	+ 101	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Sept. 15	1,188	1,156	+ 32	— 907	24·5	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,329	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Sept. 12	2,569	2,281	+ 288	— 287	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Sept. 11	4,896	4,623	+ 273	+ 2,750	98	98	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	„ 12	1,168	1,052	+ 116	+ 1,235	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Sept. 17	5,772	5,149	+ 623	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Sept. 18	1,337	1,208	+ 129	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Sept. 19	264	269	— 5	—	10	10	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Sept. 18	5,039	8,309	— 3,270	— 25,134	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	„ 7	3,695	3,515	+ 180	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Sept. 19	3,010	2,987	+ 23	+ 1,220	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Sept. 16	503	466	+ 37	—	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Aug. 20	1,693	—	+ 254	+ 798	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Sept. 11	255	241	+ 14	— 213	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 11	250	256	— 6	— 373	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Sept. 17	154	158	— 4	—	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Sept. 17	5,267	5,254	+ 13	+ 1,001	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Sept. 15	1,197	1,212	— 15	— 514	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Sept. 18	1,002	883	+ 119	+ 3,438	14	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	July 17	15,961	17,286	— 325	— 2,745	185½	179	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Sept. 15	336	274	+ 62	+ 645	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Aug. 7	4,430	4,480	— 50	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Sept. 11	1,685	1,527	+ 158	+ 1,155	28½	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	Sept 18	2,587	2,485	+ 101	+ 1,993	26	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	July 31	487	498	— 11	+ 687	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Sept. 15	135	148	— 13	—	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Sept. 15	1,325	1,379	— 54	— 465	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 11	6,933	6,450	+ 483	—	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Sept. 4	10,708	10,767	— 59	— 2,435	104	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Sept. 12	1,419	1,391	+ 28	+ 118	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Aug. 28	36,667	33,166	+ 3,501	+ 20,701	124	122½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	„ 17	216	258	— 42	— 743	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Sept. 11	217	220	— 3	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Sept. 18	9,557	9,753	— 196	—	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Sept. 19	15,892	17,345	— 1,453	— 521	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Sept. 18	144	146	— 2	— 70	2½	2½	Mar. 31	7,362	2,060,712	204,710	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Sept. 11	3,749	3,748	+ 1	— 1,159	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Sept. 11	634	641	— 7	— 314	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Sept 16	627	642	— 15	— 121	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 13	4,553	4,463	+ 90	— 3,333	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,135	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	July 18	5,718	5,528	+ 190	— 1,112	68½	66½	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Sept. 8	1,149	1,158	— 8	— 429	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug. 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Sept. 1	154	157	— 3	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 17	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Sept. 18	955	894	+ 61	—	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Sept. 9	2,308	2,192	+ 116	+ 3,492	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Sept. 16	881	778	+ 103	— 860	22½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train miles. b Half-year's figures.

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THE
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NOTES.

URBAN TRAFFIC: I. TRAMWAYS.

In the Public Service Commission report shortly to be issued by New York City, there will be found two important articles by Mr. R. H. Whitten on tramway administration in England and in Prussia. The Commissioners in their introductory note warmly approve of Government supervision. It probably safeguards the public, and certainly with us it has prevented electrolysis becoming the acute trouble it has in America through bad bonding of tramway rails and inadequate provision for return of current. On the other hand, it has retarded electrification. The American returns credit us with the electrification of 1,408 miles of track between 1898 and 1908, and estimate that in Prussia about 83% of its 2,345 miles of street railways are electrified, which contrasts with the 23,000 miles added to the American electric street railways within the same decade. Indeed, several States in America own more electric railway mileage than we possess in the whole of the United Kingdom. In the United States, too, there is greater diversity. We are safer, but less given to experimentation. We shall see what will come of the bold attempt to push trackless tramways in England. The system would be most useful in many districts, not sufficiently developed, or with roads and streets too narrow for permanent lines.

URBAN TRAFFIC: II. TUBES.

The principle of the shallow underground tram lines has hardly been applied here. It seems successful enough in the short cut between the Victoria Embankment and Theobald's-road, and we are promised something of the kind in connection with the new City Thames Bridge. Meanwhile, the electric tube seems to be the most efficient means available for dealing with our traffic problems. The latest of the projects is the proposed electric tube between Victoria and Sydenham, which will tap Upper Norwood, Sydenham, Dulwich, Denmark Hill, Camberwell, Kennington, Vauxhall, and Pimlico, and place South-East London in direct communication with the Metropolitan and District, the London, Brighton and South Coast, and the South-Eastern and Chatham and Dover Railways. A Bill will soon be deposited for this project. Then we hear of a revival of the old scheme for a part tube, part open track electric railway between Euston and Watford; while the Central London will seek to extend its line to Liverpool-street, a most useful link.

TUBIFICATION ABROAD.

A notable project, and a victory for British capital and enterprise, is the projected electric tube to connect the East and West Ends of the city of Buenos Ayres. For some time past the British Electric Tramway Co. of that progressive city has been threatened with keen competition from other financiers seeking a concession for a rival tramway system. Now, however, the city authorities have agreed upon the underground scheme, which is controlled by the English company, so the tube will complete the system, and not compete with the above-ground tramways.

ELECTRICITY IN MINES COMMITTEE.

Mr. Masterman, replying for the Home Office, told Mr. Markham, M.P., that the Expert Committee will, among other things, consider the advisability of actually carrying out experiments in connection with the use of electricity in mines. As Mr. W. K. Burke pointed out in our columns only a fortnight ago, such experiments ought to be undertaken at the expense of our Home Office, as they are by the Government in Germany, where manufacturers are given considerable assistance on the scientific side. Such assistance not only benefits the industry itself, but the users, the nation at large. Pressure should certainly be brought to bear on the Home Office in this matter. It is scarcely satisfactory for the Under Secretary to tell us that possibly the Committee will consider how far any such experiments would be useful, and by whom they could be made. A more decided note is looked for, not only by electricians, but the mining industry.

ELECTRIFYING NAPLES.

Naples, deservedly renowned for its beauty, still undeservedly retains its notoriety for the *dolce far niente* of its *lazzaroni*. As a matter of fact, modern Naples is one of the most industrious of old-world cities, largely because its wide awake Edils have known how to spend judiciously and offer all kinds of valuable concessions for the development of the manufacturing quarter in the plains. Another manifestation of their enterprise is seen in the hydro-electric scheme, which will utilise the wasted powers of the Volturno river. The dam will be built high up the river and water conducted to the generating station, 50 miles from Naples, by means of sluices. Turbines will drive the three-phase generators, the current will be stepped up from 5,000 to 45,000 volts, and it is expected to be able to transmit 16,000 h.p. In this way a fresh impetus will be given to the industrial suburb of Naples, while the citizens themselves will also benefit by power being made available for domestic purposes.

ELECTRIC WRITING.

Electricity has once more been enlisted in the service of business, an invention having been perfected which will make the tampering with all forms of credit notes, and many other documents, impossible. A glass topped desk is provided with an aluminium plate. Beneath this are a couple of electric batteries, a rheostat, condensers and resistances connected with the aluminium plate. The circuit is completed by a stylographic pen, connected by an ordinary flexible cord to the batteries. The cheque or other document is placed on the aluminium plate, which is then written over with the stylus, with the result that a series of small sparks are seen to burn tiny holes in the paper or parchment, leaving the words traced out in brown—the tiny carbonised dots. Such a document cannot be tampered with, and if only the apparatus answers well in practice, these little glass desks, with their appurtenances, should soon be seen in every bank and business office. It is only in accordance with the fitness of things that this invention is due to a Parsee gentleman, for Parsees are almost as intimately connected with banking as were the olden Lombards.

ARABIAN NIGHTS IMPROVED.

We have strange company among the prophets. Certainly no one expected to find the Welsbach Co. backing up electricity. However, the unexpected has happened. And, after all, it is natural enough, for Baron Auer von Welsbach has been identified with the use of rare earths for both gas and electric lighting. The new comers in the field of metallic filament lamp supply are making a bold bid for popular patronage. To offer to remove all carbon lamps and replace them with Welsbach filament lamps free of charge, merely on an understanding that the company shall receive the difference saved by consumers in the charge for electric

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current during one quarter is tempting, and may well produce a rush between this and the end of December, when this new and revised offer of "old lamps for new" is to be withdrawn. The project is calculated to make central station engineers say things; but it will be wiser to be up and doing: cheapening cost of production and distribution, finding new outlets for power, and devising equitable systems of charging. Then, indeed, they will reap much of the benefit that the increase of customers should bring.

WIND THE GENERATOR.

A financial contemporary remarks, *apropos* of a German patent for wind-power electric generating plant, that it has been estimated that if the wind power blowing over London to a height of 500 ft. could be harnessed, it would do work equivalent to that of a 500,000 h.p. steam engine going day and night. Wind-wheels of all kinds are well enough known, and many are used in England as well as in the Colonies to generate electricity, using storage batteries. The difficulty is, however, that wind power in most places is so uncertain, thus necessitating a costly storage battery outfit. Wind cannot be utilised economically for big schemes, though it is usefully enough employed for many country house and farm installations, working dynamos, generating electricity for lighting, pumping and other purposes. London could not utilise its wind power to advantage, but many a seaside town of moderate size, so situated topographically that the regulation alternations of land and sea breezes can be relied upon, could.

LIGHTNING CONDUCTORS.

Specifying and fixing of lightning conductors is too often left to the plumber or the building contractor. Its installation demands considerable electrical knowledge, for lightning is not only a high potential, but also a high frequency current, and it therefore prefers a straight path to a crooked one. Thus the neat bend in the copper tape round ledges or copings of buildings is really a trap, in that it is likely to cause the current to pass into the building instead of direct to earth. Again, the making of good earth connection is an important matter, especially in dry climates, for even when a good earth is made in the first instance unless it be kept moist, its purpose fails. A badly fixed lightning conductor is a direct invitation to disaster, inasmuch as it attracts the lightning to the building and then fails to carry the current safely away. Again, the mere fixing of a lightning conductor is not enough, for a large building should have its principal metal gutters, downspouts, railings, and piping metallically connected together and earthed, independent of the lightning conductor.

SALES ENGINEERS.

What should be the training of a sales engineer? Does he need to be a practical man? So many men are now occupying the position of salesmen to engineering firms who have never worked at the bench or in the drawing office, that one begins to wonder if it is really necessary to go through an engineering training to qualify for the commercial side. As the commercial side is the best paying one, and gives most scope, it is a matter of considerable interest to engineers. In the Colonies the successful salesman must be a practical engineer, able, if need be, to take off his coat and put a job right. Of course, in England repair shops are at hand, and this practical knowledge is not likely to be so useful, but at the same time it is just as well that the man on the road should be able to talk to a possible purchaser as an expert engineer. A promoted clerk will naturally work for less than a trained engineer, but it is short-sighted policy of a management to overlook the very natural prejudices of the engineering profession. Engineers don't like to see clerks pitchforked into positions which rightly belong to trained men of their own profession. A writer in one of our contemporaries has suggested that engineers should refuse to interview salesmen of engineering firms who cannot show that they are members or associate members of one of the engineering institutions. The suggestion is one that is being much discussed. It is pointed out that one of the reasons for German success in foreign markets is the ability of the trained traveller to discuss technical problems and to report to his employers the needs of local users and how they can best be met.

WATER VERSUS COAL.

One of the most interesting things which is going to be demonstrated within the next few years is the question whether coal fuel countries can compete with water power countries. Can England, for example, manufacture electric furnace products as cheaply as Norway or Germany. Tremendous issues lie around the solution of this question, for if it were to be conclusively proved that steel made by hydro-electric power was better and cheaper than when made by heat obtained from fuel and gas the world would be turned topsey-turvy. As a matter of fact, there are indications already that this upheaval of economic conditions will not take place because the modern methods of getting the power out of coal are being improved so vastly. There is no reason why electric furnace processes should not be made to pay in England. Take carbide of calcium, for example. When it first came to the front it was made in Yorkshire by the late Samson Fox. Then hydro-electric plants were laid down on the Continent, and nearly all the carbide supply of the world came from them, the output of Norway and Sweden alone went up to over 150,000 tons per annum. The next step was the starting of a works in connection with the Yorkshire Electric Power Co. This has now been working for some months, and the figures obtained show that carbide can be made in Yorkshire cheaper than it can be delivered to that county from abroad. With large Mond gas plants dotted about the country each producing sulphate of ammonia as the main product and gas as the bye product there ought to be a great future for electric furnace work in this country.

ECONOMICAL "WIRELESS."

One of the latest developments in wireless telegraphy is a New Zealand system, which comes forward with claims of remarkable economy combined with efficiency. The cost of a Marconi station is approximately £2,000, but under the system invented by Mr. A. Irwin Crooks, of Auckland, we are promised a station at less than £300, to exchange messages over an area of from 300 to 400 miles radius. Tests recently made with the apparatus by the War Office are declared to have been satisfactory, and the verdict of "wireless" experts in this country, to whom the system is to be submitted by Sir John Quick, Postmaster-General of the Commonwealth of New Zealand, will be awaited with considerable interest.

COSMIC ELECTRO-MAGNETIC DISTURBANCE.

VIEWS OF SIR OLIVER LODGE.

The remarkable magnetic storm experienced during the week-end raises the point whether the more general application of wireless telegraphy will result in earlier indication to the observatories of approaching disturbances. The storm appears to have been one of the most severe and widespread recorded for many years. Singularly enough, no auroral manifestation seems to have been observed in this country, but an aurora was witnessed in the South of France, as well as at Cape Town, East London and Port Elizabeth. Telegraphic and telephonic communication was considerably interrupted, and the trouble, of course, affected the despatch of cable messages abroad. Sir Oliver Lodge points out that cosmic electro-magnetic disturbances of this kind are now believed to be due to solar radio activity. For, in addition to its ordinary radiation, on which the earth entirely depends, the sun is at times technically radioactive, and the eruption not only produces sun spots, but also expels crowds of electrons, which fly with prodigious speed in straight lines after the manner of the beta rays in radium. Whenever a torrent of these minute electrified projectiles rush past the earth, as they do at the rate of some thousand miles a second, they constitute a powerful electric current, and are liable to deflect magnetic needles. Some of them, however, as in the recent case, actually encounter the earth's atmosphere, and, though they are mostly deflected to the Poles, some of them, especially at the times of the Equinox, may come down near the Equator. Those which journey to the Poles are accompanied by an opposite current in the crust of the earth from the Equator to the Poles, and this it is which disturbs the telegraphs—being picked up or tapped by them *en route*. They also produce auroras in the neighbourhood of the Poles. Those which enter the atmosphere elsewhere act as nuclei for condensation of moisture, and, by screening the sun's rays, are probably responsible for some of the dull and overcast weather. Local thunderstorms are also a not unlikely result. These atmospheric conditions might be mitigated, at least as far as the dull weather is concerned, by artificial supplies of positive electricity to the upper atmosphere in large quantities. There is no remedy for the magnetic storms due to cosmic causes, nor for the corresponding earth currents, but telegraphic disturbance can be eliminated by the use of double lines or return wires.

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CURRENT CONSUMPTION.*

By R. S. PILCHER (General Manager, Corporation Tramways, Aberdeen).

Everyone connected with the management of electric tramways in these days realises the importance of the subject of current consumption, whether the tramways department has its own power station or not. The cost of electricity to any tramway system may be the question of a profit or loss on the year's working. In Aberdeen the cost of current averages at 1·10d. per unit, and the units consumed work out at 1·25 per car mile, making a cost of 1·37d. per mile run. The proportion of this to our working expenses is 23%, or more than half the cost of all our wages paid. I notice that in some of the largest towns in the country, the power expenses are about 30% of their total working expenses, and in one town they are as high as 35%. I think you will all agree with me that no effort should be spared in trying to prevent the systematic increases in current consumption which are to be seen all over the kingdom.

It is a fact, I believe, that the records of most towns in the United Kingdom and Ireland show an increase year by year in the consumption of current per car mile, and this is chiefly owing to track and car equipments becoming older, as well as to the great increase there has been in recent years in the number of top covered cars in use. I believe the increase through top covers is due in a small degree to the extra weight and windage of the covers, but in a larger degree to the extra carrying capacity of the cars in wet weather, and, in consequence, the greater number of stops which the cars have to make in a given time.

I have heard some tramway officials speaking on this subject, who think that there is a great deal of current wasted through defective motor fields, badly worn pinions and gears, bent axles, etc., and I believe that in systems which have only been running a few years, much of the increased consumption may be due to this. But most of our systems have now been running over five years, and have replaced pinions, started to replace gears and field coils, in this way continually renewing the car equipments, so that I am inclined to think that the bringing forward of these causes of increased current consumption is rather apt to blind us to the true remedy, which, in my opinion, is to be found in the correct method of driving. We, in Aberdeen, could not afford to scrap any more field coils, and we get the full life from gears and pinions, but, we can afford to give a great deal of attention to the motormen.

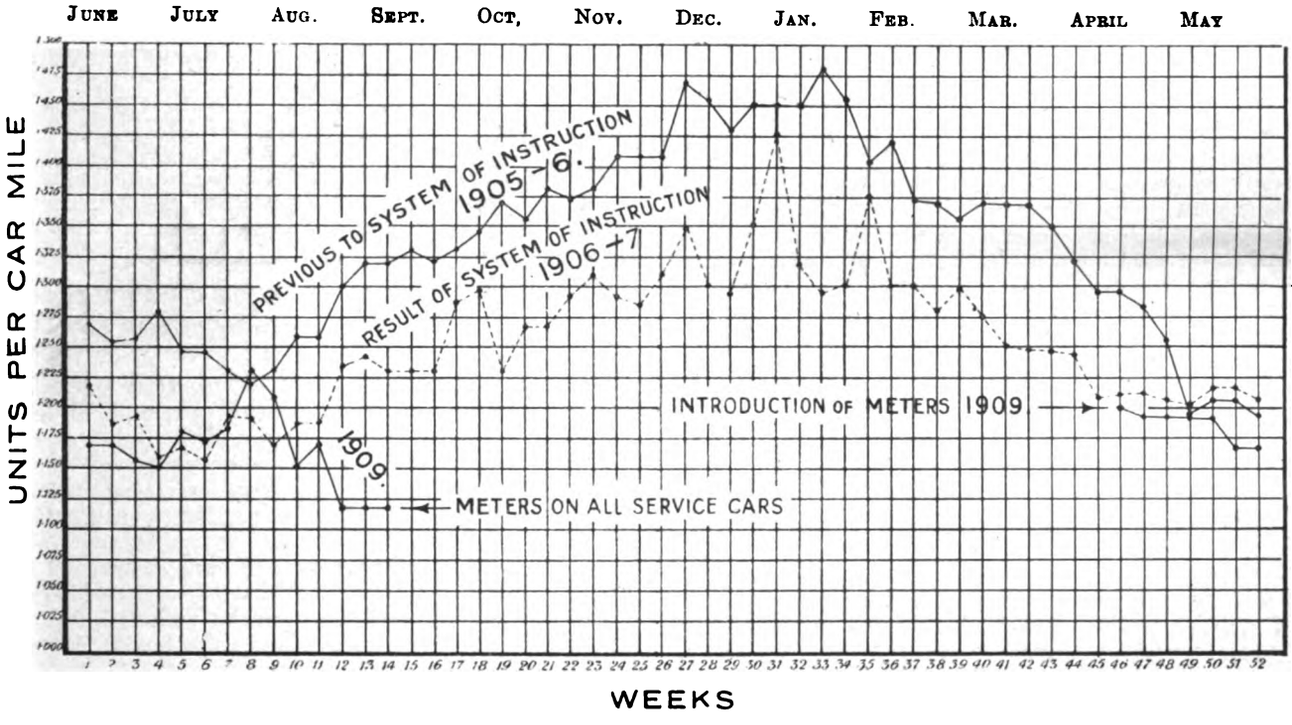
Five years ago I experimented on one of the English tramway systems with a view to saving current, and by instructing the motormen in the series parallel system of controlling motors, and by showing how it was possible to save current without decreasing the speed of cars, a reduction of over 7% was made.

In Aberdeen I started a similar system three years ago, which has also been very successful. In the first place, each motorman is brought into the office, and before a blackboard thoroughly instructed in the series parallel system of control by means of diagrams. I spent a great deal of time in illustrating the difference between two motors running in series and two motors running in parallel, also how it is that when motors are in series they only have half pressure, half speed, and half the consumption of current. I find that it has to be very simply illustrated before the men can understand. My usual illustration takes the form of water, as I find that the men seem to grasp my meaning much sooner when referring to water than when speaking of electricity.

The motormen seem to have great difficulty in realising how it is that parallel consumes so much more than series, and especially how the first notch in series and the first notch in parallel consume more than the second and third notches. Each man is instructed how to use the momentum of his car to the best advantage, and he is shown how to keep up the same speed with less use of the power notches of controller. He is shown how the careful driver can, after arriving at the top speed, maintain it off the series position, whilst the careless driver would have his controller on parallel all the time. The men are also instructed not to run their cars on parallel, unless they have sufficiently clear space ahead to get the full benefit in speed of extra consumption. All the motormen are informed of the cost of current, and it never fails to impress them, because they previously did not appear to realise that electricity cost anything. Each motorman is put upon his honour to do the very best he can for the department, and he is informed of the reductions made. After having been thoroughly instructed in the office, he is given a printed instruction paper which shows where he should be running in parallel, and where in series, also where he should be coasting. I find that he soon learns the instructions, and gets into the habit of abiding by them. All our drivers are kept to their respective routes, otherwise I could not expect them to know the routes so well. A good inspector, who is tactful and not likely to ruffle the men, is put on the road to see that they carry out their instructions and to see there is no rushing to and from the different termini.

Previous to this system being introduced into Aberdeen, the rise in current consumption each year had varied

CURVES OF CONSUMPTION.



* Paper read at Eighth Annual Conference of Municipal Tramways Association, September 22nd-24th.

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between 6 and 12% per car mile, and immediately it was introduced there was a reduction. The first year the reduction was 6% on the year previous, or a saving of £640. in addition to which the gradual increase was checked. Since then we have maintained the same consumption per car mile, *i.e.*, for three years, and as we have been adding to the number of top covered cars, at the rate of six each year, I consider that this is equivalent to a gradual reduction.

Some months back I experimented with 10 ampere-hour meters, each meter being placed on a different route, and I noticed a further decrease in the consumption of current. The Aberdeen tramways system has now got all its service cars fitted with ampere-hour meters, and the consumption of current is lower at present with 41 top covered cars than it has been for the last five years, although there were only three top covered cars in use five years ago. These meters have already paid for themselves by the reductions made. One of the meters had been on a car for a month, and, thinking that the consumption on this car was rather high, I changed the drivers, and the first week after the change, the current consumed by the new driver showed a decrease of 16s., which has since been maintained. This will serve to show what could be done when applied to a large system. The consumption of current is shown each day and week against each man, a sense of healthy rivalry thus being created between the different men on each route in their effort to show the lowest consumption per car mile. I find that our motormen like the cars with the meters on them; they become interested in watching the current consumption each trip and each day, and I do not think it is necessary to become arbitrary or too strict with the men. I believe good results can be obtained without severe measures. Although we have saved several thousands of pounds in three years in Aberdeen, there has never been a single motorman suspended in connection with this subject. The average motorman is a little slow to understand the subject, but the explanation should be simplified. The main point is to get them interested in the subject, and when they understand they will certainly reduce the consumption of current.

I find that in Aberdeen the routes which use the most current are not always those routes which have the steepest gradients, but that the speed of the car and the number of stoppages has a material effect upon the current consumed. The cars which run the slowest, even although there are several fair gradients on these routes, use the least current, and on other routes where there is hardly any gradient the consumption is high, because of the high speed at which the cars have to travel, together with the greater number of stops.

Theory would teach us that the faster the car travels the more economical is the current consumption per car mile; in practice I find just the opposite. It is of no use to give the efficiency of a car running in parallel against a car running in series, without taking into consideration the conditions of starting and stopping, combined with the fact that it is harder to keep time with a high average speed than with a low average speed, and will, in consequence, use more current when accelerating its speed. We have a route in Aberdeen on which seven cars operate. Some time back one car was taken off this route, but the six cars which were left used much more current than the seven cars had done, proving that in practice the faster the cars run the more current they will use per car mile.

Sometimes mechanical controller regulators are advocated to save current, but I think that they are of little use except to prevent the abuse of the equipments by notching up too fast. My own impression is that any system of electric tramways which has no method of checking current consumption will use at least 5% more current per car mile than a system which has a systematic check upon its drivers. Of course, I believe that in those towns where there are very many steep gradients and few level tracks, there is not so much scope for this subject as in fairly level towns. If current is to be saved without interfering with efficiency (and it can be saved), the first thing to do is to instruct your motormen specially on this subject, and follow this up by a direct check upon them. It matters little whether you use watt-hour meters, ampere-hour meters, or time-meters. I believe the same effect can be obtained by any of these. It is not so much a question of accurately measuring the consumption of current by each car, but rather of having a comparison day by day with other cars on the same route.

On dry days, or after several dry days, when there is a great deal of dust accumulated about the rails, the current consumption rises upon the car meters, and as Aberdeen is fortunate enough to possess a special sprinkling car fitted with rail nozzles, which the cleansing department use for watering the streets, this water car is sent out to clean the rails.

Different rail cleaners are often advocated for the purpose of reducing current consumption, but I think that most of them, although they clear the groove, leave a lot of dirt and dust upon the tread of the rail in dry weather; therefore, I think that the best rail cleaner is a water car. Although the current consumed on a wet rail is less than on a dry rail, I find that on rainy days the consumption of current is higher than on dry days, but this is owing to the greater number of passengers carried at rush-hours, and, consequently, the greater number of stoppages.

In Aberdeen, simultaneously with the introduction of systematic supervision of the drivers, I noticed a great improvement in the time-keeping of cars; also, which is very important, a great reduction in motor troubles, the number of armatures in for repair being greatly decreased. The car repairs for Aberdeen last year stood at ·41d. per car mile, and I believe this is largely due to the reduction in current consumed.

I think the question "which particular type of meter should be adopted?" is quite a secondary point. We in Aberdeen saved a great deal before adopting any meter. There is no doubt, however, that the meter is a most valuable part of our system of check now, and saves a great deal of supervision.

CONTINENTAL AND BRITISH TRAMWAYS.*

By A. R. FEARNLEY, General Manager, Sheffield Corporation Tramways.

In comparing the working of bow collector and trolley boom systems, like most British managers, I have only had actual working experience of the trolley system. In 1907 I had, however, the opportunity of experimenting with a bow collector which was manufactured by Messrs. Brecknell, Munro & Rogers, Ltd., for a Russian tramway, and whilst, of course, our overhead line had not been constructed for a collector of this type, we found that there would have been little difficulty in obtaining very satisfactory results with this arrangement if the overhead line had been suitable. At the same time, knowing the serious disadvantages of the trolley, and from what I have seen of the bow collector, and the little experience I have had with it, I am inclined to the opinion that, as used on the Continent, it is the better arrangement. I am of the opinion that the trolley boom, with its attendant overhead fittings, is the most unmechanical feature of the whole of our tramway equipment, and despite all that can be done in the way of perfecting our overhead work by keeping the line over the track, planting extra poles and fixing extra pull-offs to ease the curves and by regular and systematic examination of trolley standards, trolley heads and overhead fittings, there is still a big weakness in this attachment. Many officials may state that their trolleys work with very little trouble, with few accidents and at a low cost, and to a certain extent no doubt this view of the question is an accurate one. At the same time, we must admit that, notwithstanding every precaution, many serious accidents are narrowly averted, a considerable number of which are never heard of officially, especially if some carelessness has taken place and there appears to be no likelihood of the occurrence coming to the ears of the officials. The bow collector seems to give entire freedom from danger in this respect. It further very considerably simplifies the overhead fittings and construction work, although, on the other hand, it may shorten the life of the trolley wire. I am not in a position to say that the bow collector can be maintained as cheaply as the trolley boom, as, despite personal enquiries and

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considerable correspondence, the figures which I have been able to obtain regarding the maintenance of the bow collector are very limited. I tried in three large cities on the Continent to get some exact figures showing the cost of working the bow collector, but, on each occasion, whether from the fact that they thought the figures might appear elsewhere at an inconvenient time or not, or for some other reason, I was unable to obtain definite information.

The cost of trolley upkeep in Sheffield for our last financial year amounted to £1,031 14s., or ·0336d. per car mile. The cost on a line where the bow collector is in use was given to me as being ·041d. per car mile, and, in my opinion, the bow collector would be a considerable advantage if it could be worked with such a small difference in cost.

Rail-less Electric Trolley Cars.

Reports of this recent addition to the method of meeting the requirements of suburban districts lying beyond the point to which it is considered financially safe to construct tramway tracks, show that there are very considerable possibilities in this system for the future, and, in my opinion, if it is given a fair trial without unnecessary restrictions and red flag regulations, it will, within the next few years, form an important addition to our tramway business.

Reports on the working of railless electric traction systems have been presented to four or five different corporations. Lengthy extracts from these reports have appeared, and I do not therefore propose to repeat the description of the system which is now well known to the majority of members of the Conference. I have, however, attached some technical data describing in detail the type of motor which is employed on the railless electric cars in use in connection with the Vienna Municipal Tramway system, which I believe has not been published before. Illustrations of these motors have appeared in the reports made by the deputations, and also in the technical journals.

In comparing this method of dealing with suburban traffic, I would say that I think it is superior to any system of horse, steam, electric, or petrol 'bus, which, so far as my knowledge extends, is at work in this country at the present time.

A number of the members of the Conference have had an opportunity of seeing these cars at work under varying conditions, and there is no doubt that if the old trouble on account of anticipated interference or damage to roads, is not made too much of, many suburban districts which are to-day without any connection with our existing tramway systems, and in some cases without any convenient means of access to our cities, will be able to be linked up by a system of this description at a low capital cost, and yet obtain a satisfactory service.

The question as to how far the working of railless electric traction will in future obviate the laying down of tramway tracks, is a most important one, and the subject is one which is worthy of the consideration of all municipalities who are considering the extension of their tramway routes into outside districts which are only thinly populated. The probability is that a system of railless cars would in such cases be found sufficient for many years to come, and the laying down of tramway track, with the consequent heavy capital expenditure, might be delayed for a considerable period.

As members are well aware, tramway track extensions of this description are not only expensive from point of view of capital required for outlay on track, etc., but it is usually found that street widening and road improvements, etc., which are demanded by the outside authorities, are also considerable burdens, and if this can be delayed until such times as the population has increased to such an extent as to place beyond doubt the question of its financial success, it will certainly be to the advantage of the municipalities concerned.

Some considerable time has now elapsed since the reports of the deputations regarding the feasibility of adopting the railless electric cars were made, and as yet no corporation has obtained the necessary powers to work such a system, but it is anticipated that at least two of our large cities (Leeds and Sheffield) will obtain these powers within the next twelve months.

The reasons which a Committee in the House of Commons recently gave for striking out a clause empowering a tramway company, who were promoting a Bill, to work railless electric cars, will be interesting. They were :—

1. That they appeared to have no immediate intention of carrying out the experiment.
2. That the cases which they submitted where this system was in operation were not routes in streets of places where the traffic was as great as in the town referred to (*i.e.*, a town of about 126,000 inhabitants).

These reasons may be of use to members as showing the attitude which may be taken up by a Parliamentary Committee when this matter is again brought forward in a Parliamentary Bill.

Conclusion.

Another method which one notices in comparing the ways of working, and one which is frequently adopted on the Continental systems, is the placing of the tramway tracks at the side of footwalks. This method is rarely seen in this country, and then only where its adoption is compulsory, the Board of Trade usually viewing such work with considerable misgiving, and specifying low speeds for cars running on track in such positions. On the contrary, it seems to be accepted in many places on the Continent as a necessary arrangement for the convenience of the tramway passengers, and it does not appear to lead to any increase in accidents, and is certainly a very great convenience in the loading and unloading of cars.

In regard to the track, I find that we are adopting very similar methods to those in operation on the Continent. They appear to have had in use for a considerable time rails with wider groove and tread than the old English types which are now rapidly being abandoned for the British standard sections. Speaking generally of permanent way construction, I should say that in few places on the Continent is it equal to the permanent way to be seen on the majority of our municipal tramway systems. The junctions, crossings, and paving near the rails are certainly not kept in as good a condition as we are accustomed to see in this country.

With regard to the trolley wire, grooved wire is very largely used, and no doubt it has been found of equal advantage with the bow collector as with the trolley boom.

Comparisons of our methods might be carried considerably further, but it must be remembered that the climate and the conditions of living in the Continental cities vary considerably from our own, and in comparing the tramway systems, these must also be borne in mind. Generally speaking, we must agree that their methods and system appear to meet the requirements of, and to give satisfaction to, their passengers. It is interesting to find that at their tramway conferences they are dealing with the same subjects and attempting to elucidate the same problems that have engaged and are engaging the attention of the members of our own Association. For instance, at the Annual Conference of the German Tramway and Light Railways Association, which I have just had the pleasure of attending in Hamburg, they were discussing the questions of :—

The repairs and renewals of car motors.

The standardization of rail sections for tramways and light railways ;

The cause of corrugations on tramway rails and the question of sharing the cost of carrying out the investigations in the inquiry which they are making ;

The best form of salt car and snow plough ;

The medical examination of motormen and conductors ;

all of which subjects are at the present time being, or have recently been, dealt with by our own Association. In some of the points raised there is no doubt our Continental friends are in advance of us, and I trust that the comparisons have been made in a fair way and in such a manner as may assist us in arriving at conclusions as to whether or not, in certain phases of their tramway work, it would be advisable to follow their example.

Electric Hub-Motors on the Vienna Municipal Trackless Trolley System.

The electro motor of the trackless trolley vehicle gives about 20 h.p. effective for a current of 500 volts at about 190 revolutions per minute, and the motors can be overloaded constantly for a longer period without detrimental heating up to double this amount.

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They are designed so that the field magnet spindle is mounted and fixed on the axle as an internal pole star. The armature is placed outside, and forms a whole with the wheel itself in such way that it revolves as a wheel around the pole star (field magnet). For this purpose it is carried on two ball-bearings, one each side of the field magnet. The field magnet consists of the best steel, and has ten poles, which are rivetted together under a specially patented process.

Each spool is wound in a patented way, and consists of a flat copper band of uniform section service, but of variable width and depth. In this way the space between the spools is used in an entirely useful manner all through, although those spaces get narrower towards the centre of the wheel on account of the radial disposition of the spools themselves. The armature is built in a similar way out of the best steel, and consists of a great number of spools thoroughly insulated by a silk winding, which are built into the frame of the wheel, which frame is made out of special gun metal.

The collector is placed outside this, and is arranged in a vertical plane so that the vibration of the car cannot lift the brushes, which consist of special carbons. In this way it is sufficient to have very weak springs pressing on the brushes, which causes an absolutely insignificant and minimum of wear of the collector plates, and an absolutely sparkless working.

For overhead line purposes, the motor consists only of four brushes, which are fixed on one ring, which is affixed in front of the collector. It is sufficient to take off the cover plate which is put on top of the collector to oversee the whole motor, and this enables one to fix or tighten up any part at wish. The motors are completely dust and water proof, and a special design of the axle makes it possible to take off with a simple and unique movement the whole wheel motor, and at the same time the radius rod, which is designed as fixing point of the brakes. The motors are placed in the back wheels for trackless trolley system, and in the front wheels for fire brigade work, sometimes also on trackless trolley lines of heavy gradient four motor wheels are employed—two at the back and two at the front—in which case the front wheels are fitted with a special design securing perfect steering even in the case of a sudden breakdown of one of the front wheel motors. The general rule, however, for trackless trolley is a back wheel drive, the brakes being fitted on separate air-cooled drums of very big diameter.

The efficiency of the electro-motors on the brake varies between 80 and 90%, which in itself is an extremely favourable efficiency grade, and if one considers that the power is directly brought to the motors in the wheel itself, and therefore no gearing or change of power or transformation of any kind is employed, this represents the efficiency at the wheel for a given current on the overhead line, which result it is claimed cannot be beaten by motors of any other type.

ELECTRIC POWER IN STEEL PLANTS.*

By R. TSCHENTSCHER.

Previously to September, 1904, the capacity of electric power plants in American steel mills varied locally from 200 to 3,000 kw. The largest units were of approximately 1,000 kw. capacity, and only direct current at a pressure of 250 volts was used. Plans in contemplation over a year before 1904 resulted in the construction of the first steel mill power plant of any magnitude at the south works of the Illinois Steel Co. This plant consisted of a 4,000 kw. station composed of two 2,000 kw. 25 cycle, three phase, 2,200 volt steam engine-driven generators. It was put in operation during September, 1904, and supplied two converter sub-stations, transformers for local alternating current motors, and a 22,000 volt transmission line 10 miles long supplying alternating current motors at a cement plant. Since 1904, many of the comparatively small electric power plants in steel mills have been increased to several times their original capacity.

Steel mills may be divided into four general classes, namely:—

A. Finishing mills, or those that buy steel in the shape of blooms or billets, and reduce them to a commercial form.

B. Steel-making mills, or those that buy iron and other materials needed in making steel. These mills are equipped with steel furnaces, and reduce their product to a commercial form.

C. Self-contained steel mills, or those that buy the raw materials necessary to make iron. These mills are equipped with blast furnaces, steel furnaces, and rolling mills for finishing the product.

D. Self-contained steel mills which also supply power to auxiliary plants, such as cement mills, or to other consumers.

A. The electrical problems differ somewhat in the mills as classified above. In finishing mills the electric plant usually consists of a direct current, steam-driven station of from 200 to 1,000 kw., supplying power for table motors, cranes, conveyors, lights, etc. No alternating current power is used, and the maintenance is a simple matter. The future problems of such a plant may result in the installation of motors to drive the mill rolls, replacing wasteful non-condensing engine and inefficient boiler equipment, and the installation of a modern efficient generating system, either steam-turbine or producer gas engine-driven (unless natural gas is available). The matter of installing storage-batteries and other refinements is a local one.

B. In existing steel-making mills the electric plant, though similar to that of plant *A*, is of somewhat larger capacity, ranging from 400 to 2,000 kw. The power demand is also for a similar purpose, and a mixed alternating current and direct current system is not required. The future problems of such a plant are similar to those of plant *A*. The development of the electric steel furnace may, however, be such that a commercially feasible equipment might result, and "cold metal" (pig iron, scrap, etc.) be converted into steel, thus doing away with cupolas or Bessemer converter installation. The electric power problem would then be materially altered, as described later.

C. In existing self-contained mills, the present problems are so diversified that a generalisation is not as feasible as in the two preceding classes. The electric plant problem is virtually a local one. A few general remarks may, however, be made. The electric power plants of such mills range from 500 to 10,000 kw. capacity, the larger capacity depending upon whether motor-driven rolling mills are in service, and other considerations of large power demand. In plants without motor-driven rolling mills a single direct current system often exists, which, when properly arranged, makes for a decidedly simple and easily maintained equipment. The power demand consists of: 1. Ore-handling equipment, such as unloaders, conveyors, distributors, etc. 2. Sundry blast-furnace service, such as raw material supply cars, skip hoists, etc. 3. Steel-furnace application such as raw material, hot metal and scavenger cranes, charging machines, stripper cranes, etc. 4. And for the sundry rolling mill purposes as previously enumerated.

In mills without large concentrated power demand the problem of installing storage batteries is a local one, and will depend frequently on the ore-handling equipment. If this be considerable, or if located some distance from the power plant, then questions of power-plant capacity or of voltage at the ore-handling plant may be solved advantageously by proper storage battery installation instead of added direct current generators in the former case and alternating current generators and converters in the latter case. Where such ore-handling load does not exist, the station power fluctuations will in general not be over 10 or 20%, and sufficient generating equipment only is needed. This equipment may be operated at a high load factor, the necessary maintenance being attended to on Sunday when the rolling-mill load does not exist. The desirable arrangement of simplicity and uniformity of equipment which exists in every industry is most pronounced in mill work, on account of the comparatively large repair expense, the inefficient operatives, and the costliness of delays. Therefore, a single generating system with simple distribution is desirable and feasible in plants of this kind.

In plants with motor-driven mills or other sources of considerable power demand, the problem becomes rather complicated. Again, it is one of local treatment, though no doubt a few general principles may apply. The generating requirements will in most cases result in an alternating current equipment. If the plant is an existing

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one, and inefficient rolling-mill engine and boiler equipment is to be replaced by motors operated by means of efficient power generated in the vicinity of the blast furnaces so that blast furnace gas may be utilised, then the commercial limitations will not usually admit of replacing the existing direct current generating station. A second station must be built, either adjoining the direct current station or at some more advantageous point. Proper electrical connecting apparatus between the two stations must be supplied. This will usually consist of a converter floating between the two station bus-bars. The advantage of this arrangement cannot be overestimated, as operating conditions will usually be such that at stated intervals (Sundays) either station may be shut down in whole or in part. The selection of proper alternating voltage may also be a local one, though the experience of the last 5 years shows that the increase of electrical application in steel mills is so rapid that a pressure of less than 6,600 volts for local generation and distribution will no doubt result later in an unwieldy arrangement of switchboard and cable equipment and distributing feeders. The frequency of 25 cycles, now used almost exclusively, is most suitable, and nothing has yet appeared to indicate that a higher or a lower frequency would be more desirable.

D. It will no doubt be of some interest to discuss specifically a few of the electrical problems encountered in a large steel mill. For this purpose the plant of the Illinois Steel Co. at South Chicago, Ill., will be outlined. This plant comes under classification *D*, previously referred to; namely, self-contained steel mills which also supply power to auxiliary plants, such as cement mills, or to other consumers. Naturally enough, it is in such plants that the greater variety of electrical problems exists and where electrical application will be most extensive.

The South Chicago works of the Illinois Steel Co. is a good example of the self-contained steel mill. Its development during the last 5 years has been remarkable. Prior to September, 1904, the electrical equipment of this plant consisted of a direct current generating equipment of 2,900 kw. at 250 volts pressure. Even at that time this was the largest electrical installation in an American steel plant. The electrical power demand consisted of that usually found in mills under classification *C*, namely, all classes of cranes, mill tables, and miscellaneous equipment, illumination, etc. Since that time additional blast furnaces, ore-handling equipment, steel-making mills, finishing mills, and two cement plants have been added. Where steam engines had been used at blast furnace skips, motors were installed, and the cost of operating was reduced. Where steam engines had been used for ore handling and for all new ore-handling equipment, motors were installed, the output increased, and the cost reduced. Where new rolling mills were designed, motors on the main rolls were specified, with consequent increased tonnage at lower fuel and maintenance costs. Where new cement mills were installed, motor drive was employed throughout, and power obtained by means of high-voltage transmission lines from an efficient power plant. Again, the output was increased and the cost reduced.

Without going further into details, the electrical installations at this plant have during the last 5 years resulted in an equipment approximately as follows:—

Number of motors, both alternating current and direct current	2,000
Total motor horse-power	75,000
Total number of arc lamps	1,500
Total alternating-current generating equipment installed	16,000 kw.
New alternating-current generating equipment being installed	9,000 ,,
Total direct-current generating equipment installed	3,000 ,,
Total generating equipment	28,000 ,,
Total synchronous converter (and transformers) and motor-generator equipment	6,500 ,,
Total storage-battery equipment	1,200 ,,
Total transformer equipment	31,000 ,,

The variety of the equipment may be judged from the various existing voltages, namely, 250 volt direct current; 110, 440, 1,100, 2,200, and 22,000 volt alternating current. This plant comes under the heading of "evolution plants," that is, plants wherein steam and hydraulic equipment have been in process of replacement by electrical equipment. The solution of the various problems in such a plant does not result in the more desirable and simple systems which will be found in future new plants, for in the new plants the large variety of voltages mentioned above will surely be avoided.

One of the problems in steel mills now receiving considerable attention, and which in the future will be one of the real engineering problems, is the conservation of waste heat. The existing waste heat at open hearth furnaces forms an enticing point of attack; this waste may be eliminated by replacing such furnaces by electric steel furnaces. These furnaces will be mentioned later. However, the waste heat at rolling mills does not as yet appear to be capable of satisfactory elimination. All steel before being rolled must be heated so that an even temperature and, hence, even consistency throughout the piece will result. Producer gas furnaces are now used almost exclusively for this purpose. The stack temperatures are usually very high, being between 800 and 1,200° Fahr. These temperatures may readily be reduced by passing the gases through suitable steam boilers to provide steam for turbine generators. It is not at all improbable that instances exist where, with proper installation of boilers, regenerators, turbine generators, and roll motors, a rolling mill may be made a self-contained unit, obtaining from its present waste heat sufficient power to supply electrically the entire requirements of the mill, including the roll motor, table motors, crane equipment, lights, etc.

The utilisation of the energy remaining in the exhaust from non-condensing engines and from compound engines is now receiving serious consideration, the large amount of energy being wasted in engine exhaust steam in non-condensing engines being roughly estimated at 50% of the total available energy. The rolling-mill engine appears to offer a very desirable point of attack in this connection. However, the writer wishes to emphasise that there are many other places in most steel plants where this problem might better be attacked from the standpoint of permanent equipment. By attaching a low-pressure turbine equipment to the exhaust of a non-condensing rolling mill engine, a premium is put on the retention of that engine in service. The superior operating and cost advantages of motor drive over reciprocating engine drive (with accompanying boiler equipment) cannot be taken advantage of. The steam engine with a tail in the form of a turbine generator will be much more difficult to get rid of. It would, therefore, appear that the other weak points about the mill should be first seriously investigated.

The steam engine blowing equipment at many blast furnace plants consists of well-built compound engines. The possibilities here for low-pressure turbine installation are very great. At a plant which recently came to the writer's attention, four blast furnaces receive blast from eight modern condensing blowing engines. Roughly, the amount of steam required by these engines is 300,000 lb. per hour. By the addition of less than 100,000 lb., these engines develop their required power with exhaust at 16 lb. absolute. These 400,000 lb. of steam would be sufficient to supply a low-pressure turbine generator capacity of approximately 15,000 kw. The power station installation might consist of three 5,000 kw. units. Sufficient power would be available to convert all the mills at this plant to electric drive.

One of the electrical problems at the plant of the Illinois Steel Co., which may be of interest, concerns the installation of additional generator capacity. A solution of the problem which contains many admirable points was an installation of a low-pressure turbine so designed that high-pressure steam up to full capacity will be economically utilised. Compound condensing reciprocating engines in the power station and in an adjoining blowing engine station will normally supply the steam for this turbine, which will be of 9,000 kw. capacity. Each compound engine will be so arranged that it may exhaust into the present condenser, or into the turbine main at slightly above atmospheric pressure. In case of insufficient low-pressure steam, the deficiency may be supplied from the high-pressure main, the turbine being so arranged that this high-pressure steam will be economically employed by means of a separate valve and nozzle chamber. Should no low-pressure steam be available, the full capacity at high-pressure steam may be obtained. The condensing equipment will be adequate, the yearly calculated vacuum

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averaging better than 1 in. absolute pressure. Reliability and economy are the predominating features in the installation. The operation will be watched with interest, and it is expected that gratifying results will be derived.

Another problem at this plant which may be of interest was the improvement of the power factor. The installation of alternating current roll motors, miscellaneous small alternating current motors, and the expansion of cement mills, where the sole drive is by induction motors, has so affected the power factor, that at present the station power factor is not over 70%. The largest item in bringing about this condition is a load of approximately 7,000 kw. of induction motors at a cement plant supplied by a 10 mile transmission line of 22,000 volts stepped down to 440 volts. Improvement of the station power factor by corrective means at the cement plant at once suggested itself. This might originally have been accomplished either by the installation of direct current equipment, including motor generators or synchronous converters, or by the use of a considerable number of synchronous motors in place of induction motors. The operating conditions—character of service, cement dust, and inefficient operatives—make the former comparatively impracticable; the additional complication of miscellaneous operation of synchronous motors at proper power factor by inefficient help makes the latter also undesirable. It is an ever present axiom in steel mill practice that the mill equipment should be simple, rugged, and easy of operation and repair. Whatever refinement and complication may be beneficial should be confined to engine rooms, power stations, sub-stations, etc., where labour more skilled in maintaining the equipment may be employed. The foregoing, therefore, decided that the cement mill equipment should include the induction motor, the squirrel-cage type being used wherever possible, with simple starting apparatus such as step-down transformers with starting bus-bars, instead of local compensators and starters for each motor.

The question of power factor correction resolved itself, then, into the installation of "synchronous condenser" equipment. In order to prove such an equipment commercially advisable, it is, of course, desirable to have the so-called condenser do mechanical work, so that such proportion of its initial cost and operation and investment expense could be charged against it, making the charge for power factor correction correspondingly less. However, mechanical work of sufficient magnitude did not exist at the cement plant, and the problem resolved itself into determining whether such a synchronous condenser equipment operating idle would prove a commercial proposition. A detailed study of this case was made; the following items give the points at which loss of energy would be reduced, a loss that could be expressed commercially, most of the factors being the components which influence combined efficiency:—

(*a*) At station generator fields, due to less excitation being required as the power factor improved.

(*b*) In station cables and switchboard equipment, on account of less current at improved power factor.

(*c*) In step-up transformers, due to improved power factor.

(*d*) In transmission line, due to less current and improved power factor.

(*e*) In step-down transformers for the same reason.

(*f*) In step-down transformer wiring and switchboard equipment.

To offset the foregoing there is the energy required to operate the so-called synchronous condenser. With a delivered load of approximately 7,000 kw. at 70% power factor, the over-all efficiency is approximately 83%. The installation of two 1,650 kilovolt-ampere synchronous condensers will raise this over-all efficiency to 87·5%, the net gain of power being approximately 300 kw., which at 0·5% per kw.-hour represents a yearly saving of approximately $10,000. In addition to this, the power station capacity will be appreciably increased, due to the present engine capacity exceeding present generator capacity, and due in a small measure to decrease of excitation load. This gives the commercial aspect. The purely technical aspect of improved operation (regulation and control) due to improved power factor needs but to be mentioned.

Where alternating current motors are used to drive rolls, or for miscellaneous mill purposes such as for tables, cranes, etc., where now direct current motors are used almost exclusively, the power factor conditions will no doubt require power factor correction; this may be accomplished by the installation of adequate synchronous condenser installation. The commercial problem will here be rendered more simple, for considerable mechanical load in the nature of air-compressors, pumps, fans, etc., may be supplied to render the charge for power factor correction materially less than that outlined above.

Before closing, it may be of interest to dwell upon another problem of considerable magnitude which is just becoming manifest. This refers to the manufacture of steel by means of electric power. The Illinois Steel Co. has in operation a 15-ton electric furnace of the carbon-arc type. Three 750 kilovolt-ampere, 2,200 to 100 volt, 25 cycle transformers are installed. That the making of steel by means of electricity will in the near future be an active commercial proposition in the manufacture of product where now crucible, open hearth, and Bessemer steel is used, is practically an established fact. The extent to which electric power will be necessary for this purpose can easily be conceived to require power stations of a magnitude comparable with those of the largest lighting and railway plants. The writer believes the future will demonstrate that the country's largest power generating stations will be found within the confines of the steel plants. When one considers that a steel making furnace plant utilising electric power to generate the necessary heat, and having a capacity of 4,000 tons per 24 hour, requires generating capacity of 20,000 to 30,000 kw., it is not difficult to conceive the magnitude toward which the future steel mill power plant will tend.

Let this thought be carried a little further to illustrate a plant wherein the application of electricity would be supreme. A 2,000,000 ton per year self-contained plant, where coal, flux, ore, and other raw materials enter, and where all classes of steel products, together with cement and the bi-products of coke ovens, leave the plant as finished saleable product, might consist of a blast furnace plant, a Bessemer converter plant, an electric steel-refining plant, a sufficient number of rolling mills, a cement plant, and a coke oven plant. Such a plant would require electric generating capacity depending largely on the extent to which the finished product is carried. Consider the plant as finishing three-fifths its product as rails, one-fifth as plates, and one-fifth as structural shapes. The total electric power requirements for such a plant would be over 100,000 kw., and it is quite likely that such power could be generated without burning coal for power generation fuel purposes. The so-called waste gases of blast furnaces and coke plants and the utilisation of other waste heat will supply more than the required fuel.

If now a plant be conceived wherein the product is further finished, for example, into tin plate, wire, etc., a point may be reached where fuel must be obtained from sources other than the usually considered waste sources about the plant. The possible reduction of iron from ore by electrical application, or the manufacture of steel electrically direct from ore, are mentioned merely to show a possibility. The realisation of such a possibility would produce a problem the solution of which would result in power plants in comparison with which the foregoing mentioned equipment would be inconsiderable.

ELECTRIC SMELTING IN PRODUCTION OF IRON AND STEEL.*

By E. J. LJUNGBERG (Falun, Sweden).

On the whole there is at present not much more to add to what has already been published concerning the melting of steel by use of electric current. Many types of furnace have been evolved and constructed—the Héroult, Kjellin, Stassano, Girod, Röchling-Rodenhauser, and others. It is also well known that furnaces up to a capacity of 15 tons have been built for making special steel with good commercial results. For making steel of ordinary quality the electric method still seems to be too expensive, even where cheap water-power is available.

* Paper read before the Iron and Steel Institute.

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At Gysinge, one of the works belonging to the Stora Kopparbergs Bergslag, there is one Kjellin induction furnace with a capacity of 2 tons, but as this is working as a Talbot furnace, not more than about one ton at a time is tapped.

The continuous current used in this furnace represents about 200 kw., and the output in 300 days amounts to about 1,200 tons of ingots using 50% pig and 50% scrap. As no other pig iron is used except the famous Dannemora brand made by the firm, which, as every one knows, is extremely low in phosphorus and sulphur, the process can hardly be called a refining process. The product is a carbon steel of high quality, possessing some superiority over steel made by the ordinary melting processes, the quality which I would instance specially being that it is comparatively soft to work, either hot or cold, although high in carbon. It is a superior carbon tool steel. It may be of interest to state that the company makes about 15,000 tons of Dannemora charcoal pig iron annually, of which about one-third is exported and two-thirds are used at the works at Söderfors and Elfkarleö for the manufacture of Dannemora Wallon bar iron, open-hearth, and crucible steel.

In the electric furnace, as well as in the crucible plant, there are also produced, among different kinds of special steel, high speed self-hardening steel, tungsten steel, chromium steel, and nickel steel. Such steels can easily be made in electric furnaces when the necessary care is taken. When speaking of high quality steel, all steel-makers know that the utmost care in heating, hammering, rolling, and tempering is necessary if a good result is to be obtained.

For a country like Sweden, possessing practically no coal-mines, but numerous waterfalls, the manufacture of iron and steel direct from ore by the agency of the electric current is of much more interest than the melting of pig and scrap to make steel. At the works at Domnarfvet, extensive and costly trials have therefore been made in the direct reduction of ore during this and the past few years.

In these experiments two modifications of a furnace, constructed by Mr. Wallin in Berlin, and several modifications of a furnace, constructed by Messrs. Grönvall & Lindblad (the Electro Metal Co.), Ludvika, have been tried. Of these, it is needless to describe any except the latest form.

The accompanying drawing shows a furnace similar to a common blast-furnace, but with three electrodes fed by three-phase alternating current at about 40 volts, 60 cycles, and 9,500 amperes, averaging 674 h.p., instead of tuyeres. In this furnace, which has been running for 1,903 hours, there have been produced 28 tons of iron, containing from 0·95 to 3·09% of carbon.

In the manufacture of this quantity there was used :—

	Tons.
Ore	442
Lime	24
Coke	41
Charcoal	58
Electrodes, total	6·5
Electric current (kw. hours)	891,623

or per metric ton of pig iron produced :—

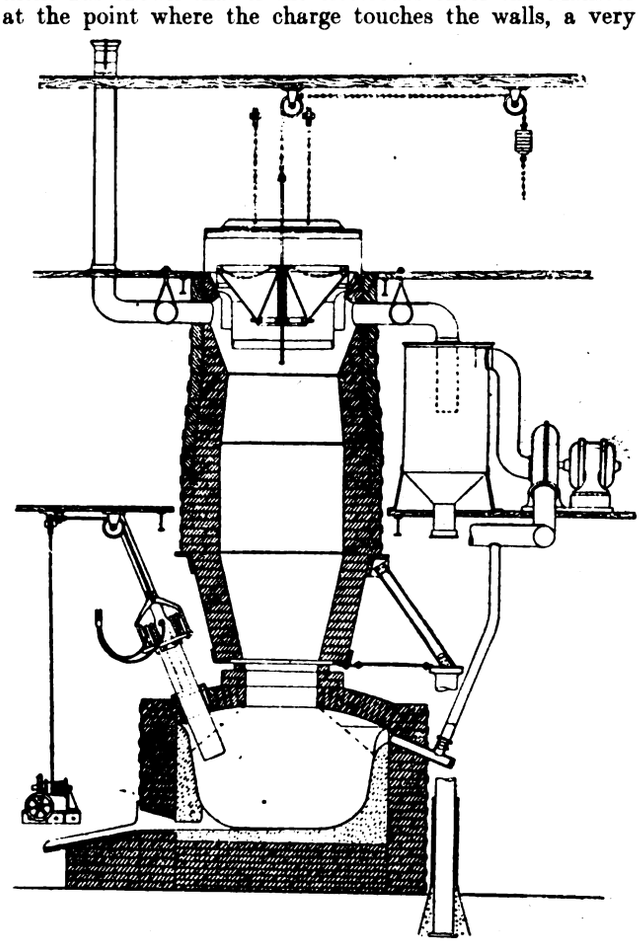
	Kilos.
Coke and charcoal	353·3
Power, horse-power year	0·492
Electrodes, effective 8·8 kgs.	
Wasted ends 13·9 „	
	22·7
Pig iron from ore and lime	60·02
Pig iron from ore alone	63·50
Pig iron per horse-power year	2·03 tons.

The temperature of the escaping gases from the furnace is generally very low, and contain on an average about 22% of carbon dioxide (from 8 to 41%). The amount of carbon monoxide varies from 39·4% to 61%. The gases contain practically no nitrogen, but steam from the water in the ore, lime, coke, or charcoal is present.

The efficiency of the electric current ought to be higher than hitherto, if the considerable loss of heat by cooling water and radiation can be reduced. These losses seem to be about 30%.

No air whatever is used in the process, and the gases are produced from the carbon in the charcoal and coke and the oxygen in the ores ($FeO + C = Fe + CO$). Either charcoal or coke may be used, but the consumption of fuel will be practically the same in either case.

According to the description of the inventor, the figure shows a vertical section through the furnace, which consists of a lower portion or smelting chamber, corresponding to the hearth of a blast-furnace, and a top section or shaft. The latter is supported on columns, which prevent any weight from bearing on the arch of the smelting chamber. The latter is so proportioned as to provide a considerable amount of free space between the charge and the arched roof through which the carbon electrodes project into the charge. The brickwork is thus protected against any very high temperature, and remains a non-conductor of electricity. This is an important feature of this furnace, since experiment has shown that if the electrodes enter the chamber at the point where the charge touches the walls, a very



SECTION OF FURNACE.

high temperature is generated at this point; the brickwork is destroyed and becomes a conductor of electricity, giving rise to a more or less complete short-circuit. The brickwork may be further cooled by means of a blast of cool gas taken from the top of the furnace and blown in round the electrodes with a fan, no heat being lost by this proceeding.

The ore and fuel are crushed to a suitable size, and are fed into the top of the furnace through the bell hopper in the usual way, the ore being partially reduced by the carbon monoxide rising through the charge. The latter spreads out in the smelting chamber as shown, and the reduction is there completed. Since the electrodes project well into the charge, the highest temperature occurs in the centre of the latter, and the brickwork is thus kept cool compared with the walls of an ordinary blast-furnace.

It will be seen from the figures given in the paper that a step has been taken in the direction of replacing a considerable part of the fuel used in making iron and steel by the electric current, and that the problem is technically solved. As regards its commercial value, it is too early to make any definite statement yet, but this will be readily understood by all iron and steel makers when they reflect how many years it has taken to bring the Bessemer, the open-hearth, and the basic processes to their present state of perfection.

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ELECTRIC FANS: THEIR USE AND ABUSE.

Considerable stir has been made in sanitary circles at home and abroad by the published results of investigations carried on by Drs. A. Sartory and Alfred Fillasier (the latter an official of the Paris Municipal Council) into the action of small ventilating fans on the purity of the atmosphere. These fans, of the exhaust type with wings revolving in a grooved rim at their periphery, and of the four blade pattern with free ends, are used on the Continent even more generally than they are in England.

As a rule, they are employed merely as fans, not as ventilators. That is to say, their chief mission is to produce a sensation of coolness by causing air waves, and in this way also hastening the dissipation of clouds of smoke and vapours. Out of the fifteen cases investigated by the two French doctors, mostly in places of public resort, such as cafés and restaurants, in only two were the fans actually used as ventilators; that is, placed in direct communication with the outer air, and so acting as exhausters, removing foul air, and thereby inducing the ingress of fresh air. In all other cases observed the fans were solely employed as agitators, being placed at levels varying from 5 to 10 ft. from the ground. Circumstances varied considerably, in one place a single fan being used in a room of 600 cubic metres capacity, in another three fans being at work in a room of only 450 cubic metres. In other words, the fanning was often overdone, too many and too powerful fans sometimes being placed in awkward positions, giving rise to draughts, incommoding the servants. But the chief point of observation was the atmosphere itself.

The method of investigation was to expose gelatine plates to the air for a measured time, and then to incubate these, cultivating the bacteria and counting them. Investigations commenced early in the morning, from 9.30 to 11 o'clock. Cultures were made from gelatine plates exposed before the fans had been set in motion, and again after the fans had been in motion for one hour. Sometimes further samples were taken after two hours working of fans, and once again after the fans had been stopped and allowed to rest for an hour.

In all fifteen cases the doctors found that the effect of the fans was to vastly increase the number of bacteria present in the atmosphere. Let us take a typical case: that of a small wine-shop, the room 100 cubic metres, one air-beating fan with no outside communication being used. At 10 o'clock, before the fan had been set to work, the air contained 18,000 bacteria to the cubic metre; one hour after the fan had been in motion the number was 42,000 bacteria to the cubic metre, and rose to 65,000 after two hours' work. The fan was then stopped, and within an hour the bacteria had dropped to 21,000 per cubic metre. An even more startling case is that of a medium-sized café, where the currents were respectively 18,500 before fanning, 35,000 after an hour's working of the fan, and 85,000 after two hours. In this instance a couple of fans were at work, and were of the flat blade pattern.

Where the fans were used as ventilators, that is to say, as exhausters and introducers of fresh air by induced draught, the results were far better. A café, 750 metres capacity, had a winged fan communicating with the outer air, and a flat blade air propeller without communication. The observations were carried out at 11 a.m., and showed, in an open part of the room, the following results: Before the fans were in motion, bacteria 10,000 per cubic metre, after one hour's fanning 17,000, after two hours 27,500. Simultaneously, observations were taken close to the air propeller, with these results: Before the fans were set in motion, bacteria 11,500 per cubic metre, after one hour's fanning 19,000, after two hours 37,000.

It would appear from this that the doctors' contention that these fans acting as agitators have the effect of raising dust and filling the air with it and its bacterial content, is well established. Under given circumstances this might prove highly dangerous; for instance, in hospitals, convalescent homes, or places of public resorts where consumptives happened to be present, for then a percentage of the bacteria would be pathogenic germs, capable of setting up specific diseases. It is, however, easy to exaggerate the danger. All bacteria are not harmful, though their presence in undue numbers betokens insanitary conditions. It is certainly well to consider the doctors' investigations and to take measures to correct the evils they point out. But this does not mean that we need subscribe to their demand for the total prohibition of all such fans. Far from it. For such fans fulfil a most useful function, if only common-sense precautions are adopted.

It is scarcely necessary for us to dwell on the fact that dust should be kept down in private and public rooms, by the judicious handling of slightly damped cloths. What directly concerns us is the adapting of the fans to the special work they have to perform. Their size and the velocity at which they run must be suited to the size of the room in which they work and other surrounding conditions.

Where they act as air exhausters, they are usually placed high up, and so may be safely run at a high velocity, for direct draughts are avoided, provided that the air inlets are so arranged as to distribute the incoming air evenly and over as wide an area as possible. As Drs. Sartory and Fillasier show, where this course is in vogue the influence of fans in increasing the bacterial content of the air is but slight, for one must remember that the rise from 10,000 to 27,000 is not all accounted for by the raising of dust by means of the fans. The first observation was taken at 11, when few people were present, the third at one o'clock, when the café would be crowded, and the atmosphere naturally more polluted.

When, however, fans are used not as ventilators proper, but as propellers for cooling the air, then it is well to augment the size of the blades and to diminish their velocity, so that refreshing air waves may be obtained without great disturbance. In fact, we must imitate, as closely as may be, the action of the large Oriental fan or the punka.

That is, if one use the ordinary types of fans in the ordinary way. But Dr. A. Richet, who was also exercised by the same phenomena that disturbed the two first-named scientists, carried his experiments further, with the result that he has been able to tell the Academie de Medicine of Paris of an admirably simple method for cleansing the atmosphere of rooms. Dr. Richet approves of the disturbing air propeller. The more violent its action, within reason, the better for his purpose. For his object is to draw all the air in a private sitting room, a hospital ward, a place of public resort, or a factory through the fan, and there to deprive it of its dust and microbes. This he does easily enough.

He places his electrically driven fan in a cylinder, opening funnel-wise at top and bottom. Over the cylinder is placed a small tank containing water, which is allowed to fall drop by drop on the wings of the revolving fan. The result is

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that a spray is at once created, which condenses on the sides of the cylinders, slowly trickling down to a waste receptacle below. But the water is no longer pure, for it has washed the air, as it rushed through the cylinder, of all impurities, including smoke, dust, and bacteria. It will thus be seen that by means of a very slight modification, the evil of which Drs. Sartory and Fillasier complain, may be converted into a blessing. The fans are used to wash the air, and the water will also help to cool the atmosphere in summer, and to correct the enervating dryness of overheated places of public resort in winter. Indeed, for places of public resort, and especially restaurants (say, smoking, rooms and billiard saloons) the system is ideal. So, too, will it be found to confer immense benefits in tropical countries.

Then, for special purposes, the tank itself may be manipulated. For instance, if running in a hospital or sick room, the water may contain a slight admixture of disinfectant. In factories where dust-producing industries are carried on the fans or the funnels at the base of the cylinders, may be so placed as to draw the dust away from the workers, and the trickling water may be made slightly sticky by the addition of some such aglutinant as soap or glycerine, or where carbonic acid is evolved to an inconvenient degree, soda or potash would be a useful addition, and chloride of copper where carbon monoxide had to be counteracted. Indeed, we may say that Drs. Sartory and Fillasier have conferred a public benefit by their investigation ; not that we adopt their conclusions, but the rather that it emphasises the utility of these air agitators, since Dr. Richet has shown how by this means one can wash, purify, and cool the atmosphere.

It is a discovery of immense importance, and it behoves makers of ventilating fans to put it to practical use.

SUCCESSFUL ELECTRICAL EXHIBITION.

CORPORATION AND CONTRACTORS COMBINE.

The Electrical Exhibition promoted by the Electricity Department of the Greenock Corporation with the co-operation of the local contractors has proved extremely successful. The object of the exhibition was to demonstrate in a practical manner the advantages of utilising electrical energy for cooking, heating, lighting and power. In order to bring in likely customers, complimentary tickets were issued by the Department, but the demand for these became so great that a charge for admission was made on the fifth and concluding day. It is estimated that nearly 10,000 visited the exhibition at the Town Hall, and hundreds were unable to obtain admission in the evenings. Numerous inquiries were received by the Corporation and the contractors represented, and several substantial orders taken during the course of the exhibition. The hall was beautifully decorated by the Burgh Electrical Engineer's (Mr. J. A. Robertson) staff with variegated electric lights, while the "electric home," comprising a suite of four rooms fitted with up-to-date electrical appliances clearly showed the value of electricity for domestic purposes. At the Corporation Power Stall were to be seen numerous applications of electricity for power purposes. Considerable attention was attracted by a small electric crane suspended from a girder, which was fitted with an electro magnet that picked up heavy iron or steel plates and girders, the hand labour being confined to the operation of the switches. Demonstrations of electrical cooking were given twice daily, the electric utensils including ovens, grills, hot-plates, toasters, milk warmers, sterilizers, kettles, etc.

Electric advertising signs, power appliances (including electrically-driven vacuum-cleaners), an electric fairy fountain, and demonstrations of Rontgen Rays were other attractive features of the exhibition. In addition to the contractors taking stands, a number of leading electrical firms in the country contributed freely of their most recent domestic and other appliances for the exhibition. At the opening ceremony, Mr. Robertson observed that while people in Greenock were comparatively familiar with the use of electricity in shipyards and other public works, there were, perhaps, not so many who knew that electricity could be applied to the humbler domestic uses of boot polishing, knife cleaning, cooking, heating, and so forth, reducing house labour to a minimum.

INTERPOLE GENERATORS AND MOTORS.*

By W. B. HIRD, M.I.E.E.

In generators and motors running at abnormally high speeds, and motors in which a high range of speed variation by means of shunt regulation is required, the reactance voltage of the short-circuited coil becomes so high that commutation cannot be satisfactorily carried out without some special device. Broadly speaking, the reactance voltage of an armature is increased by increasing the length of the armature core relatively to its diameter, and also by decreasing the total magnetic flux of the machine.

It is possible by the use of interpoles to work with values of the reactance voltage five or six times as great as would be admissible in an ordinary machine, and with careful design the results are entirely satisfactory.

The discussions which have taken place on this subject have been full of warnings as to the danger of introducing interpoles into general design merely because they were useful in special cases, and very determined attempts have been made to restrict the use of interpoles to these special cases ; but, nevertheless, the use of interpoles in machines running at moderate speeds and of ordinary output is becoming more and more frequent. It is also becoming more and more usual to find interpole machines specified by users, who have had experience of them and prefer them to ordinary machines.

The principle of all interpole designs is to provide a small auxiliary pole between two main poles, in such a position and so proportioned that it will provide just such a field as is suitable for counteracting the reactance voltage of the short-circuited coil under the brush. The interpole is always series wound, and its winding carries the whole or a fixed proportion of the armature current ; thus, so long as the iron is not saturated, the field strength under the interpole is always proportional to the armature current, so that if the design has been correctly worked out to give good commutation, say at full load, the same relation will hold between field strength and the armature current to be reversed at any other load, and the machine will work sparklessly without any change of brush position at any load, the only limit being the saturation of the iron core of the interpole. That is, the machine will carry sparklessly and without change of brush position any overload up to the point where the increased ampere-turns on the interpole cause the iron to approach saturation.

One of the simplest formulas for calculating the reactance voltage is that published by Mr. Mavor in a paper read at the International Engineering Congress in 1901. In a slightly modified form, this formula is : $P = e\,c\,f\,m\,\pi\,l/(p\,n)$, where P is the reactance voltage ; e, the E.M.F. generated in the armature ; c, the armature current ; m, the number of turns in one section ; l, the gross length of armature core ; p, the number of poles ; n, the number of magnetic lines per pole ; f, the number of lines per unit length of core due to 1 ampere flowing in one turn of the short-circuited coil. The value of f varies to some extent, but, for ordinary machines, it does not materially differ from 20 lines per inch length of core.

The value of the reactance voltage given by the formula is the maximum value ; on the assumption that the current in the short-circuited coil varies as a sine curve, to obtain good commutation, it is necessary that a field be provided under the interpole such as to generate a voltage in the short-circuited coil equal to 0·636 P.

The number of turns in the coil is m, and if R be the number of revolutions per minute of the armature, D the diameter of the armature, and λ the length of the interpole measured parallel to the shaft, the E.M.F. generated in a magnetic field of density B will be : $m \times \lambda \times B \times \pi\,D\,R / 60$; by hypothesis, this must be equal to 0·636 P, whence

$$B\lambda / l = 0{\cdot}636\ e\,c\,f \times 60 / p\,n\,\pi\,D\,R.$$

If the interpole shoe is made of the same length as the armature core $\lambda / l = 1$, and the formula gives directly the value of B required in the interpole gap. It is usual, however, to make λ less than 1 whenever possible, the advantages being to lessen the leakage between interpole and main pole, and also to minimise as much as possible the interference with the freedom of ventilation which an

*Abstract of paper read before the Institution of Electrical Engineers.

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interpole extending over the whole length of core would produce. It should also be noticed that, by decreasing the ratio ℓ / l, the value of B in the interpole air-gap is increased. If a very low value of B is used, there is no doubt that the reactance voltage of the short-circuited coil is increased by the presence of the iron pole-shoe, which decreases the reluctance of the magnetic path for lines surrounding the short-circuited coil.

If, however, the value of B is fairly high, this effect is much reduced, and the reluctance of the path and, consequently, the value of the reactance voltage is not appreciably affected by the presence of the interpole.

The width of the interpole shoe has been made equal to one slot-pitch plus one tooth-width, calculated so that the coil shall be under the interpole during the whole time of commutation; but, in practice, considerable latitude is possible in the choice of a pole-width, and from the point of view of leakage, the narrower it is, the better.

Since the interpoles are placed immediately over the brush—*i.e.*, on the axis of commutation—the whole of the armature ampere-turns act immediately in opposition to the interpole winding, and thus sufficient ampere-turns must be provided to neutralise the armature ampere-turns, in addition to those required to give the requisite value of B in the air-gap. From this it will be seen that the number of ampere-turns required on an interpole is considerable. As a matter of fact, they are frequently in excess of the number required on the main poles. The fact, however, that the interpole can usually be made of small section, so as to keep the mean turn of the winding short, enables this number of ampere-turns to be obtained with only a relatively small expenditure of copper.

The number of interpoles may be made less than the number of main poles, but although this arrangement gives good results on small machines—say, 20 h.p. motors, in which the reactance voltage is not excessive—it has not been found satsifactory in machines of any considerable size.

In order to justify the use of interpoles in small machines, it must be shown that such a machine can, by the use of interpoles, be made either better or cheaper than could be done on ordinary lines of design.

Since the material and labour expended on the interpoles make up, especially in a small machine, a not inconsiderable proportion of the total cost, a corresponding saving must be found in the other parts of the machine, due to the fact that the reactance voltage may be considerably increased without spoiling the commutation. The directions in which such a saving may be looked for are the use of a reduced depth of air-gap, allowing of smaller magnets carrying less copper; reduced number of commutator parts, saving both labour and material in the commutator; and, lastly, the possibility of working with a greater length of armature core relatively to the diameter.

The possibility of saving a considerable amount on the cost of any given machine by the latter means does not appear, up to the present, to have been fully taken advantage of. It is well-known that in the present practice the length and diameter are not chosen so as to give the machine most economical in first cost, and that greater relative length would almost invariably conduce to a lower cost price.

The way in which the costs may be expected to vary, for different diameters can be shown by curves, with d^2l as base line, and if it be assumed for the moment that the output of the machine watts/revolutions per minute is proportional to d^2l, the points where these curved lines cross will show the different lengths at which it is advantageous, from the point of view of economy in first cost to pass from one diameter to the next larger diameter. Such curves indicate that the economical lengths are considerably in excess of those usually met with. Thus the value of d^2l at which it becomes as cheap to make a 15 in. as a 12 in. machine is about 3,500, corresponding to a length for the 12 in. machine of 24 ins., and the point where the 15 in. and 18 in. curves cross corresponds to $d^2l = 5{,}800$, or a length of armature core for a 15 in. machine of 26 ins.

The question then arises whether the heating limit of output will not prevent the output of the machine being increased proportionately to its length. A long armature core dissipates the heat generated less readily than a shorter one, and when the length becomes so great as to require increased diameter of shaft, stronger spider, etc., the increased impediment to the circulation of air in the inside of the core makes the increased temperature rise more marked. When this limit to output is reached, it would appear that some method of forced ventilation, compelling the air to come in contact with the heated surfaces, might be devised to remove this limit to output also.

The use of forced ventilation of a simple form—*e.g.*, by fixing fan blades under the spider—and the use of forced commutation by interpoles has in many cases been adopted as an after thought when a machine failed to come up to expectations on test, and perhaps from this fact has arisen a feeling that such devices are not legitimate and that their use in machines of normal output is a confession of failure to obtain a suitable design on ordinary lines. The contention here is that far from being a confession of weakness, such devices are an added strength in enabling a larger output to be obtained from a cheaper machine.

Present interpole designs rely mostly on the saving to be obtained by the use of reduced air-gaps and smaller commutators with fewer parts, and find an advantage in their use even without taking full advantage in their use even without taking full advantage of the increased lengths made possible by the use of interpoles. The possible output of a machine as limited by sparking having been increased by forced commutation, it is to be expected that heating should now be found the limiting condition, and the logical conclusion appears to be that the next step is to devise improvements in the methods of getting rid of the heat, so that full advantage may be taken of the increased freedom which the interpoles give from sparking limit.

It should be noted that suggested lengths of air-gap for interpole machines are still made greater than the very small gaps to be found in induction motors, in which the mechanical difficulties have been successfully overcome, and also that the maximum lengths suggested still give a ratio of length to diameter much smaller than those commonly in use in the days of bipolar smooth-core machines. In view of these facts, it does not seem that mechanical difficulties need necessarily stand in the way of much longer armatures than we are at present used to, with smaller radial depths of air-gap.

On the score of efficiency it may be contended that increasing the losses to such an extent as to require forced ventilation will lower the efficiency of the machine; but the increased losses correspond to a more than proportionately increased output, and, therefore, to a better efficiency.

The losses will increase less rapidly than the length, and if an output proportional to the length can be obtained, the efficiency will be increased, and a margin left for the power required to circulate the air without lowering the efficiency from its former value.

A NEW ELECTRIFIED LINE.

The opening of the electrified portion of the London, Brighton and South Coast Railway has been deferred till December 1. It has been found that some of the signals need raising so as to come in a good line of sight for the drivers. Only the signals into London Bridge are affected, and the work is now in hand prior to the inspection by the Board of Trade of the portion of the line from Peckham Rye to this terminus. Experimental trains are being run daily between Peckham Rye and Battersea.

EXTENSION OF OFFICES.

We are requested to state that Messrs. Tyler & Freeman, electrical and mechanical engineers, New Bridge-street, London, E.C., who are on the Admiralty list, are re-arranging and extending their offices. They are also making up a fresh file of catalogues, and invite manufacturers of electrical and mechanical apparatus, etc., to send them catalogues with prices and discounts.

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CONTENTS.

	PAGE
Notes	445
Cosmic Electro-Magnetic Disturbance	446
Current Consumption	447
Continental and British Tramways	448
Electric Power in Steel Plants	450
Electric Smelting in Production of Iron & Steel	452
Electric Fans: Their Use and Abuse	454
Successful Electrical Exhibition	455
Interpole Generators and Motors	455
A New Electrified Line	456
The Future of Electricity	457
Correspondence	458
New Catalogues	460
Personal	460
Educational	460
Mining Switchgear and Accessories	461
Patent "Hatfield" Pump	461
Uxbridge & District Electric Supply	462
Bulkhead Fittings and Fuse Boxes	462
An Electric Light Claim	465
Testing Electrically Driven Mills	465
A Useful Traction Diagram	466
English Tantalum Lamp Works	467
The Aron Indicator	467
Technical Problems, with Solutions by Practical Men	469
Tyneside Notes	472
Midland Notes	473
American Notes	473
Companies' Meetings and Reports	474
Companies Registered	475
Contracts Open	476
Some Contracts	476
Lighting & General Notes	477
Traction Notes	478
Patents	479
Companies' Stock & Share List	483

THE FUTURE OF ELECTRICITY.

A decidedly gloomy view of the future of electricity supply business is taken by *The Times* in its Engineering Supplement. Practically the advent of the metal filament lamp is deplored. It is roundly stated that the central stations made a great mistake in not securing control of these lamps, and so acquiring the power to maintain high pressure and place a curb on their too rapid or general adoption by the public. We do not share this pessimism. Nor can we agree with the line of argument. No doubt, momentarily, the filament lamps, with their higher efficiency, and consequent lower consumption of power, have brought the central station engineers face to face with some difficult problems. There has been a falling off in the revenue from individual customers, for, to a large extent, the lamps have been used to economise consumption rather than to gain greater illumination. But it would, in our opinion, be a fatal policy to attempt to encourage wasteful consumption, to stand in the way of customers and their legitimate gain from scientific progress. Such tactics would be indefensible and futile. Our science is eminently one of progress, so that we must be prepared for improvements bringing benefits to all concerned in the matter. It may be said that the metal filament by ousting the carbon filament in illumination has only brought relief to the consumer and has penalised the producer. That is, however, a short-sighted view. It has certainly given a considerable fillip to various branches of electric engineering manufacture, and has given an immense impetus to the popularisation of electricity for lighting purposes. There can be no doubt that this economy of power, and consequent lowering of cost to the consumer is already leading to a steady widening of the area of supply, which will increase as facilities develop. Even those persons who are bent for the moment on economising rather than securing more light, will,

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in time, be induced to use current for other purposes, and also for more lamps. Meanwhile, more people will be convinced of the fact that electric lighting is really economical and within their means, and we shall find a sudden quickening of the process of electricity being introduced into smaller and lower rented houses year by year. Customers will multiply, and the demand for current for illuminating purposes once more rise, and owing to the wider base of distribution the demand is likely to be more steady than of old. If, on the other hand, the central generating stations had attempted to capture the illuminating metal filament patents, there would have arisen a harsh interference with the natural trend of demand and supply, which could only have resulted in friction and a general set-back of the industry. A monopoly of this kind could benefit only a portion of the generating stations, and even then the profits made on sales would hardly have compensated for the loss of revenue due to the falling of the amount of current charged for. If such a monopoly was to be made effective, it would have meant the keeping up of the almost prohibitive charges for the metal filament lamps that ruled on their first introduction. The public would scarcely have benefited by the scientific discovery, and that great educative force would have been removed, so that our customers would not have increased as they are doing now. Moreover, in a young, vigorous science such as ours, where so much still remains to be discovered, a monopoly such as above discussed could not be effective for long. It would last for long enough to disorganise the business, but ultimately fresh discoveries outside the ring fence would be made, and would tend straight to a demand for freer competition that would naturally arise. No, our plain duty and advantage lies in a progressive policy all along the line. If a metal filament lamp has come as a boon and a blessing to the consumer (and this, in reality, is only true if the advantages of the greater brilliancy are properly applied), we must set to work and cheapen production and distribution. We agree with our contemporary that much may be done in lowering the cost of supply by a careful study of the questions of labour, service cables, meters, and cut-outs, and, we may add, fuel or other generating power. There are great possibilities in this, and also in extending the use of current for heating, cooking and power purposes. Now, the lessening of cost of illuminating by electricity will induce more people to seriously consider electricity for these accessory services, and if we can only keep the steady advance in the manufacture of appliances shown of late, we shall witness an equally astonishing demand in this direction. But it must be recognised at once that if consumption of current is to be increased, and the day load levelled up to the night load, we must demonstrate to the consumer that electricity is economical. It is only by proving that work can be done by electricity cheaply that we can hope to secure healthy expansion. Monopoly of lamp filaments or other restrictive measures will not help us. This, however, does not mean that we should not look into our present methods of charging. Some such system as discussed in our leader last week, or even some modification of the method suggested by the Haslemere and Hindhead Electric Lighting Co. might well be carefully considered. The fixed charge according to the magnitude and nature of the installation *plus* a meterage charge on consumption of current is quite a reasonable policy, and if judicious tariffs are adopted would not have the restrictive effect on advance that would be inevitable if a brake was put on scientific progress.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "THE EDITOR, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

I TOLD YOU SO.

Sir,—In the early part of 1901 I wrote an article for THE ELECTRICAL ENGINEER entitled "A Plea for the Bow Trolley." In that article I reviewed all the various advantages of the sliding bow, namely, that it cannot jump the wire like a trolley wheel; the rubbing contact being along the bottom edge of the wire, the latter can be fixed more securely and there is no wrenching of the support and points as is the case with a wheel that "wraps" round the wire. I went on to say:

"Regarding the picking up of current . . . it will collect larger amounts of current and admit of much higher speeds than a wheel contact, and the spring of the bow itself appears to present important advantages over the more rigid wheel construction."

At that time there wasn't a sliding bow in the States, and as many engineers in this country could only slavishly copy America, I was taken seriously to task for advocating the bow and roller collector.

In May, 1904, I wrote a letter to the *Light Railway and Tramway Journal* on the same subject, and pointed out that at last some American engineer was beginning to see the disadvantages of the trolley wheel, for *The Street Railway Journal* had reported the use of a bow rolling contact on the Key route in Oakland.

It was all of no use. English engineers accepted what was given them, and the trolley wheel still holds sway. But, lo and behold, in this year of grace, eight years after my "Plea for the Bow Trolley," Mr. Fearnley, General Manager of the Sheffield Corporation Tramways, actually said at the meeting of the Municipal Tramways Association last week: "Comparing the bow collector and the trolley boom, he found the former *much superior*, and would favour it, if it could be shown to be very little more expensive in upkeep than the trolley."

Well, it is better to be late than never; but it certainly doesn't seem to pay to be up-to-date in this country. The trolley boom and wheel and the sliding bow collector are practically the same to-day as they were eight years ago. Yet of all the tramway managers and engineers who have visited the Continent, Mr. Fearnley is, apparently, the first to see straight.

Yours truly,
E. KILBURN SCOTT.

Vale House, Burnt Ash Lane, Bromley,
Kent, September 26, 1909.

THE GOVERNMENT AND ELECTRIC EXPERIMENTS.

Sir,—Mr. W. K. Burke is anxious that the British Government should help forward electrical science by carrying out, or providing funds for, experiments, and he specially mentions the use of electricity in mines as a fitting subject for such study and assistance. If he is really interested in the matter he ought to talk the matter over with any Royal Engineers whom he can button-hole. The officers of the gallant corps of Royal Engineers are notorious pot-hunters. Dangle before their eyes the

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possibility of securing remunerative, plus honorific-distinctions-getting jobs, and they will set influences to work little dreamed of by, and quite inaccessible to, the mere civilian, to force the Treasury to disgorge. That earnest E. Kilburn Scott, simple-minded man, desires to see engineers become politicians, Royal Engineers know better than that—they are courtiers, and "get there" every time and all the time.

Yours, etc.,
OBSERVER.

Kensington, September 25.

BRUSSELS EXHIBITION, 1910.

Sir,—I beg to inform you that the Chairman of the Committee of this Association has just returned from Brussels, and desires me to point out to you the importance of this Exhibition commencing in April next year. This will be the most important Exhibition which has been held on the Continent since that at Paris.

I would remind you of my letter of July 28 last, in which attention was drawn to some of the directions in which this Association can be of use to exhibitors, and beyond those mentioned, is the matter of insurance regarding which our expert wishes me to point out to members the necessity of making special arrangements jointly.

Yours, etc.,
F. B. O. HAWES, Secretary.

The National Electrical Manufacturers' Association (Incorporated), Balfour House, London, September 25.

TRAMWAY ROLLING STOCK MISHAPS.

Sir,—I read with interest the article by Mr. Spencer Robinson under the above heading in your issue of August 14, and what struck me most in studying the "practical" means of getting over the difficulties enumerated was the crudity of the methods described.

I have not the honour of Mr. Robinson's acquaintance, but judging by his utterances, conclude he is one of the "old school" of tramway men, as the "fake" methods of shop practice he describes savour much of those employed by the early American truck builders, which no self-respecting tramway man would for an instant tolerate in these more enlightened days.

Mr. Robinson says "The cause of cars refusing to take the points is largely due to defective wheels; these should be re-tyred when considerably worn." In the first place the trouble complained of is not one of frequent occurrence, and one rarely sees a "motorman tinkering with a point bar endeavouring to assist a car over points, etc." When trouble is experienced at points, this is more frequently due to either the switches not being properly set over, wear of the tongue and pivot, or a stone between the tongue and the casting than to worn wheels.

With regard to the necessity for re-tyring wheels when they become worn, it should be remembered that modern tramway car tyres have anything from 1½ in. to 2½ in. of radial thickness available for wear, and it will be evident that in wearing away this amount of steel the profile of the tyre will change, due to several causes. This change of profile of the tyre takes a long time to bring about, and would, of course, be seen by the man in charge of the car shed, unless he systematically neglects his duty, long before it reached a condition such as would cause trouble at points. The obvious thing to do in such a case is to remove the wheels and to turn the tyres to correct profile for further service.

Re-tyring becomes necessary when the tyres are worn out, but it does not necessarily follow that their shape should be such as would cause trouble at points even at this stage of their usefulness.

Life is rather too short and money too difficult to extract from the travelling public to permit of Mr. Robinson's method of removing tyres being standardised in an up-to-date tramway car repair shop, and the method usually adopted, *i.e.*, cutting by means of a power-driven hack saw, while quite as effective, is at the same time a considerably quicker and cheaper process.

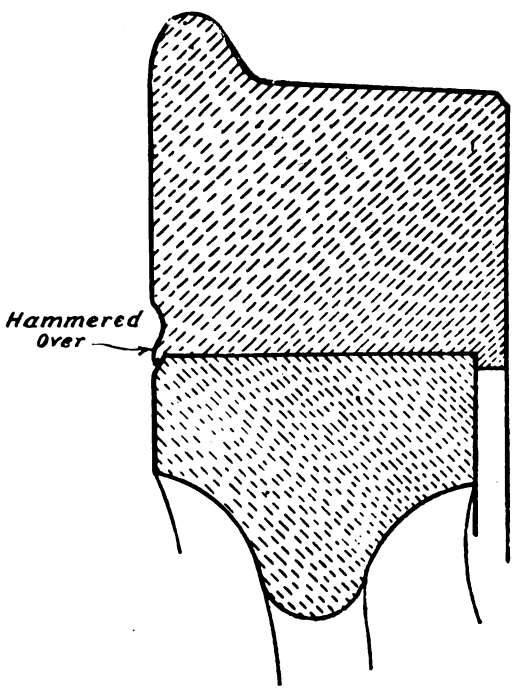
Modern steel tyres are made from ·6% to ·7% carbon steel, and should not, therefore, be cooled by a water spray when being shrunk on to wheel centres, as the stresses set up in the metal due to sudden cooling render the tyre extremely liable to breakage, and it is far better to allow the tyres to cool off in the air.

I should judge Mr. Robinson's acquaintance with the development of high speed steel and modern machine tools to be rather limited, when he talks of using a "portable emery wheel" on the periphery of a hard tyre "until further progress can be made with the ordinary lathe tool," and it would be of much interest to learn what length of time is taken to true a pair of tyres by the methods described.

The use of small studs through the rim of the wheel to fasten the tyre in place is not now considered to be necessary, and only in a few isolated cases are they used; a better and cheaper method being to chamfer the inside edge of the rim and hammer the tyre down all round the chamfered part of the rim, thus disposing of the awkward job of drilling and tapping the tyre from the underside. (See sketch attached).

I have never yet seen *wheels* shrunk on to an axle and should not care to try the job, but as Mr. Robinson prefers the "pressing-on process," will say no more on the subject.

I am glad to know that wheels when bored incorrectly will "slip on" with considerably less than the required pressure, and that the proper method of effecting a cure for the trouble is to press the wheel off and "centre pop" the axle. This is a delightfully easy way of doing it, and causes



SKETCH SHOWING METHOD OF FIXING TYRES.

one to wonder why engineers should ever trouble to develop or use such useless articles as limit gauges and micrometer calipers to ensure accuracy of the diameter of the axle and bore of the wheel.

No doubt, as all the torque of the axle has to be transmitted to the wheel by the friction of the two surfaces, the little swellings caused by the use of the centre punch improve this and render the possibility of the wheel working loose on its axle extremely remote. Whether this is so or not, if I ever see this method employed in the shop for which I am responsible, the man doing it will have to seek a new job.

Mr. Robinson's remarks on car gears are extremely entertaining, and it would appear the old notion that a car equipment would run for five years without inspection or attention permeated the undertakings with which he has been connected. The razor-edged and broken tooth pinions and loose gear wheels to which reference is made were doubtless responsible for an amount of energy consumption equal to that required for propulsion of the car and cost more money than would have been spent in renewing the pinions a dozen times. Those responsible for the pinions and gears getting into the condition described should, in my humble opinion, direct their energies into another channel, as the safety of the public is a matter with which tramway men dare not trifle.

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Mr. Robinson's remarks on brake gear are also very instructive, and the off-hand manner in which he refers to the occasional adjustment of brakes, and then, apparently, not until the car and its occupants are placed in jeopardy, leads one to suppose that the slackest of slack methods are adopted in dealing with the maintenance of this, the most important part of an electric car equipment.

I should like, for the reputation of the industry generally, to say that there are few (if any) tramway undertakings in this country where the rolling stock equipment is ever allowed to get into the disgraceful state described by your contributor, and therefore the "practical" means of getting over difficulties such as he mentions are not required by any tramway man who knows even the elementary part of his business.

Yours, etc.,
W. E. IRELAND.
Rolling Stock Superintendent,
London County Council Tramways.

DUST EXTRACTOR.

Sir,—Can any reader of the ELECTRICAL ENGINEER supply the maker's name of a domestic "Dust Extractor" on the principle of a rotary pump? We may say that we have details of the bellows extractors, but we believe there is a maker of a pump type of extractor, which is, we think, preferable to the bellows.

This matter is both important and urgent, and we shall be glad if replies are forwarded to us, care of the ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

Yours, etc.,
"CONTRACTORS."

NEW CATALOGUES.

Messrs. G. A. Harvey & Co., Lewisham, London, S.E., are issuing to the trade a 1,000-page catalogue of their specialities, etc.

In an illustrated pamphlet, Messrs. W. T. Glover & Co., Ltd., Manchester, describe an improved type of Cable Suspender which they have recently introduced. One of the features in this suspender is the abandonment of the ordinary eye-let method of suspension in favour of the wedge principle, which, it is claimed, provides very much greater strength and security.

We have received from the Rugby Lamp Co., Ltd., a copy of their new list dealing with the Rugby Metal and Carbon Filament Incandescent Lamps. The Rugby lamps are made in the firm's Rugby factory, specially built and equipped for the work.

The General Electric Co., Ltd., are issuing a very attractive illustrated pamphlet, as well as folders and picture postcards, advertising their well-known Osram Lamps. One striking design emphasizes the point that Osram lamps save three-quarters of the electric light bill. The folders are supplied with customer's name and address imprinted. Over 600,000 of the folders and cards were printed during September, and additional advertising matter has been prepared for this month.

Messrs. Lawrence Scott & Co., Ltd., Norwich, are issuing a list of their adjustable speed motors. These motors are sometimes called "variable-speed motors," but the firm prefer the word "Adjustable," as the word "Variable" also applies to series wound motors, in which the speed varies automatically with the power.

Mr. G. Branlik, Lambeth Hill, London, E.C., has forwarded to us a copy of his pamphlet with regard to a new household apparatus for the ozonisation of drinking water.

The British Thomson-Houston Co., Ltd., are sending out a list of an entirely new line of continuous current motors and generators. The new line embodies the latest features in this class of continuous current motor and generator construction.

The Electrical and Engineering Supplies Co., Ltd., London, have sent us a copy of the latest list of their Lloyd Dynamos and Motors. Illustrations are given of complete machines of the various types, and of the different parts, showing method of construction, connection and dimension diagrams, etc. The cover of the list has been so arranged as to readily take further lists which will shortly be issued.

The Tudor Accumulator Co., Ltd., London, are sending out a new illustrated Export Catalogue for Stationery Batteries. In its compilation the aim has been to provide all the data necessary to enable intending purchasers to prepare the preliminary work connected with Tudor Battery Plants without previously referring to the firm. Examples are given of estimates, which contain all items essential for a complete and up-to-date Battery Plant, and they also show the manner in which the prices are made up. There are also tables showing the approximate weight and cubage of batteries, including the necessary accessories and spares, packed for shipment, composed of 60 cells, for all the different types embodied in the list.

The latest telephone list issued by Mr. G. Braulik, London, forms an attractive volume. Printed on art paper and profusely illustrated, it gives particulars and quotations for transmitters, receivers, micro-telephones and accessories, telephone sets for battery call, telephone sets for various purposes, magneto generators and bells, switches, intercommunication telephone sets, switchboards, safety devices against lightning and powerful currents, harmonic selective ringing telephones, etc.

PERSONAL.

Mr. E. J. Houghton, Electrical Engineer to the London Brighton and South Coast Railway, is leaving the Company after a service of 52 years. His Chief Assistant (and son), Mr. R. H. Houghton, B.Sc., A.M.I.C.E., A.M.I.E.E., has been appointed Electrical Engineer in his stead, with sole charge of telegraphs, electric lighting, power and electric traction.

The Adnil Electric Co., Ltd. (late Marples Leach & Co., Ltd.), have appointed Mr. J. B. Chambers engineer and representative for the Yorkshire district. His present address is: 76, Hill Top Mount, Roundhay-road, Leeds.

Mr. Lofts (Town Electrical Engineer, Devonport, Tasmania) has been commissioned by the Leven Council to report upon lighting the town of Ulverstone with electricity.

Mr. d'Abbadie d'Arrast, manager of the Cordoba Electric Light and Power Co., has left for Europe.

The London Board of Directors have appointed Mr. S. W. Cobban an electrical foreman under a five years' agreement for the Burma Railway Electrical Department.

Mr. H. L. Tyson-Wolff, Electrical Engineer, East India Railway, contemplates a long holiday in England about the middle of November, namely, three months' *privilege* leave in combination with 12 months' furlough. Mr. A. Boyd is the senior of the company's two assistant electrical engineers, and will probably act for Mr. Wolff as electrical engineer.

Mr. S. E. Bastow, of Messrs. Bruce Peebles & Co., Ltd., was entertained to dinner by a number of his friends in Edinburgh, preparatory to his leaving this country for a tour round the world on behalf of his firm. Mr. Bastow left by the *Tunisian* from Liverpool for Canada, and will proceed from there to Australia, New Zealand, and South Africa. He expects to be away for at least six months.

EDUCATIONAL.

UNIVERSITY OF LONDON.

In connection with the opening of the session in the University College Faculty of Engineering, a Public Introductory Lecture will be given on Wednesday, October 6, at 5 p.m., by Professor J. A. Fleming, on "Electrical Inventions and the Training of Electrical Engineers." The chair will be taken by Mr. W. M. Mordey, the President of the Institution of Electrical Engineers. The special and postgraduate courses for engineers in practice and graduates in engineering for the first term will begin as follows: Railway Engineering, by Mr. H. Deans, Thursday, October 7, at 5 p.m.; Recent Methods and Instruments in Surveying, by Mr. M. T. Ormsby, Friday, October 15, at 4 p.m.; Electrical Design, by Mr. H. M. Hobart, Wednesday, October 27, at 11 a.m.

EAST HAM TECHNICAL COLLEGE.

The *Yorkshire Observer* has an appreciative notice of an old Bradford Technical College student, Mr. W. T. Clough, A.R.C.Sc., head of the Physics and Electrical Engineering Department at the East Ham Technical College. Opened four years ago, the college has taken the Oxford Local Examinations for the last three years, and in every year has achieved noteworthy distinction. In 1907, in the juniors' examination, a pupil of Mr. Clough's was placed first in the country in distinctions in physics; last year the first place in the seniors in physics distinctions fell to the school, and this year the first, second, third, and sixth places in the juniors are all taken by East Ham boys, no other school in the country obtaining more than one distinction. In the three years 16 distinctions have gone to the college—an exceptionally large proportion of the total number awarded. These results are such as have not been equalled by any school in the kingdom. Mr. Clough, who left Bradford with a National Scholarship to the Royal College of Science, and was trained by Sir Arthur Rucker, has been head of the Physics and Electrical Engineering Department at East Ham since the opening of the college.

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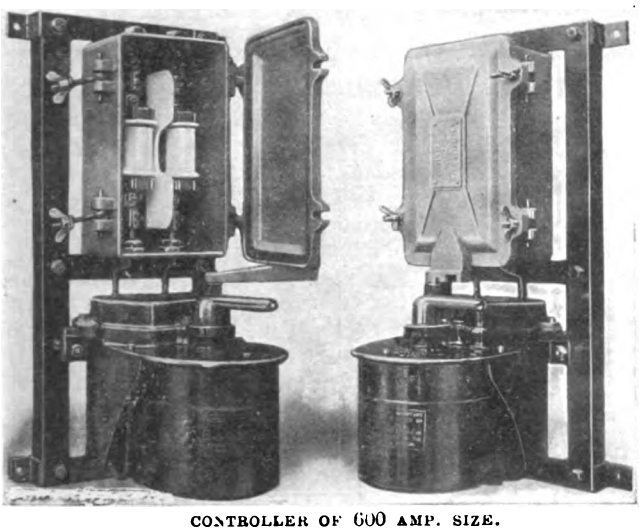
PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

MINING SWITCHGEAR & ACCESSORIES.

The exhibition of switchgear and accessories, held by Messrs. Reyrolles & Co., of Hebburn, in connection with the visit to Newcastle of the Members of the Institution of Mining Engineers, included types of the extra high tension and medium tension iron-clad switchgear which is now so well-known, together with apparatus for the description of electricity in mines designed to meet the conditions laid down by the Home Office rules for the use of electricity in mines. One of the chief innovations in this respect is the provision of wide flanges on the covers of the cases of controllers and distribution boxes, these flanges forming a metal to metal joint of very large heat-absorbing and radiating capacity. It is claimed that even should an explosion take place within the box, due to an electric spark igniting coal dust or gas, the temperature of the flame is sufficiently lowered to prevent any spreading outside the box. In this way such an explosion is limited



CONTROLLER OF 600 AMP. SIZE.

to the box itself, and, in order to make provision against mechanical fracture, these boxes are built as strong as the cylinder of a gas engine and made of the best cast-iron.

Two items, the uses of which are not confined to mining engineering, also attracted considerable attention. The first is a fool proof switch of a new pattern, in which a pin on the switch handle engages with a curved slot in the switch cover when the cover is open, rendering it impossible to close the switch until the cover is closed. When this is the case, however, the pin rides free of the slot, and the switch works quite easily. The second device is the Reyrolle mono-break controller, which has been recently developed by the firm. In the new controller, contact is broken on one pair of fingers only, and it is obvious that this allows of an exceedingly powerful magnetic field being concentrated upon the particular breaking point. The illustration is of a controller of the 600 amp. size, with nine controlling positions, in addition to an "off" position and "full-on" position.

The handle shown is on the same spindle as the contact maker, and the jaws of the blow-out magnet can clearly be seen just above the latter. For each half-revolution of the handle, the main drum advances one-twelfth of a revolution, and during this period a step of the resistance is either cut in or out of circuit, but, of course, there can be no sparking except at the contact maker. It may be said that under ordinary conditions, the main contacts will practically never require renewal, and, on account of the powerful blow-out effect provided, wear on the breaking contact is exceedingly small, but in any case the cost of renewal is almost negligible, and replacements are easily effected.

Messrs. Reyrolle & Co. have supplied three dust-proof panels to the Ashington Coal Co., who operate one of the largest coal companies in Northumberland. The board consists of three panels, and it is for use underground, the down going cable being taken direct to the middle panel and the outgoing cables being controlled by the right and left hand panels. The principal feature of this gear is that it is interlocked, so as to make it impossible to open the door giving access to the oil switches, etc., until the isolating switches have been put to the "off" position; and, further, it is impossible to close the isolating switches until the door has been closed. The isolating switches are interlocked with the oil switch handle to ensure that the circuits are never broken on the isolating switches, as this would, of course, result in a destructive arc being drawn out between the isolating switch clip and blade.

PATENT "HATFIELD" PUMP.

A "Hatfield" electrically driven pump has been supplied by Messrs. Merryweather & Sons, Greenwich-road, London, to Lord Brassey, for the protection of Normanhurst. The provision of this was the outcome of a fire in August last year, which showed the supreme importance of bringing a powerful jet to bear on a fire in the shortest possible time after its discovery. The pump is driven by an electric motor in connection with the lighting current, and a jet may be thrown over the roof in a few seconds from the alarm being given. Lord Brassey has also provided a similar pump for the Dower House at Chapelwood. In this case an arrangement is made to start the pump instantly by the electric motor, this being utilised until an oil engine can be got to work, when it can be connected up by means of a friction clutch and the pump run for an indefinite time. A similar arrangement has been fitted up by Messrs. Merryweather & Sons at Brownsea Castle, Poole Harbour. These are only three instances of a large number of country houses where the "Hatfield" pump stands sentinel over the safety of the building and its valuable contents. Water-power may be employed for driving the pump in cases where this is more convenient than the electric current. Instances of these are found at Lord Alington's seat (Crichel, Dorset) and at Sherborne Castle.

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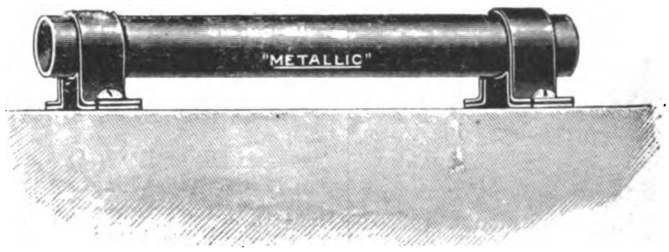

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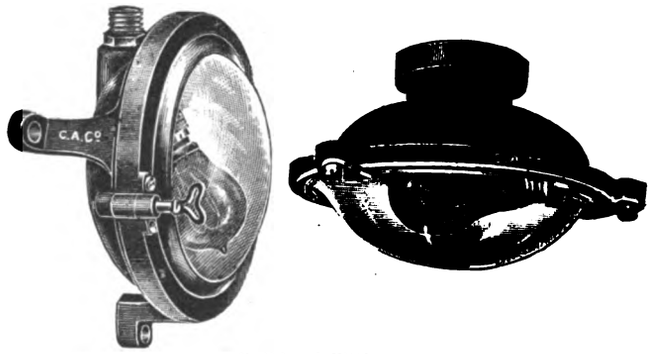
UXBRIDGE AND DISTRICT ELECTRIC SUPPLY.

THE OFFICIAL RECEIVER'S REPORT.

The Official Receiver (Mr. H. E. Burgess), reporting under the compulsory winding-up order made against the Uxbridge and District Electric Supply Co., Ltd., states that the liquidation accounts show assets valued at £75,038, to meet Debenture claims and interest £52,579, and unsecured liabilities £6,622. There is disclosed a surplus of £15,748 in assets after discharging the liabilities, but a loss of £10,526 as regards shareholders. The company was originally registered in June, 1899, as the Uxbridge and District Development Syndicate, Ltd., with a capital of £1,000, which was eventually increased to £75,000, of which £26,000 odd was subscribed for cash. A provisional order was granted to the company extending the area of supply, and in April, 1901, the present name of the company was adopted. By agreement, dated March 25, 1901, the General Electric Co. (1900), Ltd., agreed to advance £20,000 on the security of Debentures in consideration of orders for plant, works, etc., being placed with them at rates equal to 10% above competition prices. In May, 1901, the company acquired a freehold site at Uxbridge, and mains were laid extending over 37½ miles. The public supply of electricity commenced in May, 1902. Debentures to the amount of £50,000 were issued, and upon the presentation of the petition to wind up the company the debenture holders obtained the appointment of the Official Receiver as receiver to act on their behalf. The total capital expenditure of the company in connection with its undertaking is returned at £81,358, being £7,183 in excess of the share and Debenture capital subscribed. The result of the company's trading since 1900 was a profit in excess of £10,000 before charging interest on the Debentures, but no dividends were paid to the shareholders, and the company was unable to pay the interest on the Debentures for the half-year ended December, 1908, or to meet its other liabilities. The failure is attributed by the directors to want of working capital and to loss of business caused by the closing down of customers' works. The Official Receiver is acting as liquidator.

BULKHEAD FITTINGS AND FUSE BOXES.

We have received from Messrs. Haslam & Schontheil, of *Western Mail* Chambers, Cardiff, a twelve-page illustrated catalogue of cast-iron water-tight fittings for collieries, mills, ships, railways and general electric lighting. It comprises a full selection of the various types of these fittings, including single light vertical pattern, single light with bends, curved brackets, hand lamps, cluster and deck fittings, fittings for bulkhead or sconces, etc. The accompanying illustrations show two types of bulkhead fittings. These in the cheaper patterns have the glasses secured by three brass clips, but for better class work they are supplied with either strong cast-iron or polished brass doors as required.



Bulkhead Fittings.

The firm are also placing on the market a very neat type of fuse box. These are supplied either singly or with a pair mounted, and with or without sealing chambers.

We are requested to announce that the Beck Flame Lamp, Ltd., have removed their offices to Suffolk House, Laurence Pountney Hill, Cannon-street, London, E.C.

Messrs. Lacey, Sillar & Leigh have taken new offices at Iddlesleigh-mansions, Caxton-street, Westminster, London.

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TESTED VARNISH.

MAJOR'S INSULATING VARNISH.

Every batch we make is tested electrically under standard conditions to ensure uniform and excellent quality.

SAMPLES, PRICES & TESTS from MAJOR & CO., LTD., SCULCOATES, HULL.

NALDER BROS. & THOMPSON, LIMITED,

—MAKERS OF—

EVERY DESCRIPTION OF ELECTRICAL MEASURING INSTRUMENTS.

NEW AND REDUCED PRICES.

Ammeters,
Voltmeters,
Wattmeters.

Circuit Breakers,
Insulation Testing Sets
(Combined Ohmmeter and Generator).
Recording Instruments

34, QUEEN ST., LONDON, E.C.

Telegrams: "OCCLUDE, LONDON. Telephone Nos. 123 and 124 Bank.

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That's all.

THE UNITED STATES METALLIC PACKING CO., LTD., SOHO WORKS, BRADFORD.

THE MOST ACCURATE, MOST RELIABLE AND CHEAPEST METER IN THE WORLD ("D.C.")

IS THE

BASTIAN METER.

THE BASTIAN METER CO., Ltd., Kentish Town, London, N.W.

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NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

THE URBAN DISTRICT OF BRUMBY & FRODINGHAM.

TENDERS FOR STREET LIGHTING BY ELECTRICITY.

The Urban District Council of Brumby and Frodingham invite TENDERS for LIGHTING their streets by means of electricity.

Direct current at 220 volts is already available, and the number of lights will be 55 of 50 candle power each.

Tenders are to provide for poles, wiring, switches, etc., fixed complete.

Specification and plan may be obtained on payment of 10s. 6d. (which will be returned on receipt of a bona-fide Tender), on application to Mr. Joe Green, Surveyor, Council Offices, Frodingham, Scunthorpe, Lincolnshire.

Tenders, which must be received not later than October 16th next, to be addressed to Mr. G. S. Sowter, Clerk to the Council, Brigg, Lincolnshire, endorsed "Tender for Street Lighting."

The lowest or any Tender will not necessarily be accepted.

G. S. SOWTER, Clerk.

Brigg, 22nd September, 1909.

PATENTS.

INVENTIONS: CAPITAL REQUIRED.

M.INST.E.E. REQUIRES FINANCIAL ASSISTANCE TO START MANUFACTURE OF ENTIRELY NOVEL LINE OF SMALL MOTORS; to be made in large quantities like cycle parts. Difficulty of winding for 220 and 400 volts overcome. Can be placed on market at about half present prices. New types of small starters. Resistance units and Magnetos can also be made. A financial man with some technical training preferred.—Apply to "GAMMA RHO," c/o THE ELECTRICAL ENGINEER Offices, 149, Fleet Street, London, E.C.

INVENTION FOR SALE.

TUMBLECUTTER, of entirely new system. Having great technical preferences, strong and much cheaper to manufacture than all other modern makes. Patents registered all over the world. Box 1407, c/o Nordisk Annoncebureau, Copenhagen.

TECHNICAL CLASSES.

THE SIR JOHN CASS TECHNICAL INSTITUTE,
JEWRY STREET, ALDGATE, E.C.

PRINCIPAL—CHARLES A. KEANE, D.Sc., PH.D., F.I.C.

The following courses of EVENING LECTURES and PRACTICAL WORK on FUEL will be given during the Session 1909–10.

LIQUID, SOLID & GASEOUS FUEL,
by J. S. S. BRAME, Lecturer on Chemistry at the Royal Naval College, Greenwich.
A course of Lectures, Monday evenings, 8–9 p.m., commencing MONDAY, OCTOBER 18TH.

FUEL ANALYSIS,
by C. P. BANNISTER, Assoc. R.S.M., M.I.M.M.
A course of Laboratory Work. Summer Term, Mondays 7–10 p.m., commencing MONDAY, APRIL 18TH, 1910.

TECHNICAL GAS ANALYSIS.
by CHARLES A. KEANE, D.Sc., Ph.D., F.I.C.
A course of Laboratory Work. Summer Term, WEDNESDAY, 7–10 p.m., commencing WEDNESDAY, APRIL 20TH, 1910.

The courses of instruction are arranged to meet the requirements of those engaged in Chemical and Engineering Works, or who are concerned with the use of Fuel as a motive power.

Detailed Syllabus of the Courses may be had upon application.

BATTERSEA POLYTECHNIC, S.W.

PRINCIPAL: S. G. RAWSON, D.Sc.

SESSION 1909–10.

EVENING CLASSES COMMENCE SEPTEMBER 27TH.
DAY CLASSES COMMENCE SEPTEMBER 28TH.

ELECTRICAL ENGINEERING.
HEAD OF DEPARTMENT: A. W. ASHTON, M.Sc.

DAY AND EVENING CLASSES IN—
DIRECT CURRENTS.
ALTERNATING CURRENTS.
ELECTRIC TRACTION.
ELECTRICAL DESIGN.

EVENING CLASSES IN—
TELEGRAPHY.
TELEPHONY.
ELECTRIC WIRING.

For Prospectus and full particulars apply to the SECRETARY.

ENGINEERING AND TECHNICAL OPTICS.

NORTHAMPTON POLYTECHNIC INSTITUTE, CLERKENWELL LONDON, E.C.

MECHANICAL AND ELECTRICAL ENGINEERING AND ELECTRO-CHEMISTRY.

FULL DAY COURSES in the Theory and Practice of the above Subjects will commence on MONDAY, 4th October, 1909. ENTRANCE EXAMINATION on WEDNESDAY and THURSDAY, 29th and 30th September. These Courses include periods spent in Commercial Workshops, and extend over four years. They also prepare for the degree of B.Sc. in Engineering at the University of London. Fees £15, or £11 per annum.

Three Entrance Scholarships of the value of £52 each will be offered for competition at the Entrance Examination in September next.

TECHNICAL OPTICS.

FULL and PART TIME DAY COURSES in all branches of this important department of Applied Science given in specially equipped laboratories and lecture rooms.

EVENING TECHNICAL COURSES

in all branches of Electrical and Mechanical Engineering will commence on MONDAY, September 27th, 1909.

The Laboratories are well equipped for both alternate (single and polyphase) and continuous current work, and for all kinds of electrical testing.

Full particulars as to fees, dates, &c., and all information respecting the work of the Institute, can be obtained at the Institute or on application to

R. MULLINEUX WALMSLEY, D.Sc.,
Principal.

UNIVERSITY OF DURHAM.

ARMSTRONG COLLEGE, NEWCASTLE-ON-TYNE.

PRINCIPAL—SIR ISAMBARD OWEN, D.C.L., M.D.

SESSION OF 1909/10 (COMMENCING SEPTEMBER 27th, 1909).

DEPARTMENTS of MECHANICAL, MARINE, CIVIL, and ELECTRICAL ENGINEERING, NAVAL ARCHITECTURE, MINING, METALLURGY AGRICULTURE, and of PURE SCIENCE and LETTERS.

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Adams Mfg. Co., Ltd., London & Bedford.

PLANT WANTED AND FOR SALE.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words. 4d.

WANTED, METALS, RUBBER, LAMP TOPS, MERCURY PLATINUM, FALSE TEETH, etc.—WASTE AGENCY 2, Jackson Road, Holloway.

FOR SALE.—One 165 Kilowatt D. C. Steam Dynamo by Alley and McLellen and Lancashire Dynamo Co., in good condition—Full particulars on application to the—Engineer, Electricity Works, Rhy.

PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND CO., LTD., 44, Clerkenwell Road, London, E.C. N.B.—Platinum Sold.

SITUATIONS VACANT.

Advertisements under this heading: Three words for One Penny; minimum charge, Sixpence (prepaid).

MEN OUT OF EMPLOYMENT in all branches of the Electrical Trade should write to Box No. 20, c/o THE ELECTRICAL ENGINEER, 149, Fleet Street, London, E.C.

WANTED for an Electrical Power Station in the Federated Malay States, a Chief Electrical Engineer. Must be accustomed to high tension, turbine generator, transformer, electrical winding plant, ordinary motors, and lighting.—Write, stating qualifications to "MALAYA," c/o. of Messrs. Deacon, Leadenhall Street, London, E.C.

ENGINEER, A.M.I.E.E., expert, with large valuable connection; capable organizer and designer, desires important position—Apply Box No. 16, "The Electrical Engineer," 149, Fleet Street, London, E.C.

AN ELECTRIC LIGHT CLAIM.

At the Grantham Police Court, John Beer, builder, of Park-road, was summoned by the Urban Electric Supply Co. to recover £11 2s. 9d. for electric light, etc., supplied.

Defendant declared that he never had a bill, and had never burned the light either. He had been using candles for the last 12 months.

Mr. Jenkinson, a clerk in the employ of the Electric Light Co., said he had made 11 visits to the defendant in respect of the account. The amount owing was for five quarters, from September 30, 1907, to February 17, 1909, for light, wires, and meters.

Defendant reiterated that he had not had the light.

Frank Evans stated that he went to the defendant's house to fix a slot meter, but he could not get in until the fourth visit. He gave the reading of the old meter at that time, but he did not know what the previous reading was.

The Mayor here interposed that it would be better if these cases were taken to the County Court in the future. Was the slot meter ordered by the defendant?

Mr. Jenkinson: It was put in to protect our interests.

The Bench decided that the defendant must pay the amount claimed.

TESTING ELECTRICALLY DRIVEN MILLS.*

By C. A. ABLETT, B.Sc., A.M.Inst.C.E.

The energy consumption of an electrically driven reversing rolling-mill as expressed in kilowatt hours (Board of Trade units) per ton rolled, can be determined in the simplest possible manner by inserting an ordinary integrating wattmeter in the supply system, which is an instrument that can always be left in circuit and requires no attention. If a reading of this instrument before the commencement of a shift, and a second reading at the end of the shift, are taken, the difference gives the total kilowatt hours used during the shift, and dividing this by the tonnage rolled, the total kilowatt hours per ton is obtained. Such readings can quite easily be taken for every shift, and a continuous check on the energy consumption can be kept. Results expressed in kilowatt hours per ton are generally found most useful, as the cost of the kilowatt hour varies according to local conditions, and knowing this cost, the total cost of power can be arrived at directly. The efficiency of the electrical plant can also be checked in the simplest possible manner by placing a second integrating wattmeter in the armature circuit of the mill motor.

The records of this wattmeter will be less than those of the one placed in the supply circuit, the difference being the losses in the electrical plant. This does not take account of the efficiency of the mill-motor armature, but as this is of the order of 97 to 98%, it can well be neglected. The following figures show some characteristic values for the kilowatt hours per ton rolled obtained from tests on reversing-mills:—

	Kw. hours per ton.
4½″ × 4½″ billets from 2·5-ton ingots. Output, 53 tons per hour	22·5
6″ × 6″ blooms from 2·5-ton ingots. Output, 63 tons per hour	17·5
8″ × 8″ blooms from 2·5-ton ingots. Output, 80 tons per hour	13·0
12″ × 9½″ blooms from 7-ton ingots measuring 34½″ × 25″. Output, 65 tons per hour	11·2
32″ × 9″ slabs from 6-ton ingots measuring 36″ × 19½″. Output, 40 tons per hour	4·3
32″ × 5″ slabs from 6-ton ingots measuring 36″ × 19½″. Output, 40 tons per hour	5·8
Flange rails, 100 lbs. per yard, from 2-ton ingots. Output, 30 tons per hour	48·0
Beams, 120 lbs. per yard, from 1·5-ton ingots	36·0
Channels, 92 lbs. per yard, from 1·5-ton ingots	37·0

* Abstract from paper on "The Determination of the Economy of Reversing Rolling-Mills," read before the Iron and Steel Institute.

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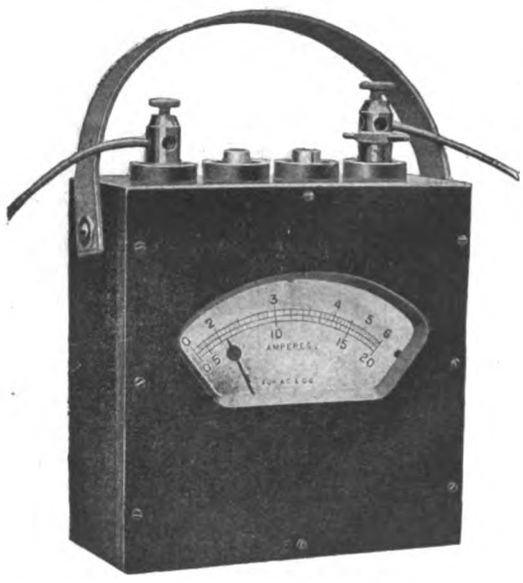


PORTABLE MOVING-IRON AMMETER,

For Direct or Alternating Currents.

Eversheds & Vignoles, Ltd.,

Acton Lane Works,

CHISWICK, LONDON, W.

Telephone : Hammersmith 221. Telegrams : "Dorothea, London."

Economical Transmission

is a problem which rests very much with the **Ball Bearings.**

Our **Ball Bearings** are the best obtainable and are made of the finest Diamond Cast Tool Steel.

They are hardened throughout —not case hardened.

They are fitted with the most ingenious, up-to-date cages in existence.

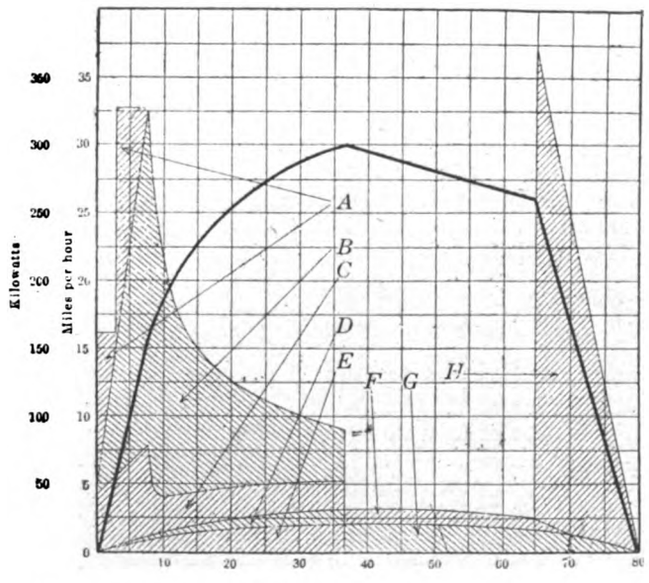
Our works are staffed with experts whose advice

Costs you Nothing

Fischers Ball & Bearing Co.
Dept. E. Birmingham
Telephone : 1210 Midland.
Telegrams: "Fisherdom, B'ham."

A USEFUL TRACTION DIAGRAM.

The diagram herewith shows in an exceptionally neat way the relationship of the various losses for a standard railway motor car, weighing 41 tons, fitted with four GE 73 motors. It is due to Mr. V. Ayres, of the Boston and Worcester Railway :—



Areas *A* show energy lost in rheostats.
Area *B* shows energy used in acceleration.
Area *C* shows energy lost in motors.
Area *D* shows energy lost in wind friction when accelerating.
Area *E* shows track and bearing friction when accelerating.
Area *F* shows energy lost in wind friction after power is shut off.
Area *G* shows energy track and bearing friction after power is shut off.
Area *H* shows energy dissipated in braking.

The values of these areas in watt-hours are as follows :

	Watt-hours.	Per cent.
Rheostat losses	157	9·52
Motor losses	285	17·28
Track and bearing friction	158	9·55
Windage	57	3·45
Acceleration	993	60·20
	1,650	100·00

It is interesting to note that the track and bearing friction is under 10%. By adopting roller bearings this can be reduced, and by such reduction the acceleration period can be shortened and the power brought down considerably. Two remarkable points in the diagram are the maximum of 326 kilo-watts taken during the starting period, and the maximum of 370 kilo-watts at commencement of braking. Surely there is no sense in wearing away brake blocks and rails, etc., at this terrific rate, when a good deal of it might be usefully returned to the line by regenerative control ?

INSULATING VARNISH.

Messrs. Major & Co., Ltd., have recently enlarged their varnish plant at Hull, and now make and stock larger quantities of insulating varnishes and compounds than previously in order to meet the increased demand. This firm makes a speciality of tested insulating varnishes ; the raw materials are carefully selected and chemically tested, and the finished varnishes are matured in tanks. each batch being electrically tested under standard conditions for puncture pressure, ohmic insulation resistance, flexibility, etc., before being sold, in laboratories specially equipped for the purpose.

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NOTICE

On and after the 1st October, 1909, the GENERAL ELECTRIC CO., LTD., will be able to deliver promptly . .

200-260 v. 32 watt

22·5 British C.P.=25 Hefner C.P.

OSRAM LAMPS.

These Lamps are in every way as efficient as the 40 and 63 Watt Single Burning High Voltage Lamps which have achieved such a notable success—and will burn at any Angle. . . . . .

SOUND DELIVERY GUARANTEED ON CONSIGNMENTS OF 25 LAMPS AND UPWARDS.

Price 4/3 each.

IT IS RECOMMENDED THAT ORDERS BE PLACED AT ONCE.

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HEAD OFFICE—**71, Queen Victoria Street, LONDON, E.C.**

REGD TRADE MARK

BRANCHES—

Victoria Bridge, Manchester.
71, Waterloo Street, Glasgow.
42, High Street, Birmingham.
30, Gallowgate, Newcastle-on-Tyne.
16, St. Andrew Street, Dublin.
Womanby Street, Cardiff.
13, Queen Street, Belfast.
10 & 12, Rue Rodier, Paris.
134, Fuencarral, Madrid.
Corner of Waterkant and Chiappini Streets, Capetown.
Corner of Loveday and Anderson Streets, Johannesburg.

AGENTS—

LAWRENCE & HANSON, Sydney and Melbourne.
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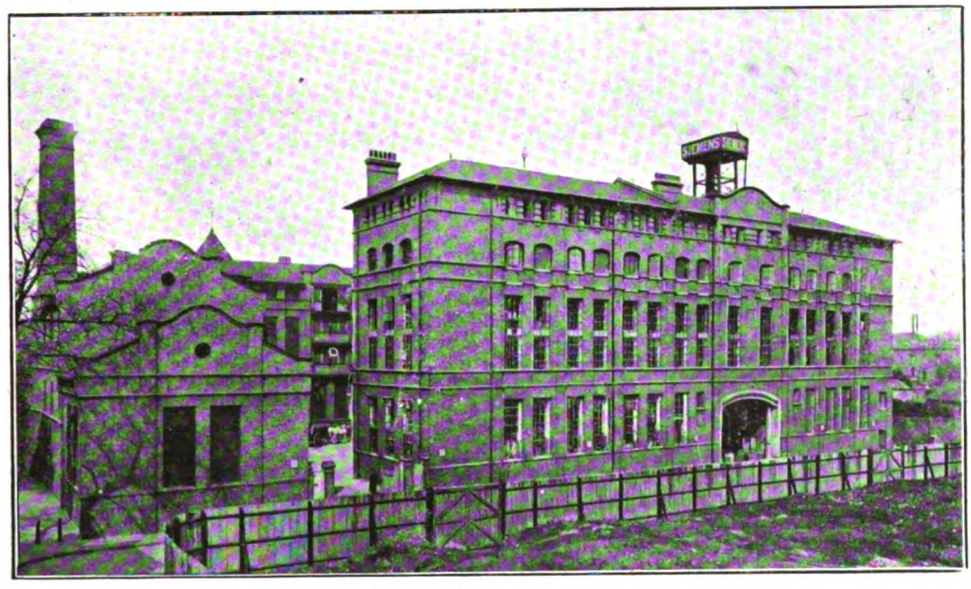
COLSON, BROOKHOUSE & PYNE, Buenos Ayres.
HUTH & CO., Valparaiso.

WORKS—**London, Witton, Birmingham, Manchester.**

ENGLISH TANTALUM LAMP WORKS.

We illustrate below part of the English Tantalum Lamp Works, Dalston, London. N. The works povidre occupation in all branches for British labour, and are conducted by the well-known firm of Messrs. Siemens Bros. Dynamo Works, Ltd.



PART OF ENGLISH TANTALUM LAMP WORKS.

SHEFFIELD MINING ELECTRICAL ENGINEERS.

A Council Meeting of the Institute of Mining Electrical Engineers will be held at the Royal Victoria Station Hotel, Sheffield, at 2 p.m on Saturday, October 2nd. A general meeting will be opened at 2.30 to report progress and announce preparations for the forthcoming session.

THE ARON INDICATOR.

The Aron Maximum Demand Indicator, recently described in our columns, is being placed on the market by the Aron Electricity Meter Co., Ltd., 80A, Salusbury-road, Kilburn, London, N.W. It consists of the well-known "Aron" clock type meter, which is suitable for all systems, *i.e.*, two and three wire D.C. or A.C., three and four wire two-phase or three-phase, and an attachment indicating the maximum demand. The accuracy of the Indicator is equal to that of the meter; it follows a straight line law equally with the meter; it requires no extra energy to work it, and no extra electrical connections; it does not increase the size of the meter and it is very easily reset.

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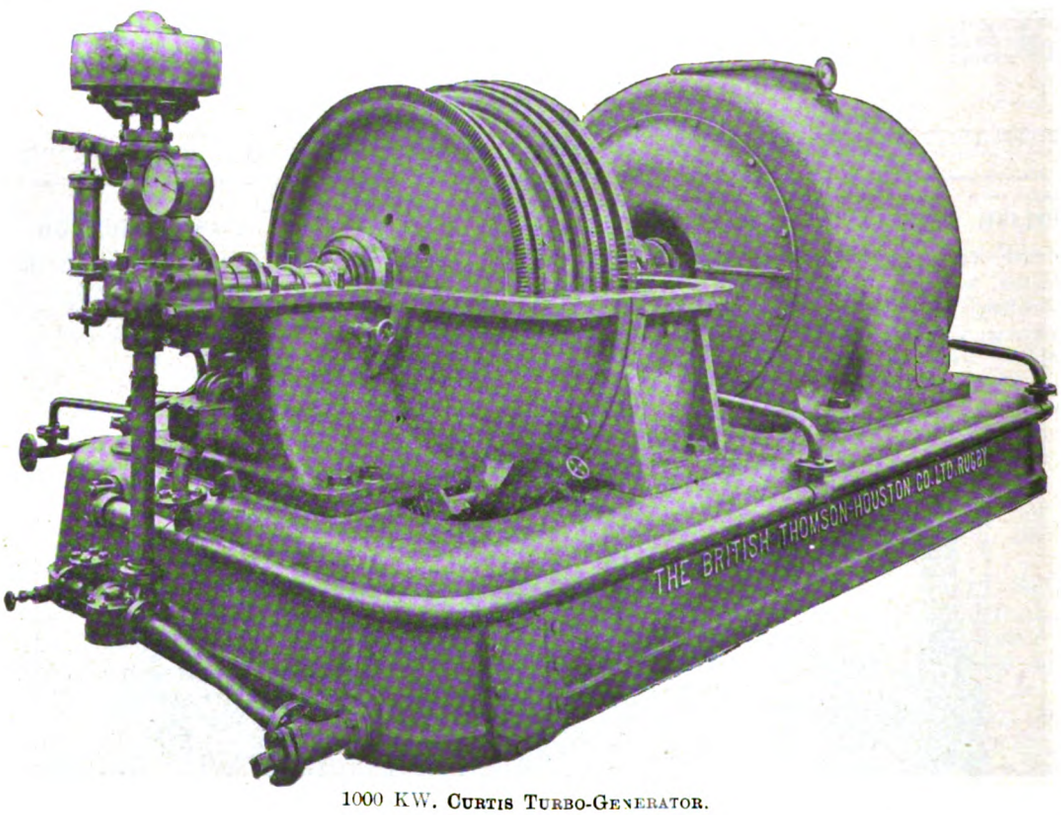
WARNING.

B.T.H. IMPULSE STEAM TURBINES.
CURTIS PATENTS.

The well-known **CURTIS TURBINES** are **IMPULSE TURBINES** in which the steam is expanded in a series of stage nozzles with abstraction of the velocity acquired in each expansion by intervening stage wheels.

These Turbines have been manufactured in Great Britain exclusively by **THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED,** for many years.

Sellers and Users of infringing Turbines are hereby notified that they will be proceeded against.



1000 KW. CURTIS TURBO-GENERATOR.

THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, have sold a total of 67 Curtis Steam Turbines aggregating a capacity of 85,000 Kilowatts.

All of these Turbines have been manufactured or are now in course of construction at their Rugby Works.

Supplied in all sizes—either vertical or horizontal.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

"If thou hast knowledge, let others light their candle at it."

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should be *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

Question No. 1201.—Describe the principle of action and the advantages and disadvantages of the wireless "detectors" now used (*excepting* the simple Marconi magnetic and coherer types). Indicate the ideal requirements, and show how nearly they are satisfied by the sets described.

Question No. 1204.—In a small central station a generator is required to give 220-in. volts for a two-wire system. In the future, as the load increases, it is proposed to alter the same generator for supplying energy at 440 volts, and by means of a balance to supply a three-wire system. Give full particulars with sketches of a special arrangement for the armature winding, so that the change-over from the lower to the higher pressure can be effected without re-winding, but simply by altering several connections. Obviously field coils would first be used in two parallel circuits and eventually connected in series. What firms supply machines with an arrangement of this description? —P.

Question No. 1205.—An electric supply company having single-phase (periodicy 100) water power plant situate in old corn mill is going to instal a 100 h.p. turbine and rope-driven alternator. To provide against shortage of water power in the summer, it is also proposed to instal accumulators (capacity 40 kw. for three hours). It is also required to drive corn mill by electric motors. Would it be feasible to instal a continuous current machine and alternator on the same shaft, using the former as a dynamo in the daytime to drive motors in corn mill and charge accumulators, and as a motor (driven by accumulators) at night during peak loads to help to drive alternator when water-power would be insufficient? Give particulars of any alternative arrangement you would recommend.—R.

Answer to Question No. 1,201 (*awarded* 10*s.*).—The chief requirements of wireless detectors are: Extreme sensitivity, minimum "damping," independence of exterior influences, and preferably automatic de coherence, the absolute non-possession of the latter property being a very serious limitation of the early coherer. This, by the way, is now used in a different form, obviating this disadvantage, but retaining the same inherent principles of action, in Fleming's oil immersed poor point-to-plane contact. Simplicity, mechanical robustness, and ease of repair are attributes of considerable importance in commercial working and on ship installations, etc., while freedom from influence by vibration is a property rarely possessed at present, but which must be achieved before such desirable objects as "wireless" communication to moving trains, and so on, become feasible.

As will be readily understood, the requirements of a wireless detector suitable for telephony are much more severe than for mere telegraphic communication. In the former case, a smooth, pure tone is essential, or the speech vibrations imposed on it will be so distorted as to be incomprehensible. For telegraphic purpose, purity of tone is unimportant, a slight sputter in the signals being immaterial so long as they can be satisfactorily broken up into the Morse code.

Methods of Testing Detectors.—The testing of detectors is a matter of some difficulty, owing to their very variable resistance and characteristics. Again, the telephone resistance is a matter of great importance, for a detector which appears less sensitive than another when using a certain telephone may prove to be far superior if used with a telephone of higher or lower resistance. Again, laboratory test distances between transmitter and receiver are so short (50 to 100 ft.) as to result in communication being frequently established between the two "stations" by purely magnetic induction. The detector, in short, cannot be tested under practical conditions by merely local transmitting and receiving circuits. In Fleming's system (see also Phil. Mag. xvii. pp. 670–6) a very steady train of oscillations is produced in a closed circuit and received by a second closed inductor circuit to which the detector and a telephone are connected. The receiving inductor is rotated till the sound of the received signals just dies away in the telephone. The displacement of the inductor from the position of maximum reception is then a measure of the detector sensitivity.

Types of Detector.—Excluding the well-known magnetic and coherer type, the chief classes of detector at present used are: (a) vacuum type, (b) electrolytic type, (c) thermal type, (d) rectifying type.

(a) *Vacuum Detectors.*—This depends on the fact that a vacuous space is conducting *from* a hot electrode *to* a cold one, but not in the opposite direction. Thus on passing high frequency aerial currents through such an "oscillation valve," they are rectified, and the pulsating direct current produced operates the receiving telephone in sympathy with the received electrostatic waves. Audion valves are easy to construct, are not affected by vibration, and are automatically decohering (or, rather, never cohere). They are also fairly sensitive, though thermal detectors are probably superior in this respect. The usual construction consists of an ordinary glow lamp bulb in which is placed an insulated cold electrode in addition to the heated filament. The latter is heated by a suitable battery, and the oscillating current so applied to the terminals of the filament and the cold electrode. The rectified current is led directly through a receiving telephone.

(b) *Electrolytic Detectors* consist usually of an electrolyte of sulphuric acid in which is placed a gold or platinum cathode and a platinum anode of very special construction. The anode consists of a Wollaston platinum wire clamped to a stout platinum lead. The fine wire, as used by the Telefunken Co., is 1-1,000 mm. diameter, and is waxed except for a length of 1-100 mm. at its tip. This tip just projects into the electrolyte. The detector is placed in series with a telephone across a 4-volt battery. The latter instantly polarises the anode and prevents further current flow till high frequency aerial currents are supplied to the cell. These depolarised the anode, and by allowing a momentary direct current to flow through the telephone, produce a click therein, which action being repeated gives a continuous buzz, broken into the Morse code by the transmitting operator. The electrolytic detector is susceptible to very accurate "timing" of the sending and receiving circuit, and is self-restoring. By its extreme sensitivity and purity of note it is suitable for use in wireless telephony.

(c) *Thermo Detectors* consist essentially of a high resistance contact at which the oscillating energy of the received waves is converted to heat. This causes a current to flow through the receiving telephone by the Peltier effect, consequent on the heating of a contact of dissimilar materials. There are many pairs of materials which may be used for this purpose, among them: metal points, usually of platinum or tellurium, etc.; and mineral substances such as iron pyrites and other metallic sulphides; also metal points or rods bearing on oxidised metal surfaces. One of the pair used is mounted rigidly, and the other provided with an adjusting screw and spring. Such thermo detectors are among the most sensitive known, are self-restoring, easily erected, but naturally very susceptible to external vibration.

(d) *Rectifying Detectors.*—One member of this class, the "audion" valve, has been already referred to. There are many natural crystals, among them carborundum, which are strongly unilateral in their conductivity, and hence can be directly applied as wireless detectors. The method of erection is as suggested for thermal detectors, and of connection as for oscillation valves. Rectifying contacts usually possess a certain degree of thermal action as well,

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which may help, but usually opposes the rectified current. Rectifying contacts, though self-restoring and probably less affected by vibration than thermal detectors, are less sensitive than the latter.

General Suitability.—Thermal and electrolytic detectors appear to be the most generally sensitive and reliable types, the electrolytic pattern being specially suitable for wireless telephony, for the reasons given. Using the method of testing already referred to, Fleming concludes that the order of sensibility is: Oscillation valves, magnetic detector, electrolytic detector, and carborundum rectifiers. It may be doubted whether the oscillation valve is really the most sensitive type, though practice appears to confirm the correctness of the remaining scale of sensibility. The relatively worthlessness of laboratory sensitivity tests has been pointed out. Personally, the writer prefers electrolytic detectors for telephonic work, and thermal detectors for general use.—"S. M. P."

Answer to Question No. 1,201 (*awarded* 5*s.*).—The following notes are specially devoted to a consideration of several recently introduced receivers and of improvements in older forms. Considering first the desiderata of a satisfactory "wireless" detector:—Automatic decoherence is usually very desirable, low detector resistance minimises the damping of the receiving circuit, and so enables sharper resonance and greater freedom from interruption (or "jamming") by other signals. The deleterious effect of resistance in decreasing the amplitude of the resonance peak in an oscillatory circuit is well shown in Fig. 2, the upper curve of which corresponds to zero resistance in this circuit, *i.e.*, the purely theoretical case in which infinite amplitude of resonance can be received. A means whereby the defect of high resistance can be overcome is shown in the diagram, Fig. 1. (Gesellschaft fur Drahtlose Telegraphie). The detector must, while possessing maximum sensibility to the waves to be received, be influenced as little as possible by any other cause (*e.g.*, vibration, stray electrostatic or magnetic fields, etc.). Other requirements

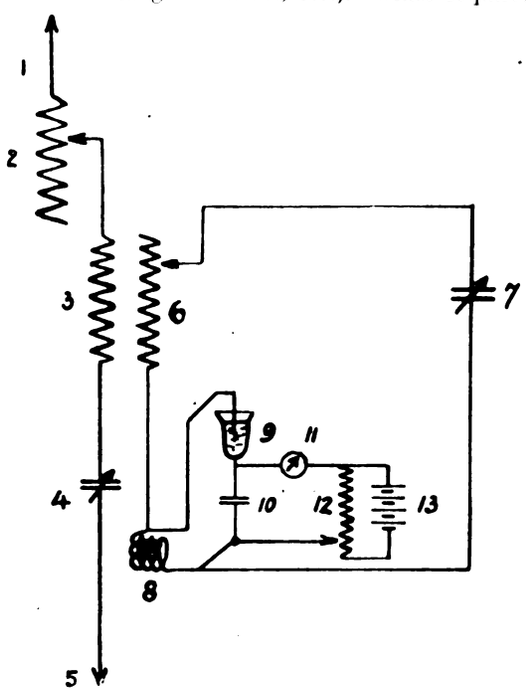

FIG. 1.

of the greatest importance as regards the commercial adoption of a detector are simplicity, ease of construction and repair, easily obtainable, and safely handled materials; reasonable mechanical strength is also necessary. Wireless telephony, employing as it does continuous trains of waves, necessitates the use of a "ticker" with many forms of detectors, though some, *e.g.*, the electrolytic type, do not need this addition. The ticker consists essentially of an electric bell magnet system, the hammer being replaced by a contact tongue which, by chopping up the continuous train of waves received, enables them to be heard in the receiving telephone. For telephonic work a detector must be quick acting, self-decohering, and preferably of the quantitative type (see below); unless its operation is very smooth, enabling a pure note to be heard in the telephone, good results are impossible. The coherer is *not* suitable for telephonic purposes, but electrolytic, thermo electric, magnetic and rectifying detectors may be used successfully. In passing, it may be noted that the recent variation of the poor contact detector introduced by Muirhead, which has as its object an increase of sensitivity and a removal of the necessity for any external decoherer, avoids the main disadvantages of the ordinary coherer. A poor contact of the point and plane type (between metals) is placed at the bottom of an oil column. The sensibility and anti-decohering characteristics are varied by the pressure of the oil (by a pump or by inclining the containing vessel to vary the effective head). Heavy paraffin oil or glycerine is used for the purpose.

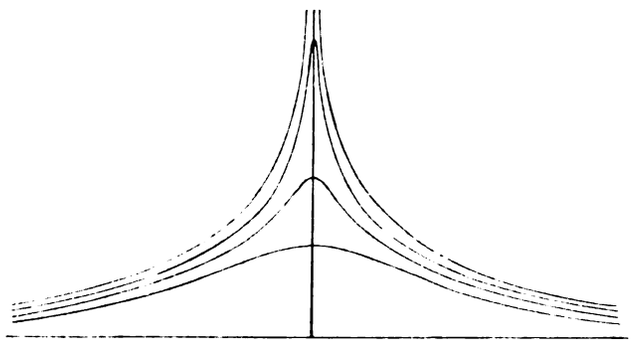

FIG. 2.

Connections of Detectors.—It is not within the scope of this article to consider the possible locations and connections of detectors in the receiving circuit; the point discussed is merely the advisability of using two detectors in parallel or in series. Jégon, as the result of considerable experiment, concludes that series connection is useless, the resultant sensibility being that of the less sensitive of the two detectors employed. Parallel coupling, however, gives a sensibility *rather higher* than that of the more sensitive set of the two, and is, therefore, advisable apart from the greater reliability of equipment so obtained.

Two main types of detector may be at once discriminated: (a) Those depending on *pressure* for their operation; (b) those operated by *current*. The coherer depends solely on the applied *P.D.* for its operation, and hence belongs to group (a), while the electrolytic detector, depending on high frequent *current* for its operation, is typical of group (b). Thermo detectors may be used as potential or current receivers according to whether they are connected in potential or current loops in the receiving circuit.

The effect produced on any detector may depend on the total energy received from the incoming wave or on the maximum amplitude of the latter. A means of determining which factor is the influencing one, Bellini and Tosi's method may be used:—If the diagram of energy transmitted from a directive transmitter station be obtained by aid of a thermo galvanometer, then detectors at the receiving station, depending on the total energy received, will give a precisely similar diagram (to this class belong thermal detectors); while those depending on the maximum amplitude of the received field, give a diagram whose *radii sectores* $\propto \sqrt[2]{}$ thermal detector's diagram. To the latter class belong imperfect contact detectors. If the receiving diagram is intermediate between the above distinct types, the detector depends partly on current, partly on potential operation, but usually with a decided bias towards one or the other.

Types of Detector.—The types here considered are the electrolytic, thermo electric, unilaterally conducting or "solid rectifier," and the vacuum, oscillation valve or audion detectors. Considering the construction and principle of action of each in turn, its advantages and disadvantages and the purposes for which it is unsuited, the following results are obtained:—

(1) *Electrolytic Detectors.*—The commonest form consists of a platinum or gold cathode immersed in an electrolyte of dilute $H_2\ SO_4$, and a platinum anode constructed as follows: Wollaston wire is drawn into a brass-capped glass jet, and after about 2 mm. of the wire have been dipped into nitric acid to remove the silver outer shell, this part is sealed into the glass by melting the tip of the jet. The platinum wire is soldered to the brass cap (subse-

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quently used as a contact point as shown), and the glass tip is ground down till a section of the Wollaston wire is exposed. The latter is known to be the case when electrical continuity is established between the brass cap and the electrolyte (tested by a dry cell and detector). The usual means of connecting such a detector is shown in Fig. 4. The battery B acts through the potential divider P and the high frequency "blocks" LL, and polarises the anode of E instantaneously. High frequency ærial currents induce similar currents in the circuit X, and, by depolarising E, allow a momentary current to flow from B through T, so producing the signal. The action is continuous, the

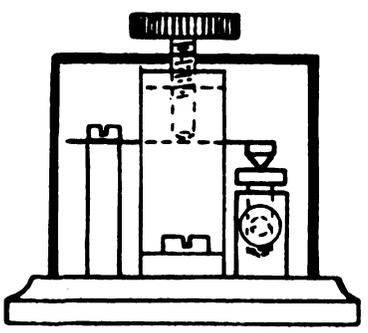

FIG. 5.

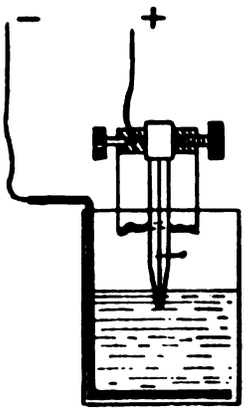

FIG. 3.

cell being "self-restoring." Though the polarisation theory above is the one usually advanced as explaining the action, Eccles has recently proposed a different explanation. He considers the action to be due to a heating of the thin film covering the platinum anode. On a platinum point 1-1,000 in. diameter, a film about 0·000,000,5 in. thick forms (Eccles), and more than half the heating effect of the current passing is concentrated on an annulas of film 0·0001 inch wide of mass $4 \cdot 10^{-10}$grm. Such a film is heated 0·5°C by 0·01erg., and as less energy than this will operate an electrolytic detector, it is quite possible Eccles' theory is correct. It finds some further support in the dependence of the detector on *current* rather than on P.D. Abrahams explains the action as a condenser effect, the average electrolytic detector having a capacity of some hundredths of a mfd. associated with a resistance of several thousands of ohms. (At about 120°C. the capacity is raised to 0·5 mfd., the resistance falling to several hundreds of ohms). Probably the action is in reality a combination of heating, condenser and electrolytic effects. § The anodic area of an electrolytic cell should be as small as possible; by employing the above construction the *depth* to which the anode penetrates is negligible, and the anode becomes merely a *surface*. Its diameter varies from 1-1,000th to several hundredths of a mm. So susceptible is the electrolytic detector to tuning that a variation in wave length of 1½ to 2% from the value to which X (Fig. 4) is tuned is sufficient to prevent audible signals in T. Tapping electrolytic detectors increases their sensibility somewhat by aiding depolarisation. By bubbling gas at four or five atmospheres pressure through the electrolyte, a great increase in sensitivity is obtained (Branly).

Effect of Temperature.—Raising the temperature of electrolytic detectors increases their sensibility. Branly states a maximum sensitivity to result at about 60°C., less satisfactory results obtaining on either side of this temperature. On the other hand, Abraham recommends 120°C. as a temperature at which sharper resonance is obtainable with about normal sensibility—probably due simply to the lower resistance at this temperature (see above).

Variations of Electrolytic Detectors.—Using a platinum anode dilute sulphuric acid gives better results than any other simple electrolyte, though other acids and some alkalis are effective to a less degree. The addition of a small quantity of fuming nitric acid to the sulphuric electrolyte reduces the critical voltage of the cell from 3·7 volts to 2·7 volts, while the substitution of a graphite cathode for the platinum or gold generally employed enables dispensation with the potential divider P, Fig. 4, direct connection to a 2-volt secondary cell being permissible. The use of two-point electrodes, either of which can be used as anode, makes the detector independent of polarity, but greatly increases its resistance. A tantalum anode gives less favourable results than platinum in electrolytic detectors.

By their extreme sensitivity, rapidity, and smoothness of action and absolute self-restoration, electrolytic detectors are admirably suited to the requirements of wireless telephony as well as telegraphy. This type has been successfully used in wireless telephonic communication up to from 300 to 500 miles.

(2) *Thermo Electric Detectors.*—A fine and adjustable contact is obtained between two dissimilar materials, as in Fig. 5. The contact is so fine and of such high resistance, that the high frequency currents induced in the receiving current being transformed to heat at it, set up a thermo electric current of sufficient strength to operate the receiving telephone in response to the signals transmitted.

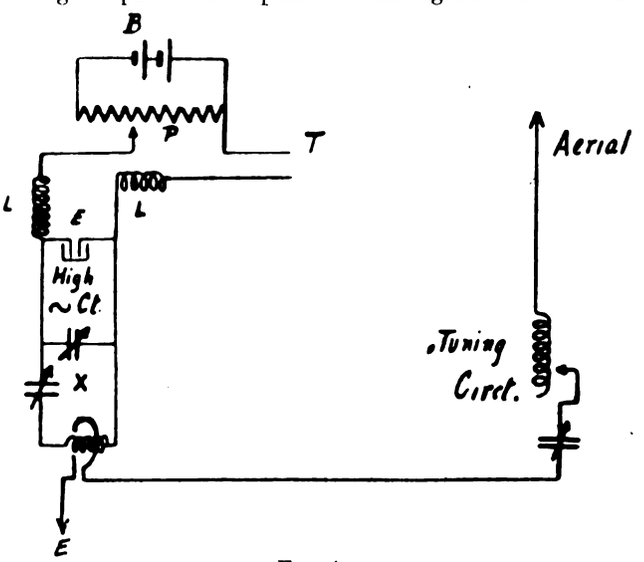

FIG. 4.

The higher the resistance of the junction (see Table I.) the greater the damping of the detector. Relatively low contact resistance maximum current flow, maximum dissipation of energy at the contact and maximum thermo-electric E.M.F., are the desirable qualities of a thermo detector. The construction of this type of detector needs no other explanation than Fig. 5. Many pairs of materials are recommended by various experimenters. In most of these a metal figures as one material and some mineral crystal or other as the second. The mineral crystals being split along their cleavage planes, present a surface far superior to any obtainable by maching or grinding. Among other thermo detectors at present known are (a) red mineral zincite (zinc oxide) split across its cleavage planes and pressed against a piece of metal. (b) An oxidised sharp edge of copper touching tin or bismuth and being spring adjusted, as in Fig. 5. (c) Possibly a very fine contact between tellurium and aluminium, though more regarding this couple is said later. In Table I. a further list of pairs is appended, the *order* of the contact resistances being as shown:—

TABLE I.

Pairs of Substances.	Approx. R. of contact ohms.	Authority.
Metal point—chalcopyrite ..	50-200	C. Tissot.
Metal point—indigo-copper	1,500 (approx.)	,, ,,
Tellurium point—brass plate	10	,, ,,
Platinum wire—chalcopyrite	1,200-1,500	,, ,,
Perikon detectors, without applied voltage	25,000	Pickard.

(3) *Rectifying Detectors.*—These detectors form a very large and successful class, though thermal detectors are more sensitive as a rule. The action here consists in the rectification of the high frequency currents induced by the received waves. The rectified current passes through the receiving telephone. The cause of the rectification is the unilateral conductivity of the crystals or pairs of metals employed. Pickard explains the action of solid rectifiers as being due to an electronic impoverishment at the con-

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stricted current path offered by the very fine contact. Fleming, on the other hand, imagines an irregular distribution of molecular electric valves over the surface of those crystals exhibiting unilateral conductivity. By a concentration of all the "valves" opening one way, at one part of a crystal current flow *via* this part is aided in one direction, and practically prevented in the opposite direction. Among the rectifying detectors now in use are: (1) *Perikon detectors*—silicon, molybdenite, and zinc oxide—chalcopyrite.

(2) Carborundum and many similar natural crystals used against platinum or tellurium, etc., as in Fig. 5.

(3) Silicon-steel, a very regular and fairly sensitive couple. Carbon-steel and tellurium-aluminium far less satisfactory, particularly the latter.

(4) *Walter's Tantalum-Mercury Detector.*—This is of great interest and importance, and consists of a fine tantalum wire just touching the surface of mercury. The full properties and theory of this type have been much discussed in the technical press during the last year, and can be only briefly noted here. The construction is practically that of Fig. 3, but mercury is essential as the second material of the contact. Tantalum from lamp filaments serves excellently. The action is dependent on a skin effect and for signals *above a certain critical strength* (which is, however, far higher than the weakest signal capable of detection by thermal or electrolytic detectors) the Walter detector is from 5 to 10 times as effective as any other known form. Having a very smooth action and good tone, and being quite auto-decohering, it is well suited for wireless telephony.

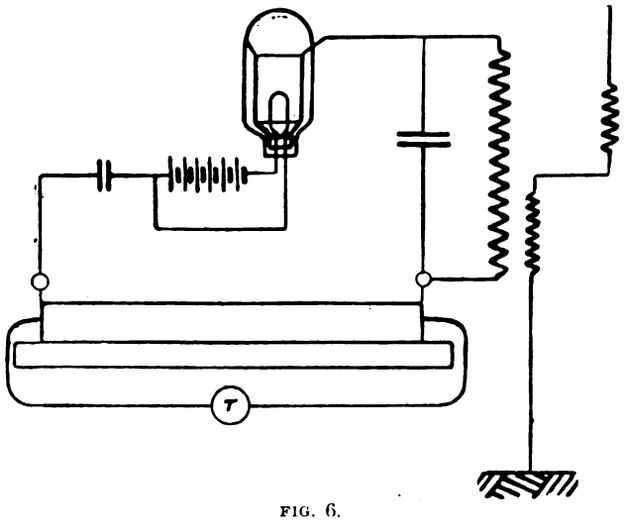

FIG. 6.

(4) *Vacuum Detectors* are merely a special case of rectifying detectors in general, the unilateral conductor here employed being the vacuous space between a hot and cold electrode in an exhausted bulb (Fig. 6). Such a space is conducting from the hot to the cold electrode, but not *vice versa*. The simple application of such oscillation valves in which the rectified current was passed directly through the receiving telephone, is considerably improved by Marconi's arrangement (Fig. 6), in which a condens stores up the rectified current (preventing it from flowing through the oscillatory circuit), and by periodic discharges through the secondary of a transformer produces the signals in a telephone connected to the primary of the latter.

Difference of opinion exists as to the value of vacuum detectors, and though the improvements following on the arrangement of Fig. 6 are considerable, the sensibility is still inferior to that of thermo detectors and electrolytic detectors.—"WREN."

THE ELECTRICAL ENGINEERS TERRITORIALS (London Division). Orders for week ending October 9, 1909.—Monday, October 4, "A" Company: Technical Drill, 7 to 9.30 p.m.; Tuesday, October 5, "B" Company: Technical Drill, 7 to 9.30 p.m.; Wednesday, October 6, Gymnasium, 6.30 to 9.30 p.m.; Thursday, October 7, "C" Company: Technical Drill, 7 to 9.30 p.m.; Friday, October 8, "D" Company: Technical Drill, 7 to 9.30 p.m. Officer Commanding, Col. R. E. B. Crompton, C.B. (Signed) P. H. Campbell, Capt. R.E., and Adjutant for Officer Commanding E.E. (L.D.).

TYNESIDE NOTES.

(By Our Correspondent.)

NEWCASTLE.

Electricity at Water Supply Works.

An interesting adaptation of electricity to the needs of the water supply of a town has recently been completed in Darlington. For some time past, owing to the development of the town, difficulty has been experienced in maintaining sufficient pressure in the high lying parts around Harrowgate Hill, etc., without creating an unnecessarily high pressure in the remainder of the distributing mains. Mr. George Winter, the Borough Surveyor, has evolved a scheme by which not only will ample supply be maintained constantly at Harrowhill, but it will not be necessary to maintain any higher pressure for the town than called for by its own requirements, and during the night when the general supply is at a minimum, the reservoir at Harrowhill is filled up, as well as certain tanks in other portions of the town, which are filled only once a day. A centrifugal pump capable of lifting 120,000 gallons of water per hour against a head of 35 ft. has been provided, and the suction of which is connected with the reservoir, and the delivery to a tank capable of holding 60,000 gallons placed above the pump. The main supply pipe from the pumping station is also carried directly into this tank together with an overflow into the reservoir. This pump is coupled directly to a compound wound motor, having an exceptionally heavy series winding, in order that the quantity of water delivered may be maintained approximately constant with a voltage varying between 430 and 500 as current is supplied from the traction trolley wire at a considerable distance from the generating station. The normal rating of this motor is 38 b.h.p., provision being made for fine speed adjustments by means of shunt regulation.

The Switchgear.

A combined main and starting switch, with no-voltage release, is provided, capable of starting up under full load; this switch is of substantial design with quick step by step motion, the time limit between each forward movement being readily adjustable by hand, and is manufactured under Moule's patent. This starting switch is started up by means of a special pattern of iron cased quick make and break float contact, operated through a copper rope connected to the float in tank, and is capable of adjustment at will. A further provision is made to prevent the motor being started up automatically, should the pump from any cause have lost its priming. A pipe connected with the upper portion of the pump is coupled to a cylinder containing a copper float, which, when up, completes the connection between solenoid main switch and tank contact; but if the water falls below a fixed level in the pump the circuit is broken, and the pump cannot be restarted until reprimed. This provision is necessary as the plant is left unattended and considerable injury could be done if the pump started up without water, though the special winding prevents the motor running at an excessive speed. The switchboard, in addition, contains an ammeter, overload circuit breaker and main fuse, the whole being totally enclosed in iron, so that it is impossible to obtain a shock from any portion, the plant being operated from the traction feeder with approximately 500 volts to earth. Provision is made, by means of a relay operated from the electricity works through one of the pilot leads, for breaking the whole circuit when required for the purpose of testing leakage current on traction system, or other reasons. Heating units are provided inside the motor and switchboard, consuming about 50 watts each, to prevent condensation and leakage on the surfaces of the apparatus. The pumping plant was supplied and erected by Messrs. Cox-Walker, Ltd., of Darlington, and the whole of the switch gear, float contacts, automatic switch gear, etc., were designed and manufactured by them to meet the special requirements called for by Mr. J. R. P. Lunn (Borough Electrical Engineer).

Electrification of Ormsby Rolling Mills.

Some little time ago the Cargo Fleet Iron Works developed the subsidiary company named the Ormsby Rolling Mills, Ltd., principally for the production of steel sections, and the electrification of these works is now well in progress. The supply of electricity is derived from the three-phase high tension mains of the Cleveland & Durham Electric Power, Ltd., at a pressure of 2,750 volts. This is applied directly to the main rolling motor, which is about 1,000 h.p., constructed by Messrs. Siemens Bros. Dynamo Works Co., Ltd. An interesting combination of this alternating current with a 500 h.p. direct current motor, and heavy fly-wheel is mounted on the same shaft as the flexible coupling connecting to the rolling mill, and both the motors are electrically connected to a rotary converter in such a way that surges of power on the main drive are compensated. As it is required to vary the speed of the shaft between 75 and 150 r.p.m., a slip regulator is also installed. In order to drive the live rolls and other apparatus a series of motors running at 440 volts, 40 periods have been supplied by the British Westinghouse Manufacturing Co., Ltd., and in the case of the live roll motors, as the work is of a very severe nature, the reversal occurring approximately every 10 seconds, the motors have specially stiffened shafts and gun metal bearings for dealing with heavy shocks.

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The motor shafts are connected to the live rolls through machine-cut gears. To indicate the abnormal features of design, it may be mentioned, for example, that the 30 h.p. motors supplied for this apparatus have shafts of 3¼ in. diameter.

Newcastle Corporation Quayside Improvement.

In connection with the handling of general merchandise on the quayside, a large travelling derrick crane, built by Messrs. Cowans, Sheldon, of Carlisle, has been installed. This crane is capable of lifting 5 tons at 60 ft. per minute, and 30 cwts. at 200 ft. per minute. It slews with the hook at a radius of 40 ft. at the rate of 400 ft. per minute and derricks at 50 ft. per minute. The length of track along which the crane operates is approximately 1,000 yards, and it travels at the rate of 50 ft. per minute with full load on the hook. The motors for the various motions were supplied by the British Westinghouse Co., Ltd., and the hoisting motor is 30 b.h.p., the derrick motor 25 b.h.p., while the slewing and travelling motors are each of 10 b.h.p. Four capstans, made by Messrs. C. A. Musker, Ltd., are supplied, each capable of lifting one ton at the rate of 150 ft. per minute, and operated by British Westinghouse motors of 15 b.h.p. Current is supplied to the motors at 500 volts, and for arc and incandescent lighting at 240 volts from the tramways power station. There is also work proceeding at the Ouseburn in connection with the formation of a new quay, and for this purpose a concrete mixer and temporary arc lighting are being operated from the same source of supply.

Miners' Federation of Great Britain.

On October 5 the annual conference of the Miners' Federation of Great Britain will be held at the Co-operative Hall, Newcastle on-Tyne, and one of the items for discussion is the resolution submitted by the Durham Miners' Union, as follows:—"In view of the Government Inspector's report on the West Stanley explosion, we move that the Executive Committee have brought before Parliament the great dangers which miners are exposed to by the use of electricity in dry and dusty mines, and press for its removal from such mines." It is interesting to note in this connection that Mr. John Wilson, M.P., in his latest monthly circular to the Durham miners, comments exhaustively on the report in connection with the above-mentioned disaster, and is of the opinion that the evidence points emphatically to the conclusion that electricity was the only possible cause of this disaster. He, therefore, asks for an exhaustive enquiry into the conditions which determine the safety, or otherwise, of electrical apparatus installed in mines.

MIDLAND NOTES.

[From Our Correspondent.]

BIRMINGHAM.

The City of Birmingham, with its enormous variety of power-using trades, is peculiarly adapted for the use of electrical motive power. In the jewellery quarter, thousands of machines are operated merely by the switching on of a button, while the removal of boilers, gas engines, and chimney stacks has effected economy while purifying the atmosphere. The most important development yet realised in the adoption of electricity has just taken place. Within the past year, a number of the largest metal rolling concerns have equipped their establishments with electrical motors, and, so far, the result has been eminently satisfactory. A few examples may be cited: The Birmingham Metal & Munitions Co. have installed 1,500 h.p. for tube drawing, and have discarded all their steam plant; Barker & Allen have 600 h.p.; the Mint Co., Ltd., 2,000 h.p., of which the largest motor is one of 350 h.p. Other concerns taking more or less large quantities are Wilkes, Son & Mapplebeck, Ltd., Messrs. Wilkinson, Earle, Bourne & Co., Ltd., Messrs. Johnson, and other well-known concerns. Generally speaking, they express satisfaction with the result. The saving of space has been most important, and in some cases it has been found possible to house the machinery motors entirely in the basement. The works, of course, are kept cooler, and the saving of fuel has been enormous. There are still a great number of metal rolling firms, stampers, and others who have not yet adopted the most modern motive power; but they are not likely long to remain passive spectators of a development which is giving their competitors a considerable advantage. An important benefit is the greater constancy and uniformity of operation. The machines run regularly, and the mills do not "stall" under specially heavy loads as they commonly did with ordinary motive power. This increases output, and improves quality, while proving generally more economical.

Coal-Cutting Machinery.

The unexpected and far-reaching effects of legislation have been manifested in Birmingham lately in a stimulated demand for electrical apparatus in connection with coal-cutting machinery. Several Birmingham firms are giving attention to the equipment of drilling machinery, and a new branch of the engineering industry is thus in course of development. A big trade in this line is anticipated within the next year or two, and it is believed that a well-made rock drill of local production would have a large sale, if makers were to turn their attention more thoroughly to this branch.

Artistic Pendant Business.

One effect of the extension of electric light, enabling the use of a downward light instead of the old-fashioned flame, has been the revival of the chandelier and other forms of pendants. Large numbers of firms in Birmingham in the brass trade are devoted to this class of manufacture, and the demand has naturally stimulated ingenuity and artistic invention in the design of these apparati. A good deal of work for churches and municipal buildings of a high class has of late found its way to leading Birmingham firms. Unless the unexpected happens, revolutionising methods of illumination, the artistic pendant business in Birmingham will soon be bigger than ever.

Extension of Electrical Trade.

Quite a number of examples can be cited of Birmingham firms which have adapted themselves to electrical machinery, as an engineering product. A conspicuous example is the firm of Belliss & Morcom, Ltd., which supplied the bulk of the electrical machinery to the Summer-lane Municipal Department, and which is rapidly developing a world-wide trade, particularly with Canada. The largest engines, including half-a-dozen 3,000 h.p., operating direct current generators, were furnished by Belliss & Morcom. A number of features in the machinery comprise the speciality of this firm, including the forced lubrication principle, by means of which oil is supplied to all the bearings under a pressure of 20 to 30 lbs. per sq. in. from oil pumps in duplicate, worked from the slide valve eccentric. New engines by Belliss & Morcom are constantly being added to the Summer-lane generating plant.

An Appreciation of Electrical Experts.

A very interesting inaugural lecture was given by Dr. Denning, the Principal of the Municipal Technical School, Smethwick, on the subject of "Artificial Light: Ancient and Modern." Dr. Denning paid a tribute to the energy and ingenuity of electric lighting experts. The present time, he said, was specially interesting, because both gas and electrical people were working very hard, and there was no prospect of gas being driven out at once, but the wonderful success achieved by electrical experts in a comparatively short time was really phenomenal. Just as the introduction of the gas manager had infused fresh vitality into gas undertakings, so the recent successful introduction of the rare earth metal filaments was expected to prove of inestimable benefit to the electric lighting engineer. The lecturer exhibited various beautiful lamps, and on the point of economy remarked that the lighting engineers had to produce a large quantity of heat energy to secure a comparatively small output of light energy. As a matter of fact, the total energy consumption of a wax candle was really sufficient to brilliantly light a large mansion, or the energy of a boy turning a handle would, if properly directed, produce as much real light as was given by the furnaces, and boilers of a large steam engine driving a group of dynamos.

Electrical Engineering Classes.

An important section of the Municipal Technical School, Birmingham, which has just recommenced its operations for the winter, is the Electrical Engineering Department. This is extremely well equipped, and has been found of the greatest use to students and apprentices in a number of Birmingham trades. The department is specially in charge of the Principal, W. E. Sumpner, D.Sc., M.I.E.E., who takes the Senior Department of Electrical Engineering. The classes are arranged to furnish students with a thorough grasp of electrical science, together with a working knowledge of its application to the industries, telegraphy, telephony, and electrical engineering. Coincident with the study of electricity, is mechanical engineering, machine drawing, and workshop work. In the Senior Department, the training is of a most practical character, including the study of lighting and power installations, high-tension transmission and distribution, motors for special purposes, starting devices, and a variety of other branches of study. A special feature is made of preparation for the B.Sc. Engineering Degree Examination of the London University. There is a design class in charge of Messrs. H. B. Matthews and G. H. Wigley, and in the electrical jointing shop instruction is given in the use and manipulation of tools, the effecting of joints of 19 strand and upwards. The school includes in its equipment excellent dynamo rooms, and thoroughly up-to-date electrical and electro-metallurgical laboratories, with the requisite furnaces. A number of its students have already distinguished themselves in various parts of the world.

AMERICAN NOTES.

[From Our Correspondent.]

NEW YORK.

It is generally anticipated that our third annual Electrical Exhibition, which will be held in Madison Square Garden, from October 11 to October 21, will be one of the most noteworthy ever held on this Continent. I think it may fairly be claimed that in matters electrical America is away ahead of any other country. Perhaps the national spirit of hustle has something to do with this, or it may be due to the fact that when anything

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new is found it is rushed on to the market, tested or untested; or it may be owing to the fact that we specialize more. Whatever be the cause, it is certain that more new things are evolved here than in London or Berlin, and though some may be worthless, a good proportion survives and gets developed. I am told by the organizers that new ideas will be found in abundance in this coming show, and among them one or two things that will make a great stir in the electrical world. Apart from a galaxy of domestic appliances, a special feature will be a great industrial exhibit representing manufacturing processes of all kinds utilizing electric drive. The interior of the Garden will represent the highest attainment of the decorator's and illuminating engineer's skill, and more than 75,000 incandescent lamps will be used for illumination. The number of exhibitors who have taken space is far beyond expectations. A noteworthy exhibit will be that of the Collrier Wireless Telephone Co., who will allow people to talk and listen hundreds of feet apart through stone walls 3 ft. thick, and fireproof metal doors closely barred, thus demonstrating that electrical waves are not interfered with no matter what the nature of the obstacle through which they may have to pass.

The Science of Illuminating.

Laying down as a basis the theorem that the illuminating engineer should not only be an engineer in the broad sense, but should also have medical knowledge of the effect of light upon the human eye, and should also know something at least of one of the fine arts, the Chicago National Electric Lamp Association has founded and is equipping a laboratory for the public dissemination of such knowledge as may be obtained on the medical and physical facts underlying illuminating engineering. A thorough and systematic search is to be made through technical publications of all kinds without regard to the language in which they may be written, and the data obtained will be verified, and on this foundation original work will be undertaken. In this connection, it should be mentioned that by the time these notes reach THE ELECTRICAL ENGINEER the third annual convention of the Illuminating Engineering Society will be in progress here in New York. Among the special features of the event will be an exhibition of electric lighting devices of the latest commercial types, as well as a historical and educational exhibit showing the progress of the art of illumination. This exhibition continues open to the public throughout the Hudson-Fulton celebration.

Nernst Developments.

The tungsten lamp is not by any means to have everything all its own way. Recent developments of the Westinghouse-Nernst glowers eliminate practically all the past objections to this type of illuminant. The slow incandescing has been got over by replacing the platinum heater by a new form which becomes immediately incandescent and lights the glowers in ten seconds. A new spring holder for multiple glower lamps makes maintenance and replacement perfectly simple, and clusters are now made for three sizes of burners—88, 110, and 132 watts, and two other sizes are available—176 and 220 watts. Prices are much lower than they were for all types, and thus the objection as to the high first cost has been materially modified, while renewal costs are, it is claimed, only half those of the tungsten. Some exceedingly handsome Nernst chandeliers are being shown at prices which compare very favourably with other types.

The Selden Patents.

By a judgment delivered by Judge Hough in the United States Circuit Court here, the "Selden patent," under which the holders seek to collect royalties from all American manufacturers and importers of motor cars, has been completely upheld in a suit for infringement of patent brought by the Electric Vehicle Co. and George Selden against certain American makers and dealers in foreign built cars. Judge Hough decided that "patents are granted for inventions; the inventor may use his discovery, or he may not, but no one else can use it for 17 years. That 17 years begins whenever the United States so decrees by its patent grant."

Railway Telegraph School.

The great success attained by the students who have graduated from its school of telegraphy at Bedford, Pa., has induced the Pennsylvania Railroad to endeavour to secure this fall the largest enrolment the school has enjoyed since it was established in 1907. The school has the personal supervision of practical railroad men—present officers of the Pennsylvania Railroad Co.—while Mr. J. B. Fisher, superintendent of telegraph at Philadelphia, is in charge of its operation, with C. F. Emerick as resident manager. That the students may have the opportunity to become thoroughly versed in railway business before attempting actual work, the regular wires of the Bedford Division are run through the school room. Standard train order blanks are furnished, that this feature of operating trains may become familiar to the students. The time required to complete the course is from six to eight months, and immediately upon its completion graduates are provided with salaried positions in direct line of promotion.

Central Stations and Co-operations.

The Tungstolier Co., of Cleveland, Ohio, has worked out an interesting plan of co-operation between the electrical dealer and contractor and the central station management based on "sound commercial common-sense and correct business principles applied to electrical interests." Under this scheme a complete plan is outlined and working material prepared for a thorough campaign on the part of the central station operator, as well as a co-operative scheme by which the contractor or supply dealer is interested in taking care of the business developed through the central station campaign. With this plan the central station manager creates a desire for use of more current and makes the initial installation. The new business developed by reason of this pioneer work is then handled by the supply man or contractor.

Electric Railway Combine.

Negotiations are in active progress for the consolidation, with a capital of $100,000,000, of the United Railways and Electric Co. of Baltimore, the Annapolis Short Line and the Maryland and Pennsylvania Railway. The Maryland Electric Railways will probably become the holding company for the other properties. Alexander Brown, senior member of the banking firm of Alexander Brown & Sons, who engineered the deal whereby all the trolley systems of Baltimore were united, is said to be the moving spirit in the latest plan for a bigger trolley combination. He is on his way from Europe, and is expected in Baltimore this week. The Maryland Electric Railways was organised after the great fire for the purpose of financing the needs of the United, and since has bought equipment, built barns, etc., which it leases to the latter at an annual rental equal to 6% on actual cost. The United is bound under the terms of the lease to purchase the property of the Maryland Electric Railways subject to a first mortgage for $2,727,000 at an amount sufficient to pay the principal of the bonds.

Big Michigan Merger.

My Chicago correspondent says that the recent announcement from the Secretary of State for Michigan's office that articles of incorporation have been filed by 18 power companies, with a total paid-in capitalization of $3,200,000, is believed to mean that practically all of the available power sites in North-Eastern Michigan have been acquired by eastern interests, which now control gas and electrical properties in many cities of the State. It has been reported that Hodenpyl, Walbridge & Co., of New York, and E. W. Clark & Co., of Philadelphia, are interested in Michigan power sites. Fourteen of the new concerns are water-power companies. Their incorporators are: E. F. Loud and H. K. Loud, of Au Sable, Mich., each of whom holds one share of stock, and L. A. Wood, of New York, to whom are credited the other 998 shares. In the second group of three companies, George E. Hardy, of Englewood, N.J., is the heavy stockholder, with W. M. Eaton and J. C. Weadock, of New York, as small holders. These companies and their capitalization are as follows: Saginaw Power Co., $1,000,000; Bay City Power Co., $500,000; and Pontiac Power Co., $200,000. The Charlotte Power Co., with a capitalization of $50,000, is incorporated by George H. Clark, E. Clark, and George A. Crawford, of Detroit.

COMPANIES' MEETINGS AND REPORTS.

YORKSHIRE ELECTRIC POWER CO.

At the 13th ordinary half-yearly meeting of the Yorkshire Electric Power Co., held at Leeds, Mr. A. G. Lupton (the Chairman) presided. The Chairman, in moving the adoption of the report, stated that the company was making steady advance. The profit of £1,069 remained, after paying interest to the amount of £1,528 on the paid-up mortgage capital, of over £67,000, whilst the mains on which that capital had been spent were only beginning to bring in revenue during the past half-year. The textile industries continued to bring in the largest revenue, but the colliery load was also increasing in a satisfactory manner. The company's meter readings confirmed what had been said of the revival of trade, and the increased output has been the result of new business. Consumers in undeveloped portions of the district were pressing for the mains to be extended to them, and the directors had decided, in the first place, to meet the urgent demand from the Castleford district. In consequence of increased demand, a boiler of a capacity 50% greater than the boilers originally installed had been put down, and it had been decided to instal a fourth turbine of a capacity equal to any two of those at present in the station. Those extensions would entail the provision of further capital. The whole of the borrowing powers had been exhausted. Under the powers of the Company's Act, further capital could only be obtained by the issue of ordinary shares at par value. That was not at present practicable, and it would be necessary to amend the company's Act by applying to Parliament for further powers to authorise the issue of preference stock. The directors considered it advisable to ask for other powers which had been granted to later-formed companies, which would much facilitate

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the work of the company. In answer to a question, the Chairman said that Brighouse was taking a supply from the company and were discontinuing their own supply.

JOHNSON-LUNDELL ELECTRIC TRACTION CO.

The report of the Johnson-Lundell Electric Traction Co., Ltd., for the 13 months to June 30, states that the sale of the works at Southall, as reported at the last meeting, was duly completed and the purchase price paid. The operations of the year have been limited to carrying forward certain improvements in the apparatus connected with the company's regenerative system and to maintaining the patents. The efforts of the board to make a sale of the patents at a satisfactory price have not yet been successful. In the course of the current year it is hoped that something in this direction may be accomplished, or that a proposal to reorganise the company may be submitted for the shareholders' consideration. Messrs. J. H. Holmes and Co. have transferred, in terms of their undertaking, the whole of the paid-up shares held by them.

CALCUTTA ELECTRIC SUPPLY.

The Directors of the Calcutta Electric Supply Corporation, Ltd., have declared an interim dividend on the Ordinary shares of the company at the rate of 6½% per annum, for the half-year ended June 30 last, such dividend to be payable on November 15 next.

ELECTRIC THEATRES, LTD.

A meeting of the shareholders of Electric Theatres, Ltd., held at the Theatre de Luxe, Strand, London, rejected a proposal by the directors to increase the capital to £400,000, to amalgamate with the London Cinematograph Co. to purchase a business of Lumiere & Co., film manufacturers, and to acquire a large number of shares in the Biograph Co. Mr. Rowland Hill, who presided, hinted that the time was coming when they would have cinematograph pictures in natural colours. The opposition was led by Mr. John Proctor, who said it was good enough for them to receive dividends at the rate of 40%.

KALGOORLIE ELECTRIC POWER AND LIGHTING.

The directors of the Kalgoorlie Electric Power & Lighting Corporation, Ltd., have declared a dividend on the Preference shares at the rate of 6% per annum for the six months ending 30th inst., payable October 15.

WILLANS & ROBINSON, LTD.

The report of the directors of Messrs. Willans & Robinson, Ltd., states that the accounts for the half-year ended June 30, 1909, show a loss of £3,501 7s. 9d. on the half-year's working. Deducting this sum from the balance of £9,516 11s. 6d. brought forward, leaves £6,015 3s. 9d. available for distribution. The directors recommend the payment of a dividend at the rate of 3% per annum on the Preference shares, which will absorb £4,999 19s., leaving a balance of £1,015 4s. 9d. to be carried forward. There is no profit available for payment of interest on, or redemption of, Funding Certificates, and it is not possible to pay any dividend on the Ordinary shares. The regrettable result shown for this half-year is due to the scarcity of work and to the low prices prevailing. The actual loss on the half-year's working at Rugby is £2,331 7s. 7d. To this has to be added £1,170 0s. 2d., the cost of keeping the Queen's Ferry Works in proper order and repair. The whole of the Debenture interest is now charged against the Rugby Account, and in considering the loss of £2,331 7s. 7d. on that account it must be borne in mind that this result is arrived at after charging the Rugby Profit and Loss Account with £4,824 0s. 8d., the amount of the Debenture interest for the half-year. The sum shown in the Profit and Loss Account as written off against depreciation of premises, plant, machinery, patents, etc., viz., £4,203 8s. 10d., is considerably less than in past half-years. The deficiency, however, in this provision is apparent and not real. A number of the working costs of the business, such as drawings, patterns, tools, and other appliances, which in past half-years have been charged against Capital Account and subsequently written off by depreciation, have in this half-year been charged direct against the Profit and Loss Account. Although, therefore, the sum shown in the accounts as written off for depreciation this half-year is less than in the past, there are direct charges against Profit and Loss Account to counterbalance this deficiency, and the actual provision made for keeping capital values on a sound basis is as ample as formerly. Debenture stock to the amount of £8,767 has been redeemed during the half-year out of the late Fire Insurance Fund. This has been purchased at prices considerably below par. The difference between the face value and price paid amounting to a sum of £1,761 6s. 6d., and the balance of the fund itself, have been added to the main Reserve Fund, which, after deducting therefrom the amount paid on Mr. Robinson's retirement, stands at £62,629 11s. 1d. The full Preference dividend for the half-year might have been made up by drawing on the Reserve Fund. The directors, however, in view of the continued depression in business, do not feel justified in recommending such a course. The Board are continuing their efforts for the disposal of Queen's Ferry Works, and although no sale has yet been effected, there is good reason to hope that negotiations now in progress will result favourably. A lawsuit, which has been hanging over the company in connection with one of their gas engine contracts has, since the books were closed, been settled by the payment of a sum of £15,000. This liability is provided for by the Reserve Fund, and the settlement of this case leaves the probable loss on the final disposal of Queen's Ferry as the only serious outstanding liability arising out of matters which were enquired into by the Advisory Committee in 1904. There is a considerable quantity of Diesel engine work in the shops at the present time; but the Diesel Co. have so far been able to place only a small proportion of the orders due under their agreement. It is hoped that before long there will be a revival in the demand for Electrical generating machinery, and the company is now in an excellent position for securing a good proportion of the business when the revival takes place. Meanwhile, every effort is being made to push new developments, such as turbo pumps, water turbines, and condensing plant, so as to widen the base of the company's operations and make it less dependent on one class of manufacture. The first of the high-lift turbo pumps has successfully passed its trials, and there are a number of these and of the water turbines under construction in the shops. The directors do not for the present propose to make any addition to the Board, nor to fill up the vacant post of Chairman. These matters have their earnest atetntion, and as soon as they are able to put forward proposals which will fully meet the best interests of the company, these will be laid before the shareholders.

LISBON ELECTRIC TRAMWAYS.

The directors of the Lisbon Electric Tramways, Ltd., have declared an interim dividend of 2½%, free of income-tax, on account of the current year, payable on the 12th proximo.

DICK, KERR & CO.

The report of Dick, Kerr & Co., Ltd., shows that the net profits for the year amount to £28,168, which, with the £81,567 brought forward, enables the directors to meet all charges and to pay 6% to the Ordinary shareholders, the carry-forward to the current year being reduced to £63,141. The severe competition referred to in the last report has been continued throughout the year in a more acute form, and, in addition, the work carried out in all departments has been considerably below the average.

COMPANIES' REGISTERED.

Anglo-Russian Refuse Destruction Co., Ltd.—Registered September 20, by C. Fred Kennedy & Co., 12-14, Abchurch-lane, E.C. Capital, £5,250, in 5,000 Ordinary shares of £1 each and 5,000 Deferred shares of 1s. each. Objects: To carry on the business of refuse destructors, founders, engineers, electricians, gas makers, engine, locomotive, carriage and wagon builders, etc. Private company.

Boudjah Electric Lighting Co., Ltd.—Registered September 14. Capital, £5,000, in £1 shares. Objects: To undertake the electric lighting of streets, public places and private dwellings in Boudjah or elsewhere; to obtain concessions for electric lighting and electric power supply in the Turkish Empire. Private Company. The first directors (to number not less than three nor more than nine) are: D. Forbes, Junr., T. S. Catto and F. W. Parry. Registered office, 110, Cannon-street, London, E.C.

Cunningham & Harris, Ltd.—Registered September 16, by Alfred Harris and Co., 55, Lincoln's Inn-fields, W.C. Capital, £5,000, in £1 shares (2,000 Pref.). Objects: To adopt an agreement with S. Harris, and to carry on the business of electrical engineers, electricians, workers of and dealers in electricity, motive power and light, etc. Private company. Registered office, 21, North Audley-street, Grosvenor-square, London, W.

Dioptric Sign Co., Ltd.—Registered September 6. Capital, £1,000, in £1 shares (250 Cumulative Preferred, 500 Ordinary, and 250 Deferred). Objects: To acquire from E. L. Warren the benefit of certain existing inventions relating to an improved sign, to develop and turn to account the same, and to carry on the business of electrical engineers, metal workers, shop fitters, gas fitters, etc. Private company.

Electrical Trolly Head Co., Ltd.—Registered September 8. Capital, £6,000, in £1 shares. Objects: To adopt an agreement with J. T. Cherry and E. H. Clive for the acquisition of certain patents, and to carry on the business of electrical engineers, etc. Minimum cash subscription, 1,000 shares.

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PLUTTE SCHEELE & Co., LTD.—Registered September 6. Capital, £6,000, in £1 shares. Objects: To adopt an agreement with F. Plutte for the acquisition of the business of Plutte Scheele & Co., and to carry on the business of manufacturers and sellers of articles and accessories required in the electrical and allied trades, etc. Private company. Registered office, 18 and 19, Queenhithe, E.C.

R. LASCELLES & Co., LTD.—Registered September 4. Capital, £1,000, in £1 shares. Objects: To adopt an agreement with R. Lascelles, and to carry on the business of mechanical, electrical and general engineers, manufacturers of and dealers in electric, magnetic, telephonic and other apparatus, etc. Private company.

SMITH & WALL, LTD.—Registered September 4. Capital, £5,000, in £1 shares. Objects: To take over the business of a fishing reel and tackle manufacturer carried on by A. Smith at Whitehead-road, Aston, as Smith & Wall. Private company. Registered office, 25, Whitehead-road, Aston, near Birmingham.

CONTRACTS OPEN.

HOME.

GLASGOW.—At the new Mitchell Library.—For supplying and fitting up the following lifts: (1) One electric passenger lift, (2) three electric book lifts, and (3) three handbook lifts, for the Corporation. Sealed and endorsed tenders must be sent to Mr. A. W. Myles, Town Clerk, City-chambers, Glasgow, by October 4.—Corporation.—Sewage Department.—Mains, switchboard, distribution boards, mains, cables, switches, etc., wiring and accessories for transmission of electrical power to motors, etc., and for lighting at the Shieldhall Outfall Works. October 4.

LONDON, W.—Metropolitan Railway Co.—Stores—No. 13, electric wires and cables; No. 14, electric lamps, carbons, switches, fuses, telephones, cells, etc.; No. 15, electrical insulating materials (mica, fibre, ebonite, etc.); No. 33, signal and telegraph ironwork, insulators, galvanized pulleys, etc.

OVERSEAS.

BILBAO.—Urban Tramways Co.—Conversion of horse tramways into electric tramways. (Co. del Tranvia Urbano).

BRUSSELS.—Belgian State Railways—Material and apparatus for electric lighting of trains, stations, etc., Spec., 752, 11, Rue de Louvain. October 6.

JASTROW.—Municipality.—Locomobile for electric service.

ROME.—Italian State Railways.—Telegraph cable. (Part., Ferrovie dello Stato, Direzione Générale, servizio contratti.) (A.). October 17.

SEOUL.—Korean Government.—500 miles of telephone lines. Est., £7,100.

SPAIN.—The Ministerio de Fomento.—Tenders for a 60 years' concession for the construction and working of an electric tramway from Sans to Coll-Blanch (Barcelona). Tenders must be enclosed in sealed envelopes, bearing on the outside the name of the tenderer, and addressed to the Dirección General de Obras Públicas, Madrid, where they will be opened at noon on November 20. To qualify any tender a deposit will be required of 1,295 pesetas (about £47), which should be enclosed in a separate envelope. An application respecting this concession has already been submitted by the Compañia General de Tranvías, who have certain preferential rights in the competition. *Local representation is necessary.*

SYDNEY.—Postmaster-General.—Switchboard apparatus for subscribers' premises. Particulars of all Australian contracts, 72, Victoria-street, Westminster, S.W. January 10, 1910.

TORONTO.—Motors, etc. October 14.

VALENCIA.—Harbour Board.—Six one-ton electric cranes for timber unloading. November 2.

SOME CONTRACTS.

Recent orders secured by the Power and Mining Department of the British Thomson-Houston Co., Ltd., of Rugby, include the following:—The Braidwater Spinning Co., Ltd.—14 three-phase motors, main switchboard, etc.; Purex, Ltd., Greenford—one 56 kw. generator, one 20 kw. generator, six d.c. motors, starting gear, and lighting material; Corlett Electrical Engineering Co., Ltd.—five d.c. motors and spares; The Carrongrove Paper Co., Ltd.—one 300 kw. d.c. generator, three three-phase motors, switchboard and wiring, etc.; Bennett Bros., London—27 d.c. motors and rheostats and 8 a.c. motors and rheostats; Williams, Harvey & Co., Ltd., Cornwall—five d.c. motors from 6 to 30 h.p., switchgear, etc.; Walter Somers & Co., Ltd., Birmingham—three 30 h.p. d.c. motors, three 15 h.p. d.c. motors and rheostats; Steel, Peech & Tozer—13 motors from 5 to 100 h.p.; Scott's Shipbuilding & Engineering Co., Ltd., Greenock—eight d.c. motors from 10 to 120 h.p., with controlling and switchgear; Glasgow Corporation—three d.c. motors from 40 to 80 h.p. and switchgear; Powell Duffryn Steam Coal Co., Ltd., Aberdare—10 three-phase motors from 5 to 30 h.p.; G. Whitehead & Co., Ltd., New Eltham—two three-phase 25 and 110 h.p. motors, switchgear and wiring; Clarke, Chapman & Co., Ltd.—two three-phase, 100 and 200 h.p. motors and switchgear.

A contract has been signed between the authorities of H.M. Naval Yard, Simons Town, and Messrs. Cunningham & Gearing, engineers, of Cape Town, for the complete internal equipment for lighting and power of the new workshops at Simons Town. The lighting includes the installation of 48 arc lamps, and the approximate wiring of 35 motors; the whole work to be carried out in cold drawn galvanised steel conduit. All fuses, automatic cut-outs, meters, main switches, etc., will be enclosed in cast-iron boxes manufactured by Messrs. Cunningham & Gearing in their works, Cape Town. In addition, the firm were also successful in securing the contract for the electric light installation of about 24 private residences attached to the Naval Yard. The whole work will be carried out under the personal supervision of Mr. R. Wightmann, Electrical Engineer, H.M. Naval Yard, Simons Town.

The Mirrlees Watson Co., Ltd., Glasgow, have recently secured the following contracts:—Low level counter current jet condensing plants (per D. Selby Biggs & Co., Consulting Engineers), for Niddrie & Benhar Coal Co., Ltd., Fife Coal Co., Ltd. (Mary Pit and Kinglassie Pit); surface condensing plant, Aktiebolaget de Lavals Angturbin, Stockholm; barometric condensing plant (Okura & Co.) for Formosa (3rd repeat); two sets large three-throw air pumps, Henry Tate & Sons, Ltd., Silvertown, E.

We understand that Messrs. Venner & Co., Westminster, London, are the sub-contractors to Messrs. Lucy & Co. for the time switches for controlling the Swansea new street lighting scheme.

In connection with the Boulder Tin Mining Co.'s (Tasmania) hydro-electric transmission scheme, Messrs. T. K. Steanes, Sydney, are the contractors for the electrical machinery, and Messrs. Finlayson Bros., Devonport, for the Pelton wheel and piping (Mr. G. H. Lofts, A.M.I.E.E., Consulting Electrical Engineer).

The contract has been secured by the Compañia Industrial de Electricidad del Rio de la Plata for the supply of the entire plant to the following electric light stations:—Olavarria—Concession Angel Brumaro. Public and private lighting, 250 h.p., with Tosi gas engines. Balcarce—Sociedad Anonima de Luz Electrica. Public and private lighting, 200 h.p., with Tosi gas engines. Santa Rosa de Toay—Concession Bancalari and Forchieri. Public and private lighting, 120 h.p., with Tosi steam engines.

Amongst many recent orders Messrs. Reavell & Co., Ipswich, have received, they report an electrically-driven compressor for the borough of Rotherham, for supplying air to the various pneumatic sewage ejectors in the borough. The machine has a large range of variation in speed, which is controlled by hand. It is also fitted with two special air relay devices, one set for the maximum pressure and the other for the minimum pressure which automatically operate a whistle when the pressure reaches either limit. They have also supplied a large machine of the quadruplex double-ended type to the order of the General Post Office for pneumatic despatch at the Central Post Office. Each end of the machine has a device for automatically controlling the volume, and may be used for either vacuum or pressure.

The Midi Railway Co. (France) has given the Allgemeine Electricitäts-Gesellschaft an order for the supply of an electric locomotive for freight and passenger service. The locomotive will have a maximum speed of 46½ miles and a normal speed of about 28 miles per hour respectively. It will be equipped with two Winter-Erchberg motors, each of 800 h.p. capacity on an hour rating, and 600 h.p. capacity on a continuous rating, and connected to driving rods without the use of gearing. There are to be three driving axles and two trailing axles.

The D.P. Battery Co., Ltd., have received an order for the renewal of the large batteries at Waterloo, owned by the Liverpool District Lighting Co., and their maintenance for a period of eight years.

CHRISTIANIA.—Messrs. Brown, Boveri & Co., of Baden, Switzerland, who are so intimately connected with many of the Alpine electric railways, have been given a large contract by Messrs. A. S. Rjukanfos & Co., of Christiania, for the electrical equipment of a factory for the extraction of saltpetre from atmospheric nitrogen. There are to be five three-phase generating units, rated single, at 17,000 k.v.d. (power factor 0·6) at 10,000 to 11,000 volts and 50 cycles. They will be coupled to water turbines of 14,000 h.p. with 250 r.p.m., by means of exciters of 130 k.w.r.p.m. This equipment is only half of the full plant ultimately to be laid down. It is claimed that when completed this will be the largest generating station in the world.

RADIOGRAPHS.—At the Royal Photographic Society's 54th exhibition at the New Gallery, Regent-street, London, W.C., there is a fine collection of radiographs. Though not numerous they are of a specialised nature which will appeal to experts.

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BUSINESS NOTES.

LIGHTING AND GENERAL—Home.

ASTON.—Protesting against annexation by Birmingham under the Greater Birmingham scheme, the Aston Council have issued a circular pointing out that the figures compiled by Birmingham show a reduction of ½d. in the £ in the Aston Manor rates, but they credit nothing in respect of profits from the electricity undertaking. In the next five years a very considerable relief to the rates from the profits earned by the Borough Electricity Department may be confidently looked for. Notwithstanding the serious trade depression which has existed, the output from the Aston Manor Electricity Department has, in the last three years, increased from one and three-quarter million units to upwards of four million units. The total income has increased in the same period from £13,938 to £24,665, and the gross profit from £4,645 to £11,087, while a net loss of £1,718 has been converted into a net profit of £2,951. This profit is shown after paying off (in the three years) £6,418 of the capital expenditure, and despite the fact that the charges for electricity supplied in Aston Manor are amongst the lowest in the kingdom, and considerably lower than the charges made in Birmingham.

BARROW-IN-FURNESS.—The Borough Electrical Engineer (Mr. H. R. Burnett) reports that for the year ended March 31 last, the total working costs of the electricity undertaking were reduced from £6,440 to £6,286, the reduction per unit being 0·048d. The total revenue increased from £12,428 to £12,902. As a result the gross profit had been increased from £5,988 to £6,615. The contribution to the sinking fund was £218 in excess of that of the previous year, so that the nett result of the year's trading was a deficit of £383, as compared with a deficit of £791 during the previous year.

BERMONDSEY (London).—The London County Council wrote to the Borough Council suggesting the provision of an "extraordinary renewals fund" in connection with their electricity undertaking. The Borough Council have replied setting out, *inter alia*, "that they are of opinion that, as the loans for electricity purposes have been taken up on the instalment principle, there is no need for the creation of an "extraordinary renewals fund." The Borough Council recognise the need of a reserve fund, and one is in existence standing at the present time with a balance of £3,807, and after the current financial year the Council anticipate being able each year to add thereto a substantial sum until the maximum of such reserve fund, viz., 10% on the capital outlay, as fixed by the Bermondsey Electric Lighting Order, is reached.

BRADFORD.—At the new Town Hall provision has been made for the Electrical Engineer's Department.

BRISTOL.—The Merchant Venturers' have obtained for the extensive workshop for boot and shoe trade students at their Technical College the loan of a large quantity of valuable machinery, which will be driven by electric motors. Electric light has also been installed.

CARDIFF.—A new electric Cinema Theatre has been opened.

CARLISLE.—The Council have received the sanction of the Local Government Board to the borrowing of £5,399 for extension of plant at the electricity works.

CHICHESTER.—The High School for Girls at Chichester, opened by the County Council for West Sussex, is lighted with electricity throughout, and a thoroughly up-to-date heating apparatus on the new cable system is installed.

DUDLEY.—The Electric Lighting Committee are improving the street lighting of the town.

EPSOM.—To the Urban Council the Clerk reported that the Epsom Union Assessment Committee had revised and fixed the rateable value of the Council's electricity undertaking at £740 this being an increase of £360 on the previous assessment. Mr Ede remarked that if the assessment stood at £740 it would mean that out of every pound they saved 6s. 2d. would have to go towards the rates.

GRAVESEND.—The Electrical Engineer (Mr. C. Fred McInnes, A.M.I.E.E.) states, in his annual report to the Corporation, that for the year ended March 31 last the gross profit (£4,689) on the electricity undertaking was greater than in any former year, and that it was steadily increasing. The surplus to be applied to the relief of the rates amounts to £418. This was the first year in which the outstanding capital appears less at the end of the year than the commencement. Actually £2,110 has been paid off loans, while additional loan expenditure during the year amounted to £939, thus reducing the outstanding capital indebtedness by £1,171. Dealing with the question of depreciation, Mr. McInnes emphasizes the fact that since the commencement the sums spent upon repairs and maintenance have amounted to £3,460. Again, the loans have been reduced by £9,638, and the reserve fund totalled £1,116. Further, as of the capital expenditure (£67,946) only a portion was represented by the more rapidly depreciating assets, it would appear there was no ground for apprehension in this respect. The revenue from tramway supply came to £3,191, public lighting £1,625, and private consumers £4,732. The charges for private supply were further reduced during the year. With regard to the Northfleet accounts, the loss of £496, as shown, was not by any means wholly trading loss. This sum included £120 capital expenditure for which a loan could not be obtained, the actual trading loss being £286, and this, with 8½ months' loan charges, by far the principal item of expenditure, and only a small portion of a year's revenue, and a first year's revenue at that. Mr. McInnes has suggested to the Corporation that more should be done than in the past to demonstrate to the ratepayer the many advantages which electricity has over any other illuminant or source of power. This was, in his opinion, the more necessary now that the metallic filament lamps have proved the superiority of electric light in every respect.

HAMPSTEAD (London).—To the Borough Council the Lighting Committee presented a return showing that the income from the sale of electricity during the year ended at Ladyday amounted to £63,197.

HANLEY.—The accounts of the Electricity Works show a profit of £415 on the past year's working.

IPSWICH.—The annual abstract of accounts issued by the Borough Accountant states that during the past year there have been losses in respect of two of the municipal undertakings, viz.: the tramways, £2,294 1s. 9d.; and electricity supply, £350 19s. 9d. As to the tramways, the traffic revenue appears at £400 less than in the previous year, and the working expenses have been £270 more. The car miles travelled have been 4,700 fewer, and the passengers carried 138,000 fewer, the actual figures being in 1907-8, 4,979,253, and in 1908-9, 4,841,411. The average fare paid per passenger was just under one penny. In the electric light department there has been a considerable increase in the number of consumers, who last year were 603, compared with 466, the units sold increasing as under: lighting, 317,417 to 369,213; power, 230,712 to 296,725. The amount received for the sale of energy has advanced in the last four years as follows: For lighting, 1906, £4,374; 1907, £4,519; 1908, £4,963; 1909, £5,791. For power, 1906, £1,036; 1907, £1,256; 1908, £1,584; 1909, £1,928.

KING'S LYNN.—For the year ended March 31 last the accounts of the Corporation Electricity Works (Mr. J. Pilling, Electrical Engineer) show gross receipts £7,231 5s. 4d., and expenditure £3,628 18s., leaving a surplus of £3,602 7s. 4d. The net profit for the year was £442 19s. 9d. Sale of current (including public lighting, £1,610 15s.) yielded £6,171 16s. 8d., and sale and repair of lamps, etc., £1,059 8s. 8d. Generation of electricity cost £1,798 9s. 3d. and distribution £757 16s. 1d. The supply for private lighting amounted to 573,495 units by meter and 4,539 units by contract, motors and heating 160,040 units, and public lighting 169,321. The number of private consumers appears at 660, against 620 in the previous year.

MALVERN.—During the summer vacation additions to the electrical mains at Malvern have been numerous, particularly at the Malvern College and College Masters' houses, where an installation comprising over 600 metallic filament lamps has just been installed upon the advice of Mr. W. J. Rendell Baker (Electrical Engineer to the Malvern Council), who prepared all specifications, etc. The work was carried out by the local firm of Mr. A. Sparkes, under the direct superintendence of Mr. J. Houlton, Engineer and Manager for Mr. Sparkes.

MEXBOROUGH.—The Local Government Board have sanctioned the borrowing by the Urban Council of £3,936 for electric lighting purposes.

NEWCASTLE EMLYN.—The town has been installed with electric light. The scheme was initiated by a number of townspeople, and a company was promoted called the Newcastle Emlyn Electric Light Co., Dr. Powell being chairman of the directors. The outlay has cost about £1,500. The electrical station is situated upon the old mill premises, and an abundant supply of water is obtained from a leet branched off from the Teify.

OGMORE VALE (Wales).—The new Workmen's Hall and Institute will be lighted by electricity generated from a plant placed in the basement.

SALFORD.—Mr. H. R. Hooper, M.Inst.C.E., Local Government Board Inspector, held an inquiry relative to an application by the Corporation for sanction to borrow £9,500 for the purpose of electricity undertakings in the borough, including a Prestwich scheme. Mr. Billington, Chairman of the Electricity Committee, said it would have been better for the undertaking if the profits had been utilised for the provision of better plant instead of being devoted to the relief of the rates. Mr. Hunt and Mr. P. Hampson protested against money being taken from the profits for the relief of the rates when the undertaking was not on a sound footing. The Town Clerk contended that the Council were acting on business lines, and that the undertaking was financially sound.

SOUTHAMPTON.—The Act of Parliament confirming the provisional order to enable the Corporation to supply the electric light in North Stoneham has received the Royal assent.

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STAINES.—The Egham & District Electric Light Co. notified the Urban Council that the company had proceeded with the promotion of their Order on the understanding that the supply should only be given from dusk to dawn, and that a large number of inhabitants had applied for the supply on the 10s. per point basis. The company pointed out that if they were compelled to supply during the day, the whole system of unlimited night supply at a fixed price must be dropped, and, therefore, the convenience of the great majority would be sacrificed for the sake of a few. The company expressed a wish to work harmoniously with the Council, and therefore they said that, if the Chamber of Commerce would prove their statement that there is a general demand for power in the daytime, and will guarantee customers for the very small amount of 20 h.p. for only six hours per day, they (the company) were prepared to reconsider the whole scheme.

STRATTON.—The Board of Guardians have resolved that the workhouse should be lighted with electricity.

TAUNTON.—The Town Council received from the Chamber of Commerce a letter, together with a report, questioning the financial soundness of the electricity undertaking as shown by the published annual accounts, and asking for certain information in order to dispel alleged feelings of uneasiness and lack of confidence. The Council did not recognise that any such feelings existed on behalf of the ratepayers generally, and decided to reply that the accounts were kept in accordance with the Board of Trade regulations and to the satisfaction of the Local Government Board. Councillor Macdonald said that if the Chamber of Commerce wanted a Local Government Board inquiry the Committee would be glad to assist them in getting it.

WEYBRIDGE.—An offer by the Urban Electric Supply Co. to fit up, light and extinguish the whole of the street lamps in the urban district for £2 17s. per lamp on a five years' contract was declined by the Council.

LIGHTING AND GENERAL—Overseas.

CANADA.—The work of erecting the Toronto transformer station in connection with the hydro-electric power transmission line has begun. All stations along the line are now under way, and the Commission is hastening the work as much as possible with a view to completion before the end of the year.—The power-house for the electric light plant at Fernie is rapidly nearing completion.

CHINA.—German electrical firms have opened branch offices and depots in many towns. Electric central stations are being planned or started at Kiren, Sutchon, Mukden, and other places.

EAGLEHAWK (Victoria).—The Eaglehawk Borough Council have decided on the erection of electric lighting plant at a cost of £7,000. The proposal is to use suction gas as the motive power, and charcoal as the fuel from which the gas is produced. The power-house is to be constructed of galvanised iron.

HAYTI.—The former contract for the electric lighting of Port-au-Prince and of Cape Hayti having lapsed owing to non-execution, the formation has been authorised of a Haytian company, under the name of the Compagnie d'éclairage électrique des villes de Port-au-Prince et du Cap-Haitien, to undertake the electric lighting of the towns.

INDIA.—The electric power installation on the Swat River for the Malakand tunnel will, it is expected, be ready this month.

LOURENCO MARQUES.—The Board of the Chamber of Commerce have passed resolutions that the present tax on wire of ten reis be increased to 40 reis; that an inspector be appointed to inspect plans for the electrical installation of lighting; and that the attention of the Government be called to the high price of electric lighting (2s. 4d.), seeing the company supply the same to the municipality for 3d.

MELBOURNE.—The annual report of the City Council Electric Lighting Committee for the year ended February 28, 1908, states that the profit for the period was £10,907. The total revenue for the year was £102,635, as against £92,364 for the previous year, showing an increase of £10,275. The revenue from the sale of current for private lighting purposes increased from £51,438 to £58,184, and the revenue from power and heating from £13,251 to £15,241. The expenditure on coal for the year was £15,705, as against £14,021 for the preceding term. Working expenses amounted to £50,177, leaving a gross profit of £52,458. The expenditure on capital account during the year amounted to £45,405, being principally in respect of additions to the supply station and on extensions of plant and mains. From the net revenue the Committee has appropriated £5,000 to the town fund, while the sinking fund has been increased by £4,648, the 1% contribution making the amount to the credit of the fund £63,981.

MEXICO.—A contract has been made between the Ministry of Fomento and Mr. William A. McLaren, whereby the latter is empowered to utilise water from the river Realito de Tubares, which runs through the States of Chihuahua and Sinaloa, to an extent not exceeding 5,000 litres per second, for hydro-electrical purposes. The concessionaire undertakes to commence surveying operations within six months, and to present plans within 12 months thereafter. The construction of the work must be begun within two years from the date of the ratification of the contract, and completed within seven years. The concessionaire is granted the right to import, free of duty, once only, all the machinery and apparatus necessary for carrying out the work, and is also authorised to construct any bridges, telegraph and telephone lines.—The gross earnings of the Mexican Light and Power Co., for the month of August, show an increase of (Mexican) $9,700, while operating expenses advanced by no less than (Mexican) $142,600, making a decline in operating profits for the month of (Mexican) $132,900, and an aggregate decline from January 1 last of (Mexican) $223,400.

NEW SOUTH WALES.—Tenders were opened at a special meeting of the Sydney City Council for the erection of the No. 2 electric lighting station at Pyrmont. The Council's estimate of the cost of construction was £43,011. Seven tenders were opened, which ranged from the lowest, that of J. Harrison & Son (£43,900), up to £44,950. The tenders were submitted to the city building surveyor for a report.—The Inverell Municipal Council unanimously adopted a recommendation in favour of installing electricity throughout the town. Mr. J. E. Donoghue, chief electrician of the Balmain Electric Supply Co., reported that an electric service would cost £10,840, providing 12 miles of mains, and a candle-power of 25,700 for street lighting, including 17 enclosed arcs, of 1,200 c.p. each; 1,070 customers could be supplied by the proposed installation. The price would be 6d. per unit for lighting, and 3d. for power. The annual profit would be about £1,480.

NEW ZEALAND.—Application has been made for 300 heads of water from the Toaroha River for a hydro-electric mining scheme at Rimu and Seddon Terrace.—The accounts in connection with the Waipori hydro-electric works for the quarter ended June last show:—Expenditure: Generation, £606 8s. 2d.; distribution, £1,055 12s. 2d.; public lamps, £56 4s. 4d.; general, £792 4s. 4d.; sinking fund, £162 10s.; bank charges, £10 16s.; interest on loan and overdrafts, £3,441 2s. 2d.; total, £6,124 17s. 2d. Revenue: Sale of current for lighting, £2,511 13s. 9d.; sale of current for power, £4,074 13s. 4d.; meter rents, £98 14s. 10d.; public lighting, £266 6s. 3d.; penalties, £5 17s. 10d.; rents, £14; total, £6,791 6s. The credit balance appears at £846 8s. 10d.

ONTARIO.—The Attorney-General has declined to grant a fiat authorising an application to the Law Courts for an injunction to restrain the Hydro-Electric Commission from carrying out their contract with the Ontario Power Co.

POTCHEFSTROOM.—A scheme of electric lighting by the municipality is being discussed.

ROME.—A referendum of the citizens has ended in a majority of 25,000 voting in favour of the scheme for the municipalisation of the electric light supply.

ROODEPOORT (South Africa).—The Roodepoort-Maraisburg municipality are making arrangements for the supply of electric current for lighting and power purposes at Maraisburg, Florida, and Roodepoort. The municipality will obtain the current from the Victoria Falls Power Co.

TASMANIA.—The Boulder Tin Mining Co. are laying down an hydro-electric transmission scheme.

WESTERN AUSTRALIA.—The Boulder City Council received an offer from the Kalgoorlie Council for improving the electric light supply in their district. The Kalgoorlie Council suggest that, as both are small communities, there would be mutual advantage if an agreement were made between the two municipalities to work conjointly. The plan proposed is that a 150 kw. dynamo should be installed at Boulder, but that instead of driving it with a steam engine it should be driven by an electric motor connected to the Kalgoorlie Council's mains. By this means an increased plant capacity would be secured at about one-eighth of the cost. In arranging for the transmission of power from Kalgoorlie the Kalgoorlie Council would incur all necessary expense up to the Boulder City boundary, from which point to the Boulder electric light station the Boulder Council would own the mains, motor, and generator, which it is estimated will cost about £1,200 complete. Alternatively the Kalgoorlie Council will supply the plant at both ends, with poles and cables, and allow a year for the repayment of the Boulder City's share; also to supply all current required from midnight until dusk the following day, and up to the capacity of the generator during the evening load when called upon, for a uniform price of threepence per unit net, the current used to be measured by meters placed in the Boulder station.

TRACTION—Home.

AYR.—The report of the Tramways General Manager (Mr. W. Grant) for the year ended May 15 last states that the total revenue for the year amounted to £15,081 7s. 7d., as against

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£15,322 3s. 5d. for the previous year, showing a decrease of £240 15s. 10d., which was entirely due to loss of traffic. The traffic receipts amounted to £14,444 11s. 9d., compared with £14,756 11s. 2d., a decrease of £312 19s. 5d. The receipts per car mile worked out at 8·87d., as compared with 9·13d. for last year. The working expenses show an increase of £219 0s. 10d. over last year. The chief items are—increased current consumption £125 11s., electrical equipment of line £108 7s. 9d., and car electrical equipment £58 9s. 4d., while the increases in wages, which have now almost reached the maximum, amounts to £55 2s., while other items show a decrease. The net balance carried to Depreciation, Renewal and Reserve Accounts appears at £1,613, and the amount transferred to the relief of the Burgh general assessment, £62. The total number of passengers carried during the year was 3,610,537, compared with 3,660,038 for the previous year. The mileage run totalled 390,105, as compared with 387,886. in the previous year. The electrical energy consumed during the year amounted to 427,436 units, or 1·09 per car mile, as against 402,035 units, or 1.03 per car mile. There has been a new anchorage device fixed on the overhead line at various points. This consists of a safety device, which prevents the wire from falling to the ground should it break.

WOOLWICH.—There is a possibility of Woolwich having three different systems of tramway traction within a radius of two miles. The London County Council has given the Borough Council notice of a proposal to proceed immediately with the extension of the double line of electric tramways, on the conduit system, from Rainton-road, Greenwich, to Woolwich Dockyard. The necessary street widenings will cost £10,950. There is a short stretch of horse tramways, connecting up an overhead system running from Abbey Wood and Bexley Heath to Beresford-square. It was proposed to extend the overhead system from the square to the ferry, but the Astronomer Royal, who has the power of veto within three miles of Greenwich Observatory, withholds his sanction to the system, owing to the fear of disturbance to the instruments at the Observatory. A system known as the "three mile system" is recommended for this section. Woolwich thus appears likely to have three different systems of tramway traction within a radius of a couple of miles.

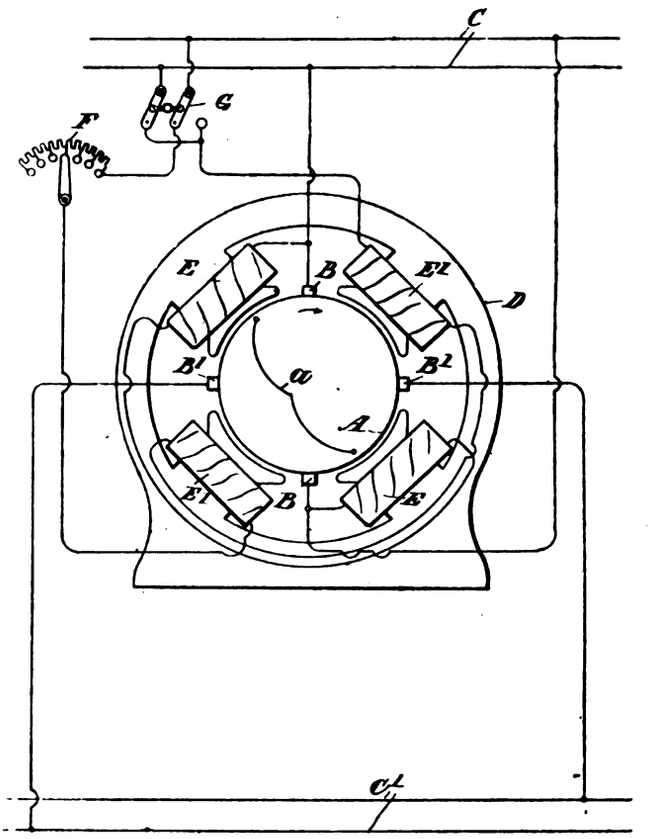
TRACTION—Overseas.

ITALY.—A Decree has been issued approving the agreement entered into between the Ministry of Public Works and the Società Ferrovia del Mottarone for the construction and working of an electric railway from Stresa to Mottarone. The concession is for a term of 70 years. There has also been issued a Decree approving the arrangement entered into between the provincial authorities of Venice and various other communal bodies in regard to the wayleaves requisite for the construction of an electric tramway from Mestre to Mirano.

PATENTS.

Dynamo Electric Machines.

18053.—1908. THE GENERAL ELECTRIC CO., Schenectady, U.S.A. In rotary converters for transforming direct current from one voltage to another, as, for instance, deriving a constant direct-current voltage from a supply circuit, the voltage of which varies, or for deriving a direct-current voltage, variable at will, from a constant potential direct-current circuit, it has been customary to employ a motor-generator set. In the improvement shown in the diagram, A represents the armature, which is provided with two sets of commutator brushes, one set BB connected to the supply circuit C, and the other set B^1B^1 connected to the load circuit C^1. The two sets of brushes are displaced from each other 90 electrical degrees, the armature in the machine shown in the drawing having a bi-polar winding, as indicated both by the diametrically opposite positions of the two brushes connected to the same circuit and also by the span of the armature coil *a*, which indicates diagrammatically the pitch of the armature winding. The field magnet D is provided with two sets of poles, one set carrying the coils EE and the other set the coils E^1E^1. These two sets of poles are displaced from each other by 90 electrical degrees, and the poles of each set, as, for instance, the two poles carrying the coils EE are of opposite polarity. The two left-hand poles form in effect a single pole, as far as the brushes BB are concerned, the right-hand poles forming the other pole for these brushes; while for the brushes B^1B^1 the two upper polar projections form a single pole, and the lower projections the other. The coils EE are connected in shunt to the brushes BB, and, consequently, are traversed by currents of constant strength and maintain the poles on which they are placed at substantially constant magnetic strength. The coils E^1E^1 are connected to the supply circuit C through a manually operated rheostat or automatic voltage regulator F and a reversing switch G. Suppose that the coils E^1 are traversed by a current of such strength and at such a direction that all four polar projections on the field magnet are of the same strength, and that the two right-hand projections are of one polarity and the other two projections of the other polarity. With respect to the brushes BB, the conditions are then the same as in an ordinary bi-polar motor. The line of effective field magnetisation is at right angles to the line brushes BB and parallel to the brushes B^1B^1. Consequently, the latter brushes are at points of zero induced voltage. Now assume the circuit of coils E^1E^1 to be open. The poles on which the coils E are placed are then alone energised, and the effect on the field magnetisation is as though it were shifted 45 electrical degrees. The same voltage is now induced between the brushes B^1B^1 that is induced between the brushes BB, so that the voltage supplied to the load circuit is equal to the voltage taken from the supply circuit. For any intermediate current strength in the coils E E^1 the voltage at the brushes B^1B^1 is between zero and the voltage of the supply circuit, while the effect on the field magnetisation is to shift its line of effective magnetisation as the current in coils E^1E^1 is hvaried. If after reducing the current in the coils E^1E^1 to zero these coils are reversed, and a gradually increasing current is introduced into them, the voltage at the brushes B^1B^1 becomes greater than the voltage at the brushes BB, so that the voltage on the load



circuit is greater than that of the supply circuit. The two upper polar projections are now of the same polarity, so that the line of effective field magnetisation makes an angle of more than 45° with the horizontal. It is not, of course, possible to carry this reverse current up to an amount equal to that in the coils EE, since, otherwise, the counter electromotive force between the brushes BB would be zero, and the machine would act as a short circuit on the supply circuit. Furthermore, before this point was reached, the speed of the machine would have increased far beyond safe limits, for unless the current in the coils EE is also varied when the relative strength of the currents in the coils EE and E^1E^1 is varied to control the voltage ratio of the machine, the speed does not remain constant, but increases with increase of voltage on the load circuit. In other words, the speed is proportionate to the component of the field magnetisation which is effective for inducing current between the brushes BB. If the rheostat F is an automatic regulator, the voltage on the circuit C^1 may be held constant, regardless of voltage fluctuations on the circuit C; or if the rheostat is manually controlled, any desired voltage may be obtained on the load circuit C^1. The direction of rotation of the armature should be as indicated by the arrow, in order to obtain best conditions for commutation. With the armature rotating in this direction, the brushes BB to which current is supplied, are near the trailing pole tips of the poles of constant strength carrying coils EE; so that by properly positioning the brushes the commutation conditions are the same as those in an ordinary motor, with the backward shift of the

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brushes, while the brushes B^1B^1 are near the leading tips of the poles of constant strength, so that the conditions are the same as those in a generator with a forward shift of the brushes. In a machine of the type illustrated, the regulation, except for the ohmicdrop in the armature is perfect, since the load current flowing between the brushes B^1B^1 in so far as it demagnetises the field, increases the speed of the machine by weakening the counter-electromotive force between the brushes BB, so that the voltage is maintained constant. Furthermore, the magnetic reactions of the motor and generator currents in the armature tend to neutralise each other, as in the ordinary rotary converter, and the ohmic loss of the armature is smaller than would be the case in either a motor or generator with the same amount of copper in the armature and carrying the same load.

Electro-Magnetic Systems.

4425.—1909.—Siemens Bros., Dynamo Works, Ltd., F.G. Broadhead & S. Hawkins, Stafford. The invention chiefly refers to improvements in electro-magnetic systems for controlling lights on railway trains in which, whilst each carriage has its own controlling arrangements, yet all the lights in the train can also be simultaneously controlled either from the guard's van or from any one of the carriages. According to the invention, the desired control on each carriage is effected by means of a sliding block, switch or contact carrier, which is actuated by the cores of a pair of solenoids. These cases form at their adjacent parts a centralising arrangement, and have a lost motion connection, so that each solenoid separately or both together can actuate the switch or other controlling device. A resistance is automatically put into the circuit of one of the solenoids, whereby the difference in the loads to be moved by the solenoids is compensated.

Railway Signalling Systems.

6985.—1909.—General Electric Co., Schenectady. This is an improvement in block signalling systems of the type in which both rails are electrically continuous for all currents, and in which sources of alternating currents connected across the rails are provided at intervals. Track relays control the signals, each having a winding connected in shunt to a short length of rail, so that the relays are normally de-energised and all signals stand at danger when no trains are running. When a train is at any point of the track, it short circuits the rail at that point and produces a flow of current towards it from adjacent sources. This flow of current from the sources ahead of the train energises a track relay at the head of the train to clear a signal.

Accumulator Plates.

6248.—1909.—Accumulatoren Fabrik, A. G., Berlin. These plates have an improved form of insulation fittings in connection with both the lugs and feet. The lugs are sheathed with thin cases of insulating material cut out and bent in such a manner that they can be pressed on to the lugs so as to fit tightly round. Each foot has a tenon and a mortise, and at each point of attachment the plate is also provided with a mortise and a tenon.

Process for Regenerating Blackened Carbon Filament Lamps.

8283.—1909.—E. A. Kruger, Altmark. After the bulb has been evacuated and the carbon deposit removed from its walls, a coating of carbon is deposited on the filament, while it is rendered incandescent by the passage of an electric current. Pure hydro-carbon in a determined quantity, without the addition of air, is admitted into the bulb, after which the lamp will be found to be as good as one with a new carbon filament.

Detachable Terminals for High and Low Tension Electric Wire on Motor Vehicles.

26420.—1908.—L. Kirby, Leatherhead. The invention consists in the general construction of a coupling device in which the electric wire is firmly clamped and the employment of a detachable spring actuated tongue-piece arranged for permanent connection to the sparking plug and detachable connection to the coupling device.

Apparatus for Signalling to the Driver of a Locomotive when in Motion.

21520.—1908.—E. P. Jelf-Reveley, Dolgelly. The track has a rising and falling rail mounted in guides so as to be capable of vertical movement, being normally held in an up position by means of a counter-weight acting through the medium of a forked lever pivotted in a bracket carried on the sleepers. The rail is adapted to engage a lever arm on the engine.

Process for Increasing the Ductility of Tungsten.

17611.—1908.—Siemens & Halske, Berlin. A small proportion of iron or cobalt and a small proportion of nickel are added to the tungsten and melted with it. The addition facilitates and hastens the production of a ductile alloy.

Electric Induction Furnaces.

18513.—1908.—Röchling'sche Eisen-und Stahlwerke, Volklingen on Saar. In electric induction furnaces, owing to the relatively great distance of the material to be melted from the iron core, great magnetic dispersion is produced. The chief object of this invention is to reduce the dispersion in a very simple and effective manner. Fig. 1 is a vertical

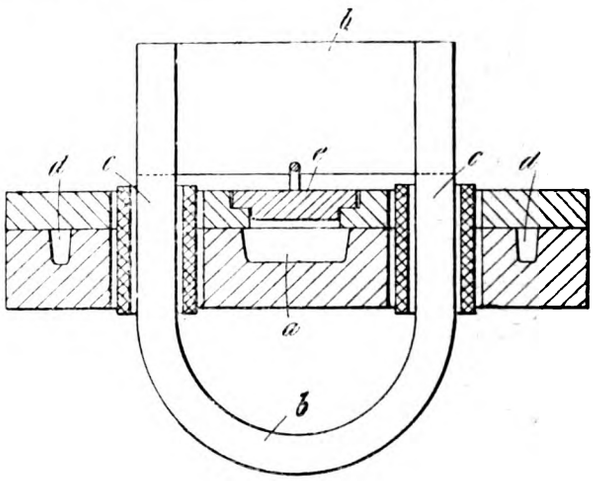

Fig. 1.

section, Fig. 2 a sectional plan, and Fig. 3 a vertical section at right angles to the position in which Fig. 1 is taken, illustrating a form of furnace constructed in accordance with this invention. The common melting chamber *a* is formed by the union of the melting channels *d* which surround the vertical limbs *c* of the closed iron core. The vertical limbs *c* are connected together by the yoke piece

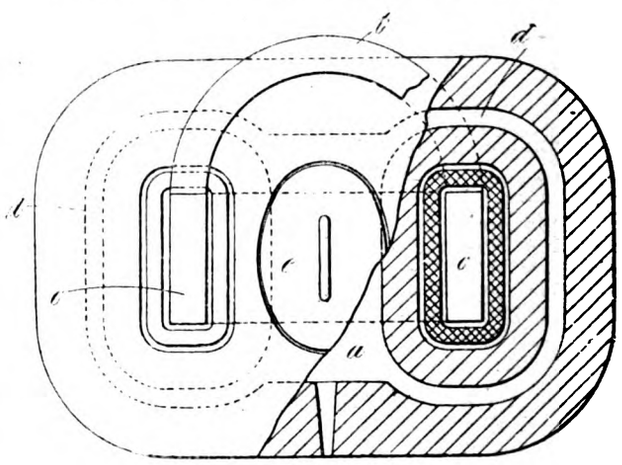

Fig. 2.

b. It will be seen that the furnace is about one-and-a-half times as long as it is wide, and that the width of the laminæ of which each of the limbs is composed is about three-and-one-half times as great as the thickness of the assemblage of laminæ. The upper of the two yoke pieces *b*, which are

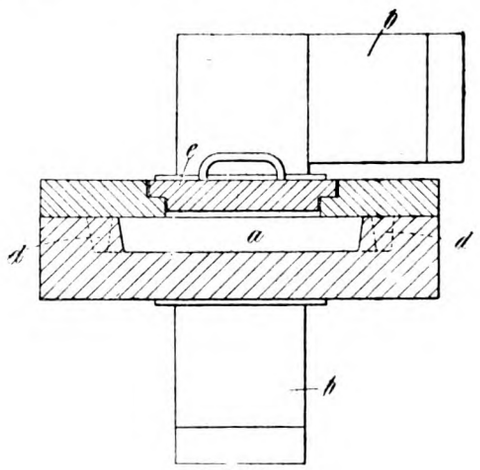

Fig 3.

bent semi-circularly and connect the ends of the limbs *c* as shown, is arranged in such a manner that it lies in a horizontal plane, with the result that free access can be

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had to the working door *e* arranged in the middle of the furnace cover and serving for the introduction of fluxes into the melting hearth *a*. The lower of the two yoke pieces is arranged in such a manner that it lies in a plane containing the longitudinal axes of the vertical limbs; by this arrangement the lower yoke piece *b* and the two limbs *cc* may consist of one piece, as shown.

Controller Mechanism of Electric Cranes.

17536.—1908.—ALLEGMEINE ELEKTRICITATS, Gesellschaft, Berline. An electro-magnetic device is employed for closing the motor circuit when the controller is in zero position. The brake magnet for operating the mechanical brake can only be inserted at the brake positions of the controller.

Electric Cranes.

21311.—1908.—J. MARSHAL, J. FLEMING and R. ANDERSON, Motherwell. This is an improvement in such cranes as are provided with a winding barrel clutchable to and declutchable from an electric motor. Between the motor and the barrel there is a friction clutch, and between the brake drum and the barrel is a clutch of the ratchet type. The ratchet clutch allows the barrel freedom of movement for hoisting while the brake is on, and holds the brake against lowering, the brake only being released to lower the load.

Electro-Galvanising Apparatus.

24467.—1908.—G. A. BECKETT, Seacombe. The electrolytic bath is fitted with a series of sprocket wheels successively placed and adapted to propel the rods to be galvanised along the bath in proximity to the anodes. An endless chain, carrying arms which engage the rods, is employed for lifting the rods from the bath and conveying them to a washing tank.

Incandescent Electric Lamps.

18054.—1908.—W. C. ARSEM, Schenectady, U.S.A. The stem inside the bulb is coated with a liquid consisting of silver oxide dissolved in ammonia. The stem is then heated to dry the coating and to convert it into a thin layer of metallic silver. The silver absorbs all the mercury that may be present in the lamp, and prevents the lamp from blackening.

Electric Signalling System.

17858.—1908.—H. C. WILSON & C. R. B. CLAFLIN, New York City, U.S.A. This is an improvement in those systems in which the signals are transmitted from a central station to receiving stations. When the instrument at the central station is actuated, it is automatically maintained active until the signal is manifested by the manifesting means at the receiving station, when the transmitting instrument is put out of action by the manifestation of the signal. Moreover, when it is desired to send two classes of signals, means are provided for rendering it impossible to send signals of one class while signals of the other class are being sent.

Electrical Switches.

7993.—1909.—A. P. LUNDBERG, G. C. LUNDBERG and P. A LUNDBERG, Islington. This is an improvement in three-way and three-position switches known as tumbler switches. By providing additional modified switches and modifying one of the three switches, control may be obtained from as many additional points as there are additional switches provided.

8429.—1909.—A. P. LUNDBERG, G. C. LUNDBERG and P. A LUNDBERG, Islington. The contact carrying member of the tumbler switch comprises two members which are stamped from sheet metal into such shapes that when the two members are placed the one on the other and secured

23423.—1908.—LODGE BROS., Birmingham. This is an improvement in switches for use with induction coils and other like apparatus in which a vibratory make and break or trembler device is employed, the object being to provide improved means for ensuring regular periodic reversal of the current through the apparatus in order to maintain the trembler contact in good condition. Fig. 1 is a sectional side elevation, and Fig. 2 a sectional front elevation of the switch. Fig. 3 is a diagram illustrating the connections for and operation of the switch when applied to the ignition apparatus of an internal combustion engine. In the application of the invention, as illustrated, to a switch for the ignition apparatus of road vehicle motors, a series of four contact pieces, b^1, b^2, b^3, b^4, are mounted equidistantly from each other around a common centre on a base *a*. Each contact is insulated, and is either gapped along one edge or formed from metal sheet with a piar of upturned projections *c*. Concentrically with the fixed contacts, an arm *d* carries the movable contacts, comprising a pair of insulated metal rollers *e*, each of which is attached to the extremity of a curved spring strip *f* secured to one end of the arm *d*. In use, the opposite fixed contacts are connected to the same circuit; thus, while the pair of opposite contact b^2b^4 are connected to the circuit of the batteries *h*, the other pair b^1b^3 are connected to the trembler circuit of the induction coil *i*. With the movable rollers pressed by their springs against or between the projections of an opposite pair of fixed contacts as b^1b^3, both circuits are open, and by the action of the springs and rollers on the said projections the arm is held against accidental displacement. On rotating the arm sufficiently to carry the rollers into

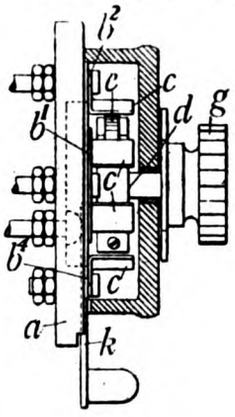

Fig.1

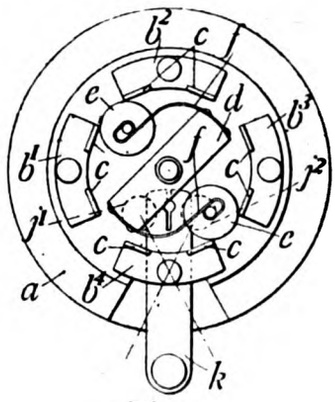

Fig.2

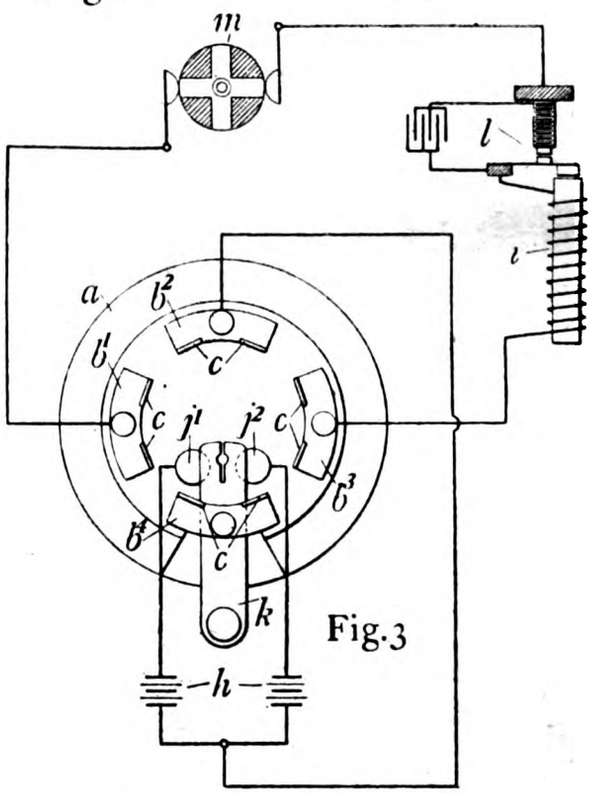

Fig.3

contact with projections of adjacent pairs of fixed contacts, the circuits are closed, the arm being again held against accidental movement by the action of the springs and rollers on the contact projections. Further rotation of the arm in the same direction carries the rollers into engagement with the rollers of an opposite pair of contacts, and the circuits are again opened. With the continued rotation of the arm, connection is again made with an adjacent pair of contacts, but this time with a different pair, and in consequence, the direction of the current in the primary of the coil is opposite to the former direction. The next movement of the arm breaks the circuit, whilst the following movement re-establishes the current with reversal of direction in the primary circuit. Thus, on progressively rotating the arm, the current through the trembler of the primary circuit is alternately interrupted and reversed. A suitable pointer attached to the knob indicates whether the switch is on or off. By providing for periodic reversal of the current through the trembler device the wearing away of contacts is avoided and the contacts are maintained in good working condition. In ordinary hand actuated reversing switches it is necessary for the user to remember the last position of the movable contact if he desires to reverse the current when the circuit is again closed. With switches constructed in accordance with this invention, this periodic reversal is performed regularly at each closing operation of the switch without any conscious effort on the part of the user, provided the

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movable contacts are rotated always in the same direction, and, in consequence, the maximum advantage of the reversing procedure is obtained. In Fig. 3 the trembler device of the induction coil is indicated by *l*, and the rotary contact maker by *m*.

Induction Coils for Ignition Purposes.

318.—1909.—CHICAGO COIL CO., Chicago, U.S.A. The primary and secondary spark coils are arranged with a suitable core and combined with a condenser. All these parts are enclosed within a casing, but made removable therefrom, so that the parts can be taken out singly or together from the case.

Holders for Electric Incandescent Lamps.

1673.—1909.—T. BIRCHALL, Withington. A spring-pressed sliding block is enclosed within a casing, and is provided with means for engaging the contacts of the lamp. The holder has means for limiting the outward movement of the block, and, by the insertion of a cross pin, the removal or insertion of a lamp from the holder is prevented.

Electrodes for Use in Electrolysis.

23930.—1908.—C. C. CONNOR, J. W. STUBBS & THE ELECTROLYTIC ALKALI CO., LTD., Manchester. The conductor bars are of metal, and are connected at intervals to cross-bars of carbon. Lead is cast round the cross-bars, so that they are mechanically and electrically firmly attached to the conductor bars.

Attachment for Telephone Instrument Transmitters.

26315.—1908.—P. B. CLARKE, Liverpool. The attachment comprises a hollow device fitted to the mouthpiece and provided with a covering of flexible insulating material which will prevent speech uttered into the telephone from being heard by others outside the device. The attachment fits over the mouthpiece and over the mouth of the person using the instrument.

Magnetic Electric Ignition Device.

28343.—1908.—L. H. WATTLES, Providence, U.S.A. The device is intended for use with internal combustion engines, and consists in means for operating the magneto with the charge compressed in the engine cylinder, and of the driving mechanism used to operate the same; and of means for insuring a circulation around the electrodes in the explosion chamber and within the area of the dead fuel stratum; and of means positive and independent of the magneto driving means for starting the magneto armature.

Electro-Plating Articles of Electrically Non-Conducting Material.

24139.—1908.—A. GERBURG, Bodenbach-an-der-Elbe. A preliminary coating is applied to the article to be coated consisting of a mixture of a conductive material, such as graphite, and dissolved alkaline silicates. For absorbent materials, about 16% conductive material and 84% silicate is a suitable proportion, while for china, glass and other non-absorbent materials, about 50% of each substance forms a workable mixture. A very thin coating of the mixture is sufficient, and when dry the coated articles are treated in the electro-plating bath.

Ship's Telegraphs.

25081.—1908.—P. R. KEPPIE, Bootle. The improvement consists in using the transmitting shaft directly to operate the bell-ringing device, and fitting a differentiating mechanism operated by the index spindle or by a shaft positively geared thereto, which controls the bell-ringing device, so that the head or astern alarm, as the case may be, is sounded in accordance with the nature of the order transmitted.

Automatic Switching Apparatus for the Distribution of Electricity.

25134.—1908.—E. G. BRYANT & R. H. PEARSON, Bournemouth. The invention consists of an insulated base upon which are mounted two main solenoides controlling a disc switch and one auxiliary solenoid controlling a throw-over device. The main solenoids are actuated by the main supply current, and the auxiliary by a battery which is controlled simultaneously with the operation of an ordinary switch; the throw-over device is controlled by the operation of the solenoid lever from the main solenoids.

Electric Batteries.

26285.—1908.—H. DE MARTES, London, W.C. The electrodes in electric accumulators are separated by means of an inert material, such as cellulose. The object is to provide a separator which is substantially pure cellulose, but is of a porous nature, or arrange so as to permit the free passage through if of the electrolyte, and, further, to enable this separator to be produced easily and economically. A woven vegetable fabric is freed from all its impurities so as only to leave the fibrous part, and then inserted between the electrodes, the separator being simply laid against the paste on the electrodes in such a way that it is not impregnated with or rendered impervious to the paste.

Winding and Disposing of Secondary Circuits of Induction Coils Used with Telephone Apparatus.

23739.—1908.—R. R. HARPER, South Tottenham. The invention is to provide means of communicating by telephone without switches to, through, or between places such as block signalling stations upon a line wire used for other purposes, and to lessen the inductive defects produced by neighbouring wires by improvements in the winding, and electrically connecting the induction coils to transmit telephone currents in sending and receiving when used with telephone apparatus. The induction coil is wound with four separate and distinct coiled insulated secondary windings, all wound side by side, in addition to the ordinary primary windings. The four secondary windings upon the coil are for use at intermediate places where the line wires are terminated, for the instruments to work in either direction, one for the telephone receiver, one for the buzzer induction coil, and one each for the up and down line wires to transmit telephone currents from one secondary loop winding to the other inductively when telephoning through the line, the primary circuits being in each case as in an ordinary telephone system of working.

Bearings of Electricity Meters.

16538.—1908.—SOEMENS-SCHUCKERTWERKE, G.m.b.h., Berlin. The object is to arrange the top bearings of electricity meters so that the noise due to the vibration of the axle of the meter is prevented. For this purpose any sideways movement of the meter axle in its top bearing is resisted by a resilient pin which is fixed at one of its ends to the bearing supports, and at its other end projects through a bearing hole into an oil well fitted to the meter axle. The end of the pin beyond the hole projects into the oil in the well, and the surfaces of contact between the bearing hole and the meter axle are lubricated by the oil which creeps up the pin. The oil well projects upward into a slightly conical hole in the bearing support, the clearance being such that the oil well can only slightly move from side to side, so that the pin cannot spring beyond a certain permissible limit and cannot wedge itself in the bearing hole.

Electrically Driven Drilling Machines.

26685.—1908.—SIEMENS BROS., Dynamo Works, Ltd., Westminster. The electric motor is situated alongside the drill driving spindle. The framework of the machine is divided into two parts in a plane which cuts the axle lines of the shaft of the motor, drill driving spindle and countershaft. These shafts are arranged in the framework in such positions as to make the division possible. By these means all the moving parts are readily accessible for the purposes of repair, and when the two parts of the framework are bolted together all the shafts are held firmly in position in their bearings.

Apparatus for Compounding Alternating Current Generators.

11558.—1908.—DR. M. BRESLAUER, Berlin. According to the invention, the asynchronous part of a cascade converter is employed for the purpose of mixing. The exciter consists of a part built and wound up after the manner of an asynchronous motor, and of a continuous current machine. These are coupled together in any suitable manner, the current machine being connected to the rotor of the exciter at suitably situated points. The asynchronous part is built in two parcels of laminations, the one being excited by the current and the other by the voltage of the main generator. A voltage will be produced in the rotor of the asynchronous part proportional to the geometrical sum of the two fields produced by the current and the voltage. The field produced by the current and that produced by the voltage may be arranged to predominate as desired. The whole arrangement can be used in such a way that the exciting current of the generator is not influenced directly, but only through the medium of the field of the exciter. In this case a very small and cheap set of three machines would suffice to produce the very small excitation current in the exciter machine.

Apparatus for Wireless Telegraphy.

17505.—1908. G. MARCONI'S WIRELESS TELEGRAPH CO., LTD., London. The moving surfaces of the transmitting apparatus consist of pegs on the adjacent faces of two parallel discs fitted to two shafts in a line with each other, and rapidly revolved in opposite directions. By this means it is possible to discharge the condenser twice as rapidly as with a single revolving disc. Owing to all the pegs on one side being exactly opposite the pegs on the other side, the discharge may take place at any of the pegs.

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COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last prices. £
British Insulated and Helsby Cables, Ord. 1-100,000	5	7¼-7⅜
—— 6 p.c. Cum. Pref., 1-100,000	5	6⅜-6½
—— 4½ p.c. Mortgage Debentures	100	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100	89-94
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 1-200,000 and 275,001-475,000	3	3/16-7/16
—— p.c. Mortgage Debenture Stock	100	38-42
Callender's Cable, Debentures	100	105-107
—— Ordinary	5	10¾-11¼
—— 5 p.c. Pref.	5	5⅛-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1	⅛-¼
Dick, Kerr, and Co., Ordinary, 1,260,000	1	1-1¼
—— 6 p.c. Cum. Pref., 1-305,000	1	1⅛-1¼
—— 4½ p.c. Debenture Stock	100	100-103
Edison and Swan United, "A" Shares, 1-99,261	3	3/16-5/16
—— "A" Shares, 01-017,139	5	1-1⅛
—— 4 p.c. Deb. Stock, Red	100	68-73
—— 5 p.c. 2nd Debentures	100	84-87
Electric Construction, Nos. 1 to 112,100	2	7/16-11/16
—— 7 p.c. Cumulative Pref.	2	1 3/16-1 7/16
—— 4 p.c. Perp. 1st Mort. Deb.	100	65-69
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100	71-77
General Electric Company (1900) 5 p.c. Cum. Pref.	10	7⅜-8⅛
—— 4 p.c. 1st Mort. Deb. Stock	100	85-88
W. T. Henley's Telegraph Works, Ordinary	5	12⅛-13⅛
—— 4½ p.c. Preference	5	5⅛-5⅜
—— 4½ p.c. Debentures	100	106-108
National Electric Construction Co., 1-170,000	1	⅛-¼
Telegraph Construction and Maintenance	12	34½-36
—— 4 p.c. Bonds	100	101-103

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Bournemouth and Poole, Ordinary	10	9½-10
Brompton and Kensington, Ordinary	5	7¼-7⅜
—— 7 p.c. Preference	5	7½-8
Canadian General Electric Co., Common Shares	$100	122-127
—— 7 p.c. Cum. Pref. Stock	$100	120-122
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5	4-4⅛
—— 4½ p.c. Cum.. Pref., 1-80,000	5	4½-5
—— 4 p.c. Debenture Stock, Red.	100	96-99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5	3⅞-4⅛
City of London, Ordinary	10	10½-11
—— 6 p.c. Cumulative Pref.	10	11⅞-12⅛
—— 5 p.c. Debenture Stock	100	121-124
—— 4½ p.c. 2nd Deb. Stk. Red.	100	100-103
County of Durham Electrical Power Distribution Co., Ordinary, 1-50,000	5	1⅛-2
—— 5 p.c. Preference, 1-50,000	5	3-3⅛
County of London Elec. Supply, Ordinary	10	7⅞-8⅛
—— 6 p.c. Cum. Pref.	10	10⅞-11⅛
—— 4½ p.c. Debentures Prov. Certs. Al pd., Rd.	100	104-107
—— 4½ p.c. 2nd Debentures, Red	100	100-103
Edmundson's Electricity Corporation, Ord., 1-80,000	5	⅛-5/16
—— 6 p.c. Cum. Pref.	5	⅞-⅞
—— 4½ p.c. First Mort. Deb.	100	58-61
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100	91-94
Kalgoorlie Electric Power and Lighting, 6 p.c. Non. Cum. Pref., 1-150,000	1	⅞-27/32
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000.	5	7-7½
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100	98-101
London Electric Ordinary	3	1⅞-2⅛
—— 6 p.c. Pref.	5	5 5⅛
—— 4 p.c. 1st Mortgage Debenture Stock, Red.	100	93-97
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	76-80
Metropolitan Ordinary, 100,001-300,000	5	4-4⅛
—— 4½ p.c. First Mortgage Debenture Stock	100	105-108
—— 4½ p.c. Cum. Pref.	5	4⅝-5
—— 3½ p.c. Mortgage Debenture, Red.	100	83½-86½
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,050 ($500) M 1-4,400 ($1,000)	—	80-82%
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb. Red	—	96-99
Newcastle-upon-Tyne Electric Supply, Ord., 1-50,000 and 57,010 to 137,500	5	4⅛-4⅜
—— do. 50,001 to 57,009	5	4⅛-4⅜
—— do., 5 p.c. Pref., 1-137,500 Non. Cum.	5	4⅜-5⅛
Notting Hill Electric Lighting	10	12½-13⅛
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	6-6⅛
—— 4 p.c. Debenture Stock	100	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1	1 5/16-1 7/16
—— 6 p.c. Non-Cum. Pref., 1-100,000	1	1-1⅛
—— 5 p.c. Debenture Stock, Red.	100	103-106
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5	5 7/16-5 11/16
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5	5⅛-6
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	—	105½-107%
Smithfield Markets Electric Supply, Ord., 1-12,000	5	⅛-¼
South London, Ordinary	4	2⅛-3
South Metropolitan Electric Light and Power Ord.	1	5/16-9/16
—— 7 p.c. Cum. Pref.	1	1 1/16-1 3/16
—— 4½ p.c. 1st Mort. Deb.	100	102-105
St. James's and Pall Mall, Ordinary, 101-20,080 and 40,081 to 60,100	5	8⅛-9⅛
—— 7 p.c. Pref. Non. Cum.	5	7-7⅛
—— 3½ p.c. Deb.	100	84-88
Urban Electric Supply Co., Ordinary	5	⅛-1
—— 5 p.c. Cumulative Preference, 50,001-100,000	5	1⅛-1⅛
—— 4½ p.c. First Mort. Debenture Stock, Red.	100	77-81
Westminster, Ordinary	5	8-9
—— 4½ p.c. Cum. Pref., 110,101-191,379	5	5-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 5 p.c. Cum. 1st Pref., 1-640,000	5	4⅛-4⅞
—— Debenture Stock, Red	100	92⅛-93⅛
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1	⅛-¼
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1	9/16-11/16
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	87-90
British Columbia Electric Railway Co., Ord. Def.	100	144-149
—— Ord. Pref.	100	118-123
—— 5 p.c. Cum. Perpetual Pref. Stock	100	106-110
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	102-104
—— 4½ p.c. Vancouver Power Deb.	100	102-105
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10	⅛-⅜
—— 6 p.c. Cm. Pf., 30,001-60,000	10	1⅞-2⅛
—— 5 p.c. Perpetual Debenture Stock	100	84-87
—— 4½ p.c. 2nd Deb. Stock	100	62-66
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100	96½-98½
Calcutta Tramways, Ord., No. 1 137,610	5	4⅛-5⅛
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5	4⅛-5
—— 4½ p.c. 1st Deb. Stock, Red.	100	98-101
Cape Electric Tramways, Nos. 1-491,222	1	3/16-7/16
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5	4⅛-5⅛
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100	97-101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5⅛-6
—— 4 p.c. Deb. Stock, Red. (1985)	100	98-101
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12⅞-13⅛
London United Trys (1901) 5 p.c. Cum. Pref.	10	2⅛-2⅜
—— 4 p.c. 1st Mt. Db. Stock, Red.	100	67-70
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	1/32-5/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1	11/16-13/16
—— 4½ p.c. Deb. Stock, Red.	100	94½-96½
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100	100½-103½
Provincial Tramways Co., Ordinary, 1-24,912	10	4-4⅛
—— 6 p.c. Cum. Pref., 1-10,000	10	9½-10⅛
San Paulo Tramway, Light, and Power Co.	$100	150-153
—— 5 p.c. 1st Mort Deb, Red. (1929) 1-12,000	$500	101-103%
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅛-¼
—— 4 p.c. Deb. Stock, Red. (1940)	100	69-73
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5	⅛-⅜
—— 6 p.c. Cum. Pref., 1-46,261	5	1⅞-2⅛
—— 4½ p.c. 1st Deb. Stock, Red.	100	81-85

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100	61-63
—— 4 p.c. Pref.	100	85-87
—— " " deferred	100	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	101-103
City and South London, Consolidated Ordinary	100	31-32
—— 4 p.c. Debenture Stock	100	100-102
—— 5 p.c. Pref. Stock '91	100	108-110
—— " " " '96	100	104-107
—— " " " '01	100	100-103
—— " " " '03	100	96-100
Liverpool Overhead, 5 p.c. Pref.	10	4⅛-5
—— Ordinary, 1-50,000	10	⅞-⅞
—— 4 p.c. Mortgage Debentures, Red., 1-1,700	—	94-96
Underground Electric Railways of London, 5 p.c. Prior Ln. Bds.	—	102⅛-103⅛

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price £
Amazon Telegraph Co., 1-25,000	10	2⅞-3⅛
—— 5 p.c. Debs., Red., within 1-1,609 Red	100	93-96
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000	97-99
Anglo-American Telegraph Co., Ordinary	100	61⅛-63⅛
—— 6 p.c. Preferred Ordinary	100	104-105
—— Deferred Ordinary	100	21⅞-22⅛
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100	90-92
Direct Spanish Telegraph Co., Ordinary	5	3-3⅛
—— 10 p.c. Cum. Preference	5	8⅛-8⅜
—— 4½ p.c. Debs., 1-600	50	100½-102½
Direct United States Cable Co.	20	13⅛-13⅜
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 p.c. Mort. Debs., within 1-8,000 (1913,	25	100-102
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	25	100-102
Eastern Extension, Australasia and China, 1-300,000	10	11⅞-12⅛
—— 4 p.c. Mort. Deb. Stock, Perp.	100	102-104
Eastern Telegraph Co., Ordinary Stock	100	129 132
—— 3½ p.c. Preference Stock	100	85-87
—— 4 p.c. Mortgage Debenture Stock	100	104½-106
Great Northern Telegraph Co. (of Copenhagen)	10	26-27
Marconi's Wireless Telegraph Co., Nos. 1-394,190	1	⅜-⅞
National Telephone, Preferred	100	106-107½
—— Deferred Stock	100	121-123
—— 6 p.c. Cum. First Pref.	10	10½-10⅝
—— 6 p.c. Cum. Second Pref.	10	10¼-10⅜
—— 5 p.c. Non. Cum. Third Pref.	5	5 7/16-5 11/16
—— 3½ p.c. Deb. Stock, Red.	100	98-100
—— 4 p.c. Deb. Stock, Red.	100	100-102
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100	100-102
West Coast of America, 1-30,000 and 53,001-53,008	2½	1⅛-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	100-102
West India and Panama Telegraph Co., Ordinary	10	11/16-13/16
—— 6 p.c. Cum. 1st Preference	10	8⅞-9⅛
—— 6 p.c. Cum. 2nd Preference	10	8⅝-9⅛
—— 5 p.c. Debs., Red., 1-800	100	101½-103½
Western Telegraph Co., 1-207,930	10	13⅛-13⅜
—— 4 p.c. Debenture Stock, Red.	100	103-105

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1909.	1908.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Sept. 22	1,347	1,373	— 26	— 583	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940,	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Aug. 7	2,770	2,650	+ 120	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Sept. 26	1,063	1,099	— 36	— 441	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Sept. 18	6,502	6,429	+ 73	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Sept. 22	1,179	1,080	+ 99	— 783	24·5	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,329	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Sept. 26	2,422	2,274	+ 148	— 168	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Sept. 18	4,889	4,554	+ 335	+ 3,085	98	98	„ 31	236,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	„ 19	1,113	1,050	+ 63	+ 1,299	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Sept. 24	5,861	5,084	+ 777	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Sept. 25	1,288	1,050	+ 238	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Sept. 26	259	268	— 9	—	10	10	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Sept. 25	5,255	8,565	— 3,310	— 28,444	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	„ 7	3,695	3,515	+ 180	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Sept. 26	3,213	3,265	— 52	+ 1,168	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Sept. 23	550	527	+ 23	—	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Sept. 17	1,716	1,397	+ 319	+ 2,183	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Sept. 18	284	276	+ 8	— 206	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Sept. 24	163	144	+ 19	—	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Sept. 24	5,563	5,199	+ 364	+ 1,328	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Sept. 22	1,211	1,193	+ 18	— 509	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Sept. 18	1,002	883	+ 119	+ 3,438	14	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Sept. 25	17,290	17,341	— 51	— 2,210	185½	179	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Sept. 22	295	276	+ 19	+ 664	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Aug. 7	4,430	4,480	— 50	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Sept. 18	1,622	1,563	+ 59	+ 1,214	28½	28½	„ 31	84,704	16,200,020	1,960,320	1·29	10·37	2,421	5·10
Hull Corporation	Sept 25	2,572	2,528	+ 44	+ 2,037	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Sept. 18	487	464	+ 23	+ 871	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Sept. 22	142	139	+ 3	— 211	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Sept. 22	1,419	1,342	+ 77	— 399	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Sept. 11	11,070	10,784	+ 286	— 2,149	104	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Sept 26	1,389	1,395	— 6	+ 166	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Sept. 11	37,276	36,503	+ 773	+ 32,621	124	122½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	„ 17	216	258	— 42	— 743	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Sept. 11	217	220	— 3	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Sept. 25	9,739	9,885	— 146	—	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Sept. 26	15,883	17,408	— 1,525	— 2,529	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Sept. 25	158	112	+ 46	— 24	2½	2½	Mar. 31	7,362	2,060,712	204,7 0	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Sept. 25	3,898	4,006	— 108	— 1,198	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Sept. 25	667	642	— 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Sept 23	639	635	+ 4	— 120	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 20	4,873	4,808	+ 65	— 3,259	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Sept. 26	5,643	5,617	+ 26	— 921	68½	66½	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Sept. 15	1,151	1,090	+ 61	— 388	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug. 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Sept. 22	169	156	+ 13	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 17	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Sept. 25	936	864	+ 72	—	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Sept. 16	2,358	2,135	+ 222	+ 3,716	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Sept. 22	879	804	+ 75	— 784	22½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train miles. *h* Half-year's figures.

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THE
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NOTES.

IRON AND STEEL SMELTING.

The autumn meeting of the Iron and Steel Institute was fruitful in suggestiveness. Many held that Herr Ljunberg in his paper on "The Production of Iron and Steel by the Electric Smelting Process" was far too half-hearted. Mr. F. B. Cross pointed out that it was a mistake to say that no advance had been made in the use of the furnace for commercial purposes, as three of them have been established at Sault Sainte Marie, Canada. He might have added that iron smelting in electric furnaces has been carried on successfully in Germany for some time past, as we showed in these columns on August 20 last. The paper, as our readers may have judged by our report last week, was full of useful hints and data, but it can hardly be regarded as giving a full account of the present state of the industry. This is a pity, because British manufacturers should be urged to venture more boldly in this direction. We should not allow our Teutonic and Scandinavian friends, or even our Canadian brethren, to reap the full benefit of electric furnace practice without our having a look in.

WATER POWER V. COAL.

Lord Airedale, who presided, justly praised Herr Ljunberg's paper, but his chief contribution to the discussion was a reasoned plea for the more extensive use of water power. He argued that we used it too little in this country, and relied too much on coal as a generator of power. There is much truth in this. That big enterprises can be carried out by means of water power the recent extension of the British Aluminium Co. show, and other instances, though on a smaller scale, could be enumerated.

ELECTRICALLY DRIVEN MILLS.

Mr. C. A. Ablett, so well known in connection with Siemen's Dynamo Works, sounded no uncertain note in his paper on "The Determination of the Currency of Reversing Rolling Mills." He declared roundly for electricity as a motive power, and justified his belief by showing that within the past year five more steel works had adopted electrically driven reversing mills, bringing up the total to twenty; one of these instances was all the more convincing as a nine years old steam engine in good condition was thrown out. Mr. Ablett acknowledged that the capital cost was, even yet, greater than a steam equipment, but notwithstanding this electricity was profitable because it economised fuel, gave a greater output, reduced cost of repairs, of attendance, lubricants and of management charges. Therefore, an increase in capital expenditure was fully justified. Mr. Ablett did not seem to think that the Ilgner system was likely to be superseded, and did not look for any immediate cheapening of plant or practice.

COST OF PRODUCTION.

According to Mr. Andrew Lamberton, of Coatbridge, Mr. Ablett's account was altogether too roseate. He criticised the method of estimating production by kilowatt hours as being academical, and wished everything to be brought down to actual cost. This is what has been done by the twenty ironmasters above referred to. However, Mr. Lamberton declared that he had based a set of estimates of the cost of producing one ton of rails from a plant turning out 300 tons in ten hours. With steam power, allowing 10% for interest on capital and depreciation, the cost per ton was 6s.; with electric power, allowing 15% for interest on capital and depreciation, the cost worked out at 8s. 8d. per ton; and so he decided against electrification of rolling mills.

A QUESTION OF DEPRECIATION.

As might be expected, Mr. Alexander Siemens was not prepared to allow this sudden jumping up of depreciation by 100% as against electricity. He argued, and he had the meeting with him in this, that there was no justification for an increased allowance for depreciation in the case of electric machinery if only the plant was properly selected. He added a point which is too apt to be overlooked, not only in mill but also in mining and other practice, that the right use of electric plant was to keep it well within its power.

SAVING.

A telling rejoinder to theoretician criticisms came from Mr. Ablett. He showed that the Rhenishe Stahlwerke people had saved a shilling a ton on a weekly output of 5,000 tons by adopting electricity, and had over and above reduced the consumption of oil by one-fifth. No wonder that three other steelworks in the neighbourhood have decided to electrify. Another convincing proof that a high allowance for depreciation is not necessary comes from the Niagara Falls Power Co., which fourteen years ago laid down an electric plant of 5,000 h.p. After 10 years it was found necessary to rewind the machines owing to defective bearings, but that was all. It must be admitted that the repairs compare favourably with steam power practice.

TRAMWAY EXTENSION.

At the Municipal Tramways Association Conference, Mr. Fell drew attention to the difficult problem of road repair expenses. In many cases tramway undertakings are undoubtedly charged too much for highway maintenance. West Ham appears to be a case in point. There, with a falling revenue from passenger traffic, to the amount of over £5,000, largely due to a growing invasion of motor buses, the charges for paving have gone up, with the consequence that the tramways have made a loss of £750. Meanwhile the heavy motor buses, while taking more passengers, do not contribute directly to road repairs. This question of paving and tramway undertakings assumes particular importance just now in view of the proposed new regulations as regards assessing for income-tax. Critics of municipal tramways often declare that they secure electricity at too low a rate, thus placing them in a position to compete unfairly with railways and omnibuses. This does not seem to be the case at East Ham, where the trams make a loss but the electricity works a handsome profit. Meanwhile, the London County Council is showing commendable zeal in pushing its tramway extensions both north and south of the Thames, and the Metropolitan Electric Tramways, Ltd., is displaying equal enterprise.

TRACKLESS TROLLEY AND ROAD REPAIR PROBLEMS.

It would appear that the trackless trolley system of the Railless Electric Traction Co., Ltd. (which the Metropolitan Electric Tramways Co. are experimenting with at Hendon) offers special advantages in this matter of road repairs. The cars obtain electricity for motive power purposes from overhead trolley wires, but do not run on rails. The wheels have rubber tyres, and the cars have a free run of the road, that is within the radius of the pole carrying the trolley

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head. These cars are much lighter in build than motor buses, therefore, with this system the road repairs expenses disappear. This point that any road surface will suit, and so no excessive wear is produced, will tell greatly in favour of this system, if not to be run independently, at least as an extension of the orthodox tramway.

NATIONALISATION OF THE "WIRELESS."

Everybody concerned is to be congratulated on the conclusion of negotiations for the transfer of Marconi Co.'s coast stations, with privileges as regards patent rights, to the Post Office. The Nation has decidedly secured a bargain, and modest as have been the demands of the Marconi Co., it retains rights which may be usefully exploited to its own and humanity's profit. The arrangement with Lloyd's is also satisfactory. Unquestionably there was a widespread feeling that no monopoly of wireless telegraphy should be allowed to grow in private hands, and this being the case, it was well that terms should be settled as early as possible.

DOES IT PAY TO CONDENSE?

At one of the London power stations it has been found that the energy required to work the air pump, circulating pump, and fans for the cooling tower costs more than the saving made by condensing. In other words, in this station it would pay to exhaust to atmosphere. The engines are of a very high-class make, with Corliss valves guaranteed to use under 20 lbs. of steam per kw. hour, and yet the whole station is taking nearly 40 lbs. It is clear, therefore, that the condensing arrangements and auxiliaries require overhauling, and no doubt there are many stations which would do with a thorough overhaul by an expert mechanical engineer. Chief engineers of electric power plants are usually electrical men who overlook the smaller mechanical details.

WHEN TO INSTALL A GENERATING PLANT.

The point at which it pays electric power users to generate their own current is a debatable one, but there can be no question that large power users are justified in laying down their own generating plants. Probably about 200 or 300 h.p. is the limit, but a good deal depends on how far the factory is from a power company's generating station. Most power supply stations work under the disadvantages of having to run mains considerable distances to consumers' premises, as well as in having to run for part of the 24 hours at inefficient loads. An isolated plant, on the other hand, is not saddled with large cable expenditure and it can be shut down at any time. The comparative non-success of the power companies is due to the above factors not having been fully recognised

GAS ENGINE DEVELOPMENTS.

If the decision of the United States Street Corporation to replace all their existing steam engines with gas engines is carried out, over a million horse-power gas engines and electric generators will be required. It is estimated that a saving of 50% will be made by this replacement, and there is every reason to believe that the Street Corporation is in earnest. The latest works built at Gary, in Indiana, have large gas engines driving alternators and dynamos, and it is the success of this plant which has led to the new programme being suggested. The Allis Chalmers and the Bullock Electric Manufacturing Co. supplied the Gary plant.

NORWAY'S FIRST SINGLE-PHASE RAILWAY.

With the opening of the railway between Thamshavn, on the Orkedals Fjord, and the mining town of Lokken, the single-phase electrification of Norwegian railways has commenced. Current is obtained from a motor generator plant at Thamshavn, transferring from a 50 period 15,000 volt three-phase supply to 6,000 volts 25 frequency, single-phase current, distributed through the overhead trolley wire, which is on the Westinghouse single catenary system. Each of the two motor generators installed is of 250 kilovolt ampere capacity, rising to 500 k.v.a. for short periods. The Westinghouse trolley construction has a hard drawn grooved copper wire 65 sq. mm. section hung from a steel cable, carried on insulators mounted on steel brackets attached to wooden poles, and supported by tie rods. At no place is the trolley wire more than 9″ from the centre line of the track, and, normally, it is 5·5 metres above rail level. Each locomotive weighs 20 tons and carries 4 motors. The current passes from a pantograph bow collector to a transformer suspended inside the cab. Control is obtained by connecting tappings to a preventive coil, from the centre of which is taken the main lead to the motors. Two motors are arranged in series with each other, in each case these motors being of the Westinghouse single-phase series compensated type, giving 40 h.p. for one hour. The locomotive gives a maximum tractive effort at starting of 4,500 lbs. at 10 miles per hour. A saloon motor car, used on the railway, furnished with a similar electrical equipment to the locomotives, except that two motors only are fitted. The contract for the railway was given to the British Westinghouse Electric and Manufacturing Co., Ltd., who, with their sub-contractors, Messrs. W. G. Bagnall (loco. bodies and frames); United Electric Car Co., Ltd. (saloon motor car); and the Skabo Railway Carriage Works, Christiania (remainder of rolling stock), have shown considerable energy in completing the work.

SCIENTIFIC EXHIBITION AT WESTMINSTER.

The model engineering exhibition which opens at the Royal Horticultural Hall, Westminster, S.W., on Friday, October 15, will contain some exceptionally interesting exhibits, among them the anti-forgery electric desk and pen described last week. There will be a number of model aeroplanes on view, including the machine designed by Mr. G. P. Smith, which won the gold medal in the recent contest at Wembley Park. Working model steam and electric railways, electric clocks, light machine tools, model motor boats, a model engineers' workshop in operation, and a working demonstration of wireless telegraphy by the latest Marconi apparatus, are some of the numerous attractions which will be presented; while in the competitions for engineering and electrical model making over a hundred entries have been received. The exhibition will remain open for eight days, from 12 noon till 10 p.m., closing on Saturday, October 23.

CHAMPIONSHIP FOR ELECTRICAL BRIGADE.

The first part of the 11th annual tournament of the London Private Fire Brigades Association was held on the Parade Ground of the Royal Hospital Schools, Greenwich, when 25 Brigades drawn from London and the provinces competed for the "Nestle" Challenge Cup for the Private Fire Brigade Championship of the United Kingdom, and for other trophies, including the "Dewar" Challenge Shield, and the "Marshall" Challenge Cup, for London Private Fire Brigades. The Robertson Electric Lamps, Ltd., Fire Brigade won the Championship of the United Kingdom, also the "Dewar" Challenge Shield, the winning times constituting records for drills of this class. They also carried off 1st prize in the 4 men drill, 1st prize in the 5 men drill, and secured a substantial lead of 18 points towards the best aggregate for the "Marshall" Challenge Cup. The second part of the tournament will take place next month.

NATIONAL INSTITUTION OF APPRENTICESHIP.

The operations of the National Institution of Apprenticeship have hitherto been limited to London and district, but the Council have in view the extension of the work to the provinces. The annual report states that there were apprenticed to electrical engineering three boys for 16 months in 1905-6, 10 for 20 months in 1906-7, and 12 for 12 months, 1908. Two boys were apprenticed to electrical installation engineering for 16 months in 1905-6, and one for 12 months, 1908. Four boys were placed for 20 months in 1906-7, and one for 12 months last year to learn the trade of electrical instrument makers. Two applicants were apprenticed in 1905-6, three in 1906-7, and two in 1908 to the work of electrical fittings makers, four of the total number being boys and three girls. In our correspondence columns we give a letter from the Lord Mayor of London in reference to the apprenticeship scheme.

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ELECTRICAL INVENTIONS AND THE TRAINING OF THE ELECTRICAL ENGINEER.*

By J. A. FLEMING, D.Sc., F.R.S.

It will readily be admitted that one of the distinguishing notes of the last seventy years has been the remarkable progress made in electrical technology, or the applications of electrical science in connection with the needs of modern life. This technical, as opposed to purely scientific, progress began with the accession of Queen Victoria, when, in 1837, the first practical commencement was made with overland electric telegraphy. Subsequently we obtained electroplating, submarine telegraphy, the telephone, the self-exciting dynamo, the electric motor, electric transmission of power, alternating current generators and transformers, electric lighting by arc and incandescent lamps, and wireless telegraphy. More recently, we have had great extensions of electrometallurgy and electrochemistry, whilst electro-agriculture and the electrical production of nitrate fertilisers from the atmosphere are benefits in process of development. By these inventions vast industries have been created involving a capital expenditure of many hundred millions sterling, and employment for millions of men. These industries do not provide merely the luxuries of civilised life. It is certain that the problems connected with the increase in the population of the world would have been greatly increased in difficulty had not mankind been able to control and use electrical discoveries and operations for annihilating distance, transmitting power, or creating light and heat. These important achievements are not the result simply of the common intelligence. They have been brought about by the superior insight and inventive powers of certain gifted men distinguished as inventors and engineers.

The profession of engineering has become in modern times one covering a vast area of knowledge and activity. So extensive is its range, that no single person can now deal with the whole of it. He is forced ultimately to specialise and to become a mechanical, civil, or electrical engineer, whilst unquestionably before long a most important branch will be aeronautical engineering. On the other hand, no one intending to make engineering a profession should specialise too early in preparing for it.

My strong advice to any student who has leanings towards engineering as a profession is, in the first place, to lay the foundation broadly, and not merely in technical, but also in some business, knowledge. For this reason I am opposed to any attempt to introduce engineering into school curricula. There is no objection to having workshop or model-making for boys, but let it be considered to be a form of recreation, and not a part of the school-time work.

It is unquestionable that the four or five years spent at school, say, between 12 and 17, ought to result in the accomplishment of far greater things in the way of knowledge of foreign languages, mathematics, and acquaintance with science generally, than is the case at present. More power ought also to be obtained of expressing ideas in good lucid English. I mention this here because we teachers in the Engineering Departments of this University find our proper work increased in difficulty and our special teaching retarded by the entirely insufficient acquaintance with mathematics, physics, chemistry, or even mere arithmetic, on the part of many first year students.

Assuming, however, that the average public schoolboy is the material presented for utilisation, three questions arise: First, which of them ought to be made engineers; secondly, what training should they receive; and, thirdly, what prospect is there of being able to obtain remunerative employment when that training is complete?

As regards the first, one prevalent idea is that a boy who is fond of making models or using tools, or carrying on domestic electrical experiments, is likely to make a good engineer. This, however, is not altogether the case. Engineering is a very arduous profession, making a demand for mental and physical powers of a high order, and no one nowadays can possibly succeed in it who is not prepared to live the strenuous life, or who is incapable of enduring fatigue or understanding difficult matters, or destitute of considerable perseverance and tenacity of purpose.

Hence, something more is wanted than the so-called mechanical turn of mind. If I were asked to say in one or two sentences what is the best augury for future success in the profession, I should say that, in addition to a very strong bodily constitution, the most important is a natural tendency of mind to do things rather than talk or read about them. The engineer is essentially a man of action, and a dealer with things rather than words. In the next place, I would say that the faculty of giving concentrated attention to the matter under consideration, to the exclusion of everything else, combined with a steady determination to reach the goal in some way, if possible; also the power of making the best use of the things at hand, are indispensable qualities of mind.

Turning, then, to the question of the training necessary to make young engineers out of youths with some of the above qualities, we may say at the outset that most practical engineers are agreed that the foundation of the special technical training should be laid in a thorough preliminary education in pure and applied science. The problems with which the engineer has to deal are at the bottom mostly matters of mechanics, physics, chemistry, and thermodynamics, and no one now has a chance of success in any department without a thorough acquaintance with these sciences. Hence, it is the general rule for first year engineering students to give their entire attention to these studies, including mathematics and graphics. Our difficulties in teaching the technical subjects are increased by the insufficient foundation often laid in this respect. When this stage is passed, the student enters on the study of the application of scientific knowledge to technical work. If this teaching is to be of any use, it must be based on the performance of practical work by the student himself. The student must not merely read in a book or hear in a lecture statements about the properties of matter, or the transformations of energy, but he must be provided with the means of rediscovering the facts for himself, and finding out what are the rules which govern certain physical operations. Knowledge thus acquired has quite a different value from mere hearsay information. Moreover, the student is brought at once into contact with the difficulties of experiment, and has to make his first beginnings in that which is the life-long exercise of the engineer, viz., getting over difficulties.

I am not, however, an advocate for setting beginners to do or take part in advanced original research. The first thing the student has to do is, so to speak, to learn the use of his weapons or tools. The chief purpose of the laboratory experience is to enable the student to learn the art of measurement. Accordingly, I have employed for many years a carefully graduated set of experimental exercises in the Electrotechnical Laboratory, by which the student is trained to use all the instruments and methods employed in electrical engineering for measurement and testing. Exact measurement is the life and soul of all engineering work, since it is the only means of obtaining knowledge as to cost, and the problems with which the engineer is concerned are not merely to achieve certain things regardless of cost, but to do them within certain strict limitations as to price and financial results.

In the laboratory the student is trained to record and tabulate or graphically represent the results of observations, to gain accuracy in observation, and to draw correct conclusions from the results.

Here, again, however, we have to deplore that so many students totally misunderstand what is their share in this lecture and laboratory work. Many of them think of the teacher as a person who is to save them trouble by administering in a peptonised form concentrated information, requiring on their part neither intellectual effort to seize nor mental digestion and assimilation afterwards. Nothing could be more absurd. The function of the teacher is to save the student time by properly directing his efforts, and not to save him trouble by doing the work for him.

Lecture and laboratory teaching are shockingly wasted unless the student gives an equal amount of time to preparation for it and to subsequent elaboration of his notes. If, however, he makes proper use of his opportunities he will generally pass through the stage of learning the use

* An Introductory Discourse delivered at University College, London, at the opening of the Session, 1909-1910, in the Engineering Department.

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of his tools and be taught to apply them in actual work. In an electrical or engineering laboratory there generally is, or ought to be, a certain amount of commercial or scientific testing going on for the purposes of investigation or reporting on appliances sent in by manufacturers or inventors. In making these tests the teachers will enrol the assistance of senior students, who thus gradually learn to swim alone, and to conduct these tests as they will have to conduct them when left to themselves in the engineering factory or test-room. Meanwhile, in many cases the student is preparing to take his degree in engineering. I am not one of those who consider that degrees in engineering are of supreme importance. No practical engineer cares a snap of the fingers whether his colleagues or assistants have the privilege of putting certain letters after their names or not; all he cares for is what they know, and, above all, what they can do. In many cases a student with originality of mind and practical bent may employ his time much better than in preparing to answer some scores of puzzling examination questions. As regards the B.Sc. degree in Engineering of the University of London, in common with many others, I think there is serious need for reform in the syllabus. The University of London syllabus must be modified so as to secure that every candidate for the engineering degree shall exhibit at least an elementary knowledge of the principles of electrical technology, so that he is not placed in after life in a position of grave disadvantage by reason of his inability to follow what is being done in one of the most important departments of engineering work.

I turn next to the consideration of what is, after all, the keystone of the arch, viz., the opportunities which are open to the student when he has completed his college education of getting a living in engineering as a profession or trade. If there is no sufficient opening in this respect, then time and money spent on education for it are an unfruitful investment.

The first point, however, to which I should like to call attention is that, owing to causes beyond the control of individuals, the various branches of engineering each have their fluctuations of prosperity and their times of high and low water. Thus in 1882, owing to the completed invention of the carbon filament glow lamp by Edison and Swan, an immense impetus was given to electrical engineering. Schemes for central supply stations were launched, and everyone who could lay hands on a fresh pattern of electric lamp and dynamo christened it a new system and floated a company to exploit it. A great demand for electricians arose, and many men in good positions in the telegraph business forsook their old love and took up with the new one of electric lighting, sometimes to their subsequent regret. But then came the ebb tide. The first Electric Lighting Act frustrated many hopes, and several years had to elapse before it could be repealed and electrical engineering again became prosperous. This, however, was followed by a flood-tide of active enterprise. Yet again, this very activity caused certain levels of the quarry to be worked out, only to be again succeeded by new work in other directions. Since electrical engineering has largely to do with public utilities, such as lighting and urban and inter-urban traffic, it is much under the control of legislation, and in the face of an increasing tendency for our representatives and legislators in Parliament to believe that they can play the part of beneficent fairies and with a wave of the wand, or rather of an Act of Parliament, create universal prosperity and happiness, there is always the fear that hasty or unwise legislation will block up the avenues which have been opened for certain work. The ideal for the student is, then, to seek to know a little of everything and everything of something in connection with engineering. With regard to electrical engineering, there are some three or four well marked divisions of it, each of which demands a special preparation. There is, first of all, the department of telegraphy, postal, submarine, and wireless. In all three there are opportunities now for the technically trained electrical engineering student to make a career. The engineering department of the General Post Office has lately thrown open certain appointments to college trained graduates, who are nominated for personal interviews to ascertain their fitness, and selected by subsequent examination. The department desires to obtain men who will help to solve new problems in connection with telegraphy, and not merely work along old grooves. Wireless telegraphy also now affords openings to men of good physique and education. The Marconi Co. take on young men as improvers or probationers, and give them a preliminary testing to ascertain their fitness for certain services. Some part of this work necessarily involves fitness or liking for a seafaring life. The work, however, has a special fascination, and there are abundant opportunities for anyone with ideas to bring himself to the front.

The next department is that connected with electric supply for lighting and traction. In this case it is absolutely requisite to have received a practical training in an engineer's shop. Unless he goes in as a premium apprentice or by interest, it is generally difficult for a beginner to make a start. In many stations the chief engineer of a supply station is allowed to take on a few men as learners with a small premium, and thus give novices an opportunity to secure a footing. The work is one requiring considerable physical endurance from the necessity of night work and the exceptional demands in case of breakdown. Success in this work is not merely a matter of engineering knowledge, but, as far as the higher positions are concerned, requires organising and business abilities of more than average excellence. The problems which concern the supply station engineer are not merely questions of engines and dynamos, but intricate questions connected with finance, cost of production, mode of charging, etc. The introduction of the metallic filament lamp has brought some of these economical questions prominently to the front. In looking back on my own experience in connection with this class of work, I am impressed with the overwhelming influence of the kind and quality of the business management brought to bear on it. Concerns which were brought to the verge of ruin by the management of one person or set of persons have been brought back to prosperity by a change of management. This shows that the difference between success and failure in engineering enterprises is not only due to technical knowledge, but to the presence or absence of power to obtain clear views of the economical side of the subject. Hence the importance in connection with engineering education of obtaining an insight into successful business methods, because the engineer who fails to grapple successfully with the financial or commercial side of his subject fails as much as the man who is technically deficient.

There are, however, opportunities of gaining good positions in connection with generating stations, and, in any case, they can be made stepping stones to other work.

The third department of electrical engineering is in connection with manufacture. The custom of taking technically untrained young men at large premiums into works has been to a very large extent discontinued. The leading firms of electrical engineers prefer now to secure men with a thoroughly good scientific and technical training, who can become more immediately useful, and to whom, therefore, a salary is at once paid. A very large number of our students here have, in past times gone straight from the Pender Electrical Laboratories here into salaried positions with many of the large electrical firms.

A fourth department of work for electrical engineering students is in connection with technical teaching. To be able to teach, however, a person must have had practical knowledge himself, and there is, therefore, small chance of gaining any of the higher positions in the technical teaching work unless a man has been or is in close contact with the actual work of the engineering profession.

Hence, the necessary adjunct of the college or university training is the workshop experience. In some cases the two are intertwined in what is called the "sandwich system," the student spending the winter months in college and the summer in the shop. The difficulty of applying this in the case of London is the great distances which separate factories, colleges, and residential districts, and the practical impossibility of complying with workshop hours unless the pupil lives close to the works. A more easily worked arrangement is for the student to complete at least two years at the college and then take a year in the works of some engineering firm, not necessarily in London, and return for a third year to the college. In this way, in a course of four years, he obtains the scientific and technical training and some shop experience. In addition to the ordinary graduate courses in our Engineering Department here, we provide now Post-graduate Courses by Lectures

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and Laboratory work for advanced study and research. In conjunction with King's College, we have arranged to subdivide this work, and as regards the Electrical Engineering Department, the subjects in which we specialise for post graduate work are in telegraphy and radiotelegraphy, also electric testing, including photometric work with reference to electric illuminants. We afford opportunity for advanced research in these matters, in which our laboratory equipment is very complete.

Apart from the teaching courses, our College Engineering Society is a valuable means for mutual and self-instruction. Every engineering students should join it and profit by the visits it conducts to various works. Also he should join in the discussions, and prepare as soon as possible to take an active part in its proceedings. It is also a matter of importance that he should enter as a student member the Institutions of Electrical or Civil Engineers, and regularly attend the meetings and learn all that he can from their public discussions. It is extremely desirable that third or fourth year students should obtain at least one opportunity of paying a visit to engineering works and stations in Germany, Switzerland, or France. It will be a revelation to them if they are able to visit, under good auspices, some of the large German electric stations or manufacturing works, or some of the large hydro-electric power stations in Switzerland, because nothing like them can be seen in this country.

In connection with this important matter of employment, there is no doubt that there is a great opening for further organisation.

The question of employment for the young would-be engineer is, however, absolutely dependent upon, and is merely one phase of, the position of the engineering business generally. If the employers cannot get business, they cannot afford employment. Hence, by way of conclusion, we may glance for a moment at present and future prospects in this business, especially in reference to electrical engineering. It is a very large question into which many factors, political, economical, and financial, all enter. There is not the slightest doubt that the economical struggle for existence between the highly educated nations of the world is bound to become very severe. Across the North Sea we have the great German nation of 60 millions highly organised for peace as well as war, as competitors with us now in every department of manufacture and industry. Also across the Atlantic the 80 millions or more of the United States with their incomparable energy and immense resources. We have not yet begun to feel the pressure of awakened Asiatic activity, but the immemorial repose and inertia of the East has been disturbed by the victories of Japan, and no man can say yet whether the Occidental or the Oriental nations will emerge the victors in a commercial and manufacturing struggle between them for the trade of the world. The one thing that is certain is that our only chance is to advance by every means both pure scientific research and its industrial applications.

There is no better instance of the conquering power of man over Nature than the remarkable industry growing up in Norway and in Germany in connection with the artificial production of fertiliser from atmospheric nitrogen, all of which would have been impossible without the labours of the electrical engineer. You are all well aware that the cereals and food vegetables, especially wheat, cannot be continually grown unless the soil is fertilised by the addition of materials supplying nitrogen in the form in which it can be assimilated by the plant. The natural fertilisers, such as guano and Chili saltpetre, are becoming exhausted. Products such as ammonia sulphate from coal distillations cannot be supplied in sufficient quantities. Some time ago, Sir William Crookes declared that unless some method could be found of obtaining the necessary nitrogen compounds from atmospheric nitrogen, the world might be faced with the prospect of universal starvation. The electrical engineer and chemist have, however, intervened.

If air is passed in a certain fashion through an electric arc, the intense heat causes some of the free nitrogen to combine with the oxygen and form nitrous oxide, and on partly cooling the gases and passing them through water towers, a dilute solution of nitric acid is obtained from which nitrate of lime can be prepared. Two such processes are at work, devised by the Birkeland-Eyde Co., and another by the engineers and chemists of the Badische Aniline fabrik in Germany. The two concerns have recently joined forces and are erecting a joint factory near the Rjukan Falls in Norway, where a fall of water of 2,820 ft. is available, from which power to the extent of 140,000 h.p. will shortly be drawn, and, ultimately, 400,000 h.p. for the purpose above described.

Another interesting process, which is the basis of an enormous industry at Odda, in Norway, is the production of calcium cyananide from atmospheric nitrogen for the same purpose. Lime and coke, when heated to a high temperature in an electric furnace, combine and produce the familiar calcic carbide used for preparing acetylene gas. If nitrogen is passed over this compound at a high temperature, it combines and forms $Ca\,C\,N_2$, a compound of great use as a fertiliser. The nitrogen required is obtained by liquifying air and allowing nitrogen to evaporate. At Odda, 23,000 h. p.are drawn from the river Tvase, and utilised for the mechanical and thermal processes required. It will thus be seen that abundant water power is a necessary condition, but this cannot be utilised without the intervention of the electrical engineer. If, however, we look around, we see other immense sources of energy not yet touched.

Consider, for instance, these few facts. The experiments of Langley and others on the solar constant show that when the sun shines in a clear sky, vertically down on the earth, its rays of light and heat expend against every acre of surface the equivalent of 7,000 h.p.† If we take 2 lbs. of coal burnt as the engine and boiler equivalent per h.p., this means that tropical sunlight gives to every square mile the equivalent of nearly 4,000 tons of coal per hour, or, say, roughly, 25,000 tons per day. Anything in the way of energy we can extract from waterfalls or even coal-mines sinks into insignificance when compared with the power wasted by the sun's rays on desert places. Although it may seem somewhat ironical to talk about wasted sunshine, seeing how little of it we have enjoyed during the past summer, nevertheless the questions arise—Can we capture any of this wasted energy, and, if so, how are we to transmit it to places where it can be utilised? To transmit it electrically by conductors is not practicable over extremely long distances. But why not wirelessly? This energy is conveyed from the sun in 8¼ minutes without wires. We have learnt to transmit small amounts of power for telegraphic purposes without wires; may we not find out how to transmit large amounts? The first practical application of the electric current was to transmit small currents with wires. Later on, we learnt how to create and transmit large currents with wires. We can now transmit small power by electromagnetic waves—why should we not discover how to transmit large amounts of power in this manner?

Tesla suggested at one time that if we could set the natural electric charge of the earth oscillating we might pick up that energy anywhere just as if we were to set the water in a swimming bath in oscillation, we could put a float on the water anywhere and use its periodic rise and fall to drive some small machinery and so tap off the energy of the oscillating water. On the other hand, it may be possible to employ solar radiation for preparing quickly some form of combustible. All the coal we burn is the result of the decomposition of carbonic dioxide by the solar rays. The oxygen in our atmosphere is the chemical equivalent of the coal in the terrestrial strata. It may be possible to accelerate some process of this kind or perform it artificially. The more effective utilisation of peat and imperfect or lower forms of carbonaceous matter is a problem that has not yet been fully solved.

Again, there is the tremendous energy locked up in atoms themselves which we have not as yet done more than realise. It is now seen to be highly probable that an atom of matter is a complex structure which has a large store of potential energy locked up in it. In some, if not in all, cases there is a spontaneous tendency for the atom to break up into simpler structures with less intrinsic total energy

† According to Scheiner, the heat received from the sun at the earth's surface would, when falling normally on 1 square centimetre of surface, impart to it about 3·75 gramme calories of heat. The heat falling on 1 square foot is equal to 14 pound-Fahrenheit units of heat. The mechanical equivalent of this last unit is about 778 foot-lbs. Hence, the heat received from the sun per square foot of the earth's surface, when rays fall normally, is the equivalent of 10,892 foot-lbs per min., or nearly ¼ of a horse-power, or 3 h.p. per square yard, or 14520 h.p. per acre. Taking half this as an average value, we have the figure in the text.

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just as dynamite or cordite are substances of which the complex molecules rearrange themselves when it is given a certain shock, into forms having less total potential energy. Hence there is a liberation of energy from the disrupting molecule which can be utilised. It is clear from all data that if we can find means of breaking down atoms in sufficient quantities, we shall have a source of power vastly exceeding any now available. We may then be able to make explosion engines worked by this means, which in bulk or weight per h.p. are much smaller than any now used. As it is, the astonishing advances made in aviation lately will certainly create a demand for further improvements in the internal combustion engine as regards size and weight per h.p., and it now remains to find a combustible or working substance which has less bulk and weight per h.p. hour stored than the petrol at present used.

Inventions which will solve some of these great problems may, however, lie in the far future, and await the coming of some master mind. Nevertheless, there is abundant work for intellects of lesser degree, and especially in connection with problems of every-day life, such, for instance, as follows :—

There is a vast field for invention still open in connection with domestic electric heating, including cooking, not yet by any means exhausted. The combustion of raw coal in house grates and kitchen ranges, with all the consequent demand for domestic labour, which is every year becoming more and more difficult to obtain, renders the problem of heat production in our houses a matter of the greatest importance. This is not only a question of decreased cost of supply of electric energy, but of decrease in the cost of and improved durability and efficiency in the heat producing apparatus, electric radiator, oven, or kettle. Domestic electric lighting has now become a matter of absolute and universal necessity, but the demand for an economical and improved domestic heating is equally large, and though gas comes to our aid at present, the whole of the difficulties are not, indeed very few of them are, solved by the use of a combustible which requires oxygen to be supplied, and, therefore, cannot be entirely enclosed, or wastes heat, and which vitiates the air.

Next, there is the improvement necessary in our urban traffic. No one can believe that the present dust-raising, noisy, malodorous and complicated petrol engine driven vehicle is destined to be the last word on mechanical traction. In spite of all previous failures, the electric motor vehicle is the proper solution of the problem. Railless electric traction has begun again to occupy attention.

If, however, we can find means of transmitting energy in large amounts through the æther economically without conductive connection, even only for a few inches, we may be able to transmit the power from a buried electric main to a moving vehicle without either overhead trolley, conduit contact plough, or even surface contact studs, and so make each vehicle absorb its driving energy (paid for by meter) from underground supply mains.

These suggestions might be indefinitely increased, but I shall not pursue them. Sufficient is it to say that in the engineering profession a young man with ideas and originality has great opportunities of doing work which will obtain speedy recognition and reward. But the condition is that he must do something new and useful. That, however, involves in every case much persevering work and immense patience in overcoming difficulties. It has been wittily said that any fool can invent, but it takes a clever man to work out the details, but it is the details that really matter. Hence the importance of acquiring not merely information, but the power to make the best use of our originating faculties.

If the qualities of character that are necessary for successful work in adult life are not acquired in youth, they never will be. But the foundations of character are laid in habits acquired by repetition. Although genius is something more than an infinite capacity for taking pains, experience shows that it is useless without that capacity, and the guiding rule of all who have done useful work is, therefore, that ancient maxim : "Whatsoever thy hand findeth to do, do it with all thy might."

BRITISH STANDARD SPECIFICATION FOR AMMETERS AND VOLTMETERS.

The Specification for Ammeters and Voltmeters (No. 49), lately issued by the Engineering Standards Committee, should be of great service to both the user and the maker alike.

The user can see at a glance the degree of accuracy he may expect for the class of instrument he requires, and the maker, if the Specification is as widely adopted as we hope it may be, will be saved an immense amount of needless trouble in tendering, and also be able to standardise his detail work, which should tend to cheapen production.

The Committee commenced the consideration of this subject in October, 1907, and issued a list of questions to the makers of instruments in order that they might have reliable data upon which to base their discussions. The results of these preliminary enquiries, we are informed, were most satisfactory, and the makers one and all evinced a strong desire for standardisation, and, moreover, by the unanimity of their replies, showed the Committee at an early stage that their work would be certain of the cordial support of the makers themselves.

In the Specification, instruments are classified as substandards, first-grade and second-grade instruments, according to their accuracy. The second-grade instrument, although of not a very high order of accuracy, should be useful in workshops and similar places where accuracy is not of vital importance. The Committee make certain definite recommendations for the construction of instruments which comply with the British Standard. Some useful recommendations are made with reference to scales, although no particular sizes for the figures are mentioned. Certain Standard scale readings for ammeters and voltmeters have been adopted, and we understand that these lists have been very carefully selected, the Committee keeping in view the ordinary requirements of the user and the cheapening of production by reduction of the numbers which have to be kept in stock. The lists represent the present demands of the industry according to the makers' catalogues, but, of course, if the demand arises for other "maximum readings," the fact that it is open to revision gives a ready means of bringing the specification absolutely up to the needs of the industry. The drop in pressure on the shunt has been standardised in order to obtain interchangibility and, we note, is different to the German Standard. The transformation ratio of a potential transformer has been fixed as well as the current in the secondary circuit of a series transformer. The Committee explain in the preface that they have not gone further into the questions affecting instrument transformers, as they intend dealing in a separate report with standards for instrument transformers, resistances and separate shunts. The question of accuracy has necessitated a great deal of investigation and prolonged discussion on account of the inherent differences in the various types of instruments as well as of the degree of accuracy attainable under practical working conditions. The difficulty of expressing in a simple manner the permissible limits of error when these had been decided upon, gave the Committee a considerable amount of preliminary work before a useful result was attained, and we are assured that the figures for the accuracy are based on actual "test records," kindly supplied for the use of the members.

The definitions which precede the Specification proper should prove of great use towards the avoidance of misunderstanding due to the user and seller not attaching the same meaning to the term employed. No definition is given for "Dead-beat," but the preface explains the reason which is due to the possibility of an instrument being made dead-beat by weakening the control, and so involving inaccuracy due to friction. Electrical instruments are now so generally used by the engineering industry, that this specification should find a very extended field of usefulness. The price of the specification is 2s. 8d. post free, and it may be procured from any bookseller, or direct from the offices of the Committee, 28, Victoria-street, Westminster. It is published for the Committee by Messrs. Crosby, Lockwood & Son, 7, Stationers' Hall Court, Ludgate Hill, E.C., and 121a, Victoria-street, S.W.

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RAILLESS TROLLEY.

By an arrangement with the Railless Electric Traction Co., Ltd., of 56, Moorgate-street, London, E.C., the Metropolitan Electric Tramways, Ltd., are testing the railless electric traction (trackless trolley) system from their depôt at Hendon. In this system, the car is of the deckless motor 'bus type, with twin pole carrying a trolley-head fitted with pairs of wheels for contact with the overhead trolley wires. The car has a metal chasis, with four rubber-tyred wheels. No tracks are used, and the pole having a mean length of 16 ft. 6 inches, the base and trolley head being suitably jointed, the car has a free range of some 17 ft. on each side of the centre of the roadway, and can curve in and out of the traffic, or round any obstacle. In fact, it has almost the freedom of a motor 'bus, with the advantage of deriving its energy from overhead wires, and consequently requiring a less heavy frame and motor than the independent 'bus, and, of course, benefiting from the use of cheaper power. It is somewhat of a pity that the demonstrations have been made with a car of a heavier build, and carrying heavier motor, than was needed; thus the full advantage of the system was not made patent to all the interested visitors. The experimental car has seating accommodation for 24 passengers, and a dead weight of close upon 6 tons. The chasis was designed and built by Messrs. James & Brown, Ltd., of Hammersmith, and is an excellent piece of work. The two motors of 25 h.p. each are of the standard British Thomson-Houston traction pattern, are fixed to the frame, placed with their axles parallel to the length of the car, on either side of the countershaft, driven through universal joints and bevel gear, Reynolds' silent chains connecting the counter shafts with the rear or driving wheels. A standard B.T.-H. pattern controller is used, fitting beneath the driver's seat, and is operated by means of a lever and a notched quadrant. A leakage indicator, and both foot and hand brakes controlling countershafts and driving wheels completes this part of the equipment. Either two or three overhead wires are used, one being negative or earthed. The trolley base is of peculiar design, it is pivoted to swing round, and besides the usual raising springs, has another set of springs working in a horizontal plane, so that adjustment is perfect. The rigid pole is in duplicate, and supports a head having three pairs of under-running trolley wheels, one pair being in contact with each wire. These wheels are pressed upwards by coiled springs and are so pivoted as to have an axial movement. Owing to this combination of twin pivoted pole with springs at head and base, perfect smooth running is secured, adjustment taking place automatically in the event of any inequalities being met with.

It is to be noted that the rubber tyres cause the car to be insulated from the roadway. To obviate the metal framework of the car becoming charged with electricity, the motor circuit is carefully insulated, and this has been found ample. However, the Railless Electric Traction Co. have taken additional precautions. When three overhead wires are used, the two outer ones are positive and the centre one negative, and in that case the metal framework is brought into contact by means of one pair of trolley wheels, this negative, or earthed wire, being several inches higher than the positive wires. When three wires are objected to, only two may be used, in that case one being positive and the other negative, and placed 7 in. apart. Here the metal framework is not connected directly to the trolley wheels, but the connection is brought to the middle of a single-pole double-throw switch, thus enabling contact to be effected at will with either pair of trolley wheels. A polarised relay is provided, one coil being energised by the trolley circuit and the other by a small storage battery, and this acts as a safety indicator. The relay remains inoperative so long as the single-pole switch is in a position to connect the framework of the car with the pair of wheels in contact with the negative wire, but should the polarity of the trolley wires become reversed, the relay at once brings into action an electric hooter, which continues to operate until the framework is brought into connection with the negative wire. This device is also provided with a second hooter which warns the driver should a breakdown occur in the motor circuit. The perfect working of this was shown at the Hendon demonstration, for when the loops at the end of the experimental line were reached, and the car turned round, the reversal of polarity was at once notified by the hooter.

The rotating trolley head is provided with a socket and plug attachment which enables a conversion to be made, so that the car may run along an ordinary tramway route, the return circuit being obtained by means of a pair of slippers suspended from the rear of the car and fitting in the groove of the rails. Even in this case the car still retains a considerable amount of freedom, so it can run on either side of the track.

The trackless trolley system has had considerable vogue and success on the Continent, and there is no reason why it should not meet with support on this side of the Channel. Certainly the experimental line that has been put up by the Railless Trolley Traction Co., and is being worked by the Metropolitan Tramways has every appearance of being thoroughly practical. Owing to the lowness of capital cost, of running expenses, and the avoidance of most of the highway maintenance problems, the system should prove most useful under many and varying conditions.

INCOME TAX ASSESSMENT.

At the instance of certain municipalities and municipal associations, the Board of Inland Revenue has agreed to a scheme for determining the allowances for wear and tear in respect of tramways and light railways, gas, water, and electricity undertakings. We append the instructions sent to the Surveyors of Taxes:—

TRAMWAYS.

Permanent Way.—Allowance for Maintenance to Cover Depreciation.—Life.

1. The life of the permanent way is to be taken as 12, 14, or 16 years, according to the traffic thereon. The classification is to be based on the average car mileage per mile of track per annum of the financial year preceding the year of assessment, namely:—

(1) Not exceeding 50,000 car miles per mile of track—16 years.
(2) Over 50,000 and not exceeding 75,000 car miles per mile of track—14 years.
(3) Over 75,000 and not exceeding 125,000 car miles per mile of track—12 years.
(4) Over 125,000 car miles per mile of track—special consideration.

2. Where there are special circumstances, such as exceptional gradients and the compulsory use of wood-paving, etc., tending to show that the car mileage does not fairly represent the wear and tear of the track, each such case is entitled to special consideration.

Cost of Renewals.

3. The cost of renewals, including setts or other paving, but excluding concrete foundations, should be taken at £4,400 per mile of single track until the general renewal of the track takes place.

Basis of Computation of Depreciation Allowance.

4. No allowance should be made in computing the assessable profits in respect of any expenditure on repairs or maintenance of the permanent way, but the allowance for depreciation should be computed at such a sum per annum as will in the aggregate over the determined life of the permanent way be equal to the cost of renewal as above fixed plus the estimated repairs for that period:—

Cost of renewal per mile as above ..	£4,400
Add for example:—	
Estimated cost of repairs at £100 per mile per annum, for an undertaking with a life of 16 years	£1,600
	£6,000
Amount to be allowed per annum in lieu of depreciation, 1-16th	£375

5. The amount to be added in respect of ordinary repairs should be determined by taking the actual average expenditure as shown in the accounts of the undertaking for *the last three years*, or such period less than three years as the undertaking has been in existence.

6. Repairs under this head should be understood to include renewals of special track work at junctions and cross-overs, which occur at frequent intervals.

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Periodical Adjustment.

7. Inasmuch as the expenditure on repairs is expected to increase as the track begins to wear, in which case the figure to be adopted under this head, which is to be based on past experience, will be unsatisfactory, the amount of such estimate should come up for revision at the end of every five years, and an adjustment should be made by increasing or diminishing the allowance as the circumstances require, having regard to the basis of calculation outlined above.

8. A strict account should be kept by the Corporation and the surveyor of the annual allowances, and of the actual expenditure on repairs and renewals; and at the end of 10 or 15 years (*i.e.*, the second or third revision), or at such time as the general renewal of the track shall have taken place, the amount to be annually allowed should be reconsidered and increased or diminished for succeeding years as the ascertained facts shall show to be necessary, provided that under no circumstances shall the allowances for previous years be re-opened.

9. All expenditure on extensions and improvements should be excluded from the working expenses for income tax purposes; and the necessary additional allowance for depreciation on the lines suggested above (*i.e.*, mileage) should be at once allowed on such expenditure and added to the sum already allowable.

10. The allowance of £4,400 for renewal of permanent way mentioned above is intended to apply to the overhead trolley system. Special arrangements should be made, on the lines of the foregoing, in the case of the conduit, surface contact, or other system. The number of such cases is very small. As the circumstances vary very considerably in each case, the amount to be allowed for renewals should in the first instance be arrived at by arrangement with the Chief Inspector of Taxes.

Cables.

11. In addition to repairs, depreciation should be allowed at the rate of 3% per annum on the written down value.

Overhead Equipment—i.e., *Trolley Wires and Connections.*

12. No depreciation should be allowed; all expenditure on maintenance and renewals should be charged as working expenses, as and when incurred.

Cars and other Rolling Stock.

13. Subject to the ensuing clause expenditure on maintenance and renewals should be treated as working expenses, and allowed in lieu of depreciation.

14. Depreciation, however, should be allowed in lieu of renewals where the circumstances justify such an allowance, provided that a strict account is kept of all renewals, and that if such renewals are charged to revenue account, they shall be shown separately in such account and added back in computing the assessable profits.

15. The allowance in such case should be 7% per annum on the written down value.

16. In any case the annual expenditure on repairs is to be allowed as a deduction in computing the assessable profits.

General Plant and Machinery.

17. All other plant and machinery, including standards, brackets, and workshop tools, but excluding loose implements, office furniture, and small articles which require frequent renewal, should be bulked together and depreciation allowed thereon at the rate of 5% per annum on the written down value, in addition to the cost of repairs.

Clauses 18 to 20 refer to gas and water undertakings.

ELECTRIC LIGHTING UNDERTAKINGS.

Cables.

21. In addition to repairs, allowance for depreciation may be granted at the rate of 3% per annum on the written-down value.

Plant and Machinery.

22. On all other plant, exclusive of loose tools, meters, and office furniture, depreciation may be allowed at the rate of 5% per annum on the written-down value, in addition to the cost of repairs.

Conduits.

23. No allowance should be made for depreciation; but annual expenditure on repairs and renewals may be allowed as working expenses, as and when incurred.

Meters, Loose Tools, and Office Furniture.

24. No allowance should be made for depreciation; but annual expenditure on repairs and renewals may be allowed as working expenses, as and when incurred.

GENERAL.

25. In all cases where depreciation allowances are granted, a strict account should be kept of the annual expenditure on renewals (and repairs in the case of tramway tracks), including replacements due to obsolescence, and of the amounts allowed for depreciation and obsolescence, whether under this arrangement, or under any arrangement made prior hereto, and a readjustment should be made for the future, if necessary, at end of every five years, as detailed under Tramways (Permanent Way), subject, however, to the special provisions applicable to Tramways (Permanent Way).

26. Where depreciation allowances other than those for the permanent way of tramways are granted, renewals should be carefully distinguished, and, if charged against revenue, they should be notified to the Surveyor, in order that they may be added back in arriving at the income-tax liability.

27. "Written-down value" means original prime cost, plus subsequent additions, less all allowances actually granted by the Revenue in respect of wear and tear.

28. These proposals are to take effect for the year 1908-9, and for years preceding in cases where claims of depreciation are at the present time awaiting settlement.

29. The computations necessary for any future adjustment should be duly made, agreed and recorded each year, whether the accounts for the particular year under review show any assessable income-tax liability or not.

30. Where, in any cases, allowances for depreciation have been made which are now to be discontinued, and they have not been exhausted by renewals already effected, the amount of such unexhausted allowances should be determined by agreement between the Surveyor and the Corporation or Company, and deducted from the expenditure on future renewals as and when they are effected.

31. All cases of dispute should be referred to the Board through the Chief Inspector of Taxes.

COMMENT ON THE SCHEME.

The Secretary of the Machinery Users' Association writes to our contemporary, the editor of *The Machinery User*, pointing out that this scheme disregards the provisions of the Taxing Acts and the decisions of the Courts as to the principle to be adopted in conceding the allowance for depreciation under the Act of 1878. He says that it is to the interest of the Treasury to induce users of machinery or plant, to defer the claims which they are legally entitled to make each year under the Act of 1878 for wear and tear, until such time as they may have renewed that machinery or plant; but in arrangements of this character it is often lost sight of by the taxpayers that the authorities are in effect importing a condition which is not contained in the Act, namely, that before the allowance is granted the "machinery and plant" shall have been renewed. Many machines and tools last 20 or 30 years before they are renewed, but in each year during that period their value is being reduced by "wear and tear," and this exhaustion of value is charged against the profits in one form or another as part of their cost of production; but by deferring the allowance under the Act they are paying tax on profits that have not been earned and giving the Crown the use of the money so paid for an indefinite period. In fact, it may be for ever, because, as the case of the London County Council *v.* Edwards (Surveyor of Taxes) shows the taxpayer has no legal right to anything more than the loss by wear and tear during the year of assessment. It may also be that the machinery user falls upon bad times, and has no assessable profits in the years when he makes his renewals. Further than this, the matter may be altogether lost sight of when the renewal is made, and no claim can be made for its allowance, and great difficulty may also arise after the lapse of so many years in proving that there has been a renewal, the cost of which has not been allowed previously. These are questions which experience shows often arise, and it is known that the tax is thus paid upon large sums which in effect are not "profits." The only thing that is made certain by the proposed arrangement is that the Crown will get the tax,

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but it will remain uncertain that the taxpayer will ever get it back again.

The recent appeal of the London County Council arose out of the refusal of the Income-Tax Commissioners to allow the cost of certain replacements of plant rendered necessary by the conversion of their tramways undertaking from horse to electric traction. In the course of his judgment, Mr. Justice Channell made the following observations :—

> ". . . what was done was that as regards the tramways, which were altered so as to be worked by electric power, nothing was spent for renewals, inasmuch as a different thing was substituted for the former tramways,"

and it is common experience that scientific progress is constantly evolving similar changes in the character of plant used in other industrial enterprises; and be these changes either greater or less in degree than was the case with the Council's tramways, the principle laid down was that in order that a claim for "renewals" may wholly succeed, the plant installed by way of relpacement must conform in every respect with that which it replaces, and where this is not the case the allowance of the claim will be still further dependent upon the goodwill of the Board, and this is hardly a satisfactory substitute for the rights which are conferred upon the taxpayer by the Act of 1878.

The further observations of Mr. Justice Channell are also instructive: "There was no security that the parties would agree to continue the practice," but "the difficulty of using the practice actually adopted arose from the difficulty in ceasing to use it at any particular time. The London County Council might have objected to the usual practice of calculating the depreciation [by the way of conceding the cost of renewals] when before the Commissioners, on the ground that it was not applicable under the altered circumstances. If they had done so, the Surveyor of Taxes could not have objected to the estimate being made under the statute." He, therefore, thinks that authorities and companies should carefully consider their position before accepting the proposition of the Inland Revenue Department.

COST OF DEFERRED MAINTENANCE.

The following article, reprinted from the *Electrical Review and Western Electrician*, Chicago, deserves careful perusal, as having a direct bearing on the new instructions issued by the Inland Revenue Board to the Income Tax Surveyors, and some of the dangers attaching thereto, touched upon in our leader columns.

Our contempory says that in the administration of industrial plants the problem of economical maintenance is a matter of constant engineering interest. If operating conditions remained stationary after the establishment of a plant, it would be a comparatively simple task to forecast the amount of money which each year's service legitimately requires for keeping the equipment in efficient condition; but with the tendency toward expansion of output and the changes in methods of production which appear in most installations from time to time, the standards by which maintenance may be judged are continually varying, when the disbursements for one period are compared with those for another. This means that unless general conditions, as well as analyses of the expenditures on the unit basis, are taken into account, the plant is liable on the one hand to suffer from spasmodic appropriations for improving its equipment efficiency, and on the other from unwise changes in its design or unjustified departures from previous practice when extensions become necessary.

The fundamental requirements of adequate maintenance are not complex, for they are simply included in the exercise of that prudent foresight known in the vernacular as the "stitch in time," which reduces waste in the field of machinery operation in the same manner as in other fields where wear and tear are higher. The same causes always produce the same results. Unfortunately, with complicated systems of apparatus manipulated by even more intricate personalities, it is extremely difficult to sift the causes of wear and tear to the bottom, and to reduce to figures which are worth anything, the service performance which brings about a definite amount of wear on a machine or group of appliances of known characteristics. In the difficulty of the problem lies its fascination, however, and every engineer who analyses the performance of his equipment in a scientific way helps to lighten the dark and unexplored areas of puzzling experience with equipment failures and excessive expenditures for rehabilitation. The difficulty is that in so many cases the data collected are not sufficiently complete to enable accurate judgments to be passed. The number of factors neglected or approximated is too great.

Four years' maintenance costs taken from the unusually complete records of a central station of the engine-driven type illustrate the need of full data before one can criticise the administration of a plant from the financial point of view. The station capacity at the beginning of the four years was 450 kw., and in the second year it became 1,250 kw. through the addition of another generator. No further increase was made. The energy generated increased from about 930,000 kw.-hours to 1,400,000 kw.-hours. In the first year the cost of station buliding, steam and electrical equipment maintenance per kw.-hour was 0·20 cent; in the second year it was 0·11 cent; in the third, 0·26 cent; and in the fourth, 0·16 cent. A tenth of a cent is not a very large affair in itself, but when applied to over a million-and-a-third kw.-hours in a year it amounts to over a hundred dollars a month. Before an analysis can be made of even so considerable a variation as this in the repair account of any particular sub-division of the station apparatus, one must know not only what were the larger items of expense which produced the variations in unit-repair cost, but the extent of service which was imposed upon different units in the station, the approximate outputs of each, number and extent of severe overloads, character of the preceding repairs, magnitude of fluctuations in the load curve, occurrence of temporary adjustments, and the number and nature of any noteworthy failures. It would be a great help in the future administration of such plants if the unusual occurrences could be recorded more fully by the engineers in charge of the stations, either in the regular log of the daily runs, or in a special emergency book having pages of sufficient size to permit the insertion of all the data which would form the principal support of a thorough report of the situation in each instance. It is not enough from the standpoint of high-class maintenance analysis to state that a certain increase in the steam-plant repairs for a given month was due to the replacement of a cylinder head on No. 2 engine. Something of the history of the engine before the change became necessary should be available to the man who has to study the prospective expenditures of the plant in the light of its past records. It is true that, except in very rare instances, it is too much to expect the average operating employé to put down the full and accurate particulars desirable in connection with equipment failures or pending replacements, but this matter can be handled profitably by the engineering staff if the right questions are opportunely considered in conference with the operating force.

It seems to some managers as though refined studies of equipment maintenance were worth little in their effect upon expenses, but experience has shown, notably in the electric-railway field, that the more carefully defects are analysed, the fewer occur, provided that the results are exhibited before the division heads in charge of the detailed work in the car service. In one notable instance the company has cut down the failures of its cars on the streets by nearly 20% a year through a tabulation of the defects each month and a study of them in the presence and with the co-operation of its carhouse foremen and division superintendents. There is still need on this system, however, of getting to the bottom of obscure troubles which occur, for only by such a course can costly interruptions be minimised. Reduced failures mean decreased shop expenses and a lower rate of depreciation, but service reliability is worth more as a rule than saving in repair costs.

The relation of service reliability to maintenance, and particularly to deferred repairs, neglected through pressure of traffic or shortage of tunds, is at present extremely indefinite, but none the less direct and inescapable. When the campaign for economical operation reaches its height

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in any company it is an easy matter to cut down the repairs from those desirable under the most prosperous conditions to the fewest which will keep the system in motion. The shrinkage in repair bills which such a policy often produces is gratifying in its effect upon net earnings, but there are few policies so hazardous as that of cutting down the necessary routine repairs. Not only are subsequent expenditures for maintenance relatively heavier, but the danger of accidents is increased, the life of the equipment is shortened, the saleability of the plant diminished, and the economy of production often seriously impaired. Anxiety to declare early dividends and to maintain a well-established dividend rate should never be permitted to result in the neglect of equipment through deferred maintenance. In the long run the cost of deferred maintenance will prove to be greater than that of normal and regular repairs, faced squarely as they become due in the exigencies of operation.

THE MAJORANA SYSTEM OF WIRELESS TELEPHONY.*

By H. J. REIFF.

This new system of wave telephony is of great interest and practical value. Hence a description of it will be of interest to our readers.

The transmitting apparatus includes a generator of almost undamped oscillations, but Majorana combines it in certain cases with the Poulsen apparatus for completely undamped vibrations. The special feature, however, is a hydro-electric microphone connected with the mast wire, and supplies sounds corresponding with the undamped oscillations. The apparatus is represented diagrammatically in Figs. 1 and 2. The coil S, together with the condenser C and the self-induction L, produces the waves. A is the air wire coupled inductively with the coil T. E is the earth, and the microphone M is between it and T. The microphone is a bell hydraulic telephone. The water S falls through the opening O on to a pointed wire P fixed vertically under O (Fig. 2). P is surrounded by an insulating ring I, itself surrounded by a broader ring R. The continuous current of a telephone is connected with both R and P. When the water to which, conductivity is imparted by means of a little sulphuric acid, falls over the sharp end of P and the ring R, it establishes a circuit for the telephone current abovementioned. If the flow of water is made intermittent, the

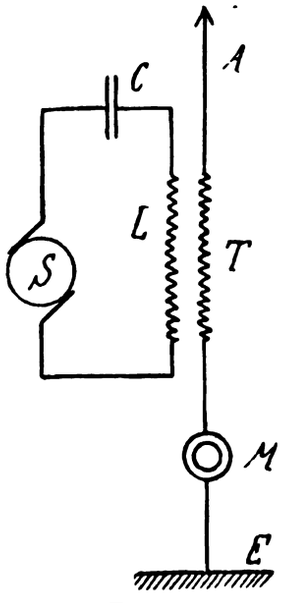

FIG. 1.

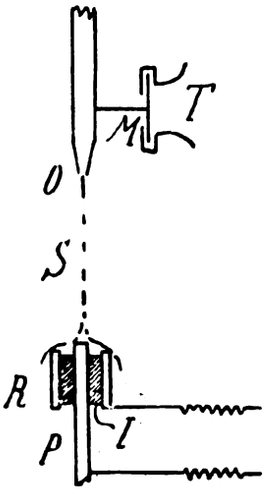

FIG. 2.

telephone circuit is correspondingly made and broken. Now, this intermittency is produced by certain sound waves falling on the stream of water and breaking it up into drops. The waves are sent to O through the funnel T and the membrane M.

The novelty in Majorana's arrangement is that, in using this well-known form of microphone, the defects of it in reproducing the human voice are got rid of. This is done

*Translated from *Der Elektrotechniker*.

(Fig. 3) by connecting the water supply pipe Z by means of a rubber connector G with the pipe A ending in the fine jet (O in Fig. 2), from which the water finally issues. A is made with much thinner material than Z, and this, together with the flexibility of A enables the delicate variations of the human voice to be transmitted to the telephone almost intact.

Another advantage of the Majorana system is that it can utilise currents of greater voltage, as well as of greater amperage, than has hitherto been possible without loss of sensibility or exactitude of reproduction. With high voltages, the distance between P and R can be increased within reasonable limits, and the apparatus is equally suitable for high amperages, because the water conducting

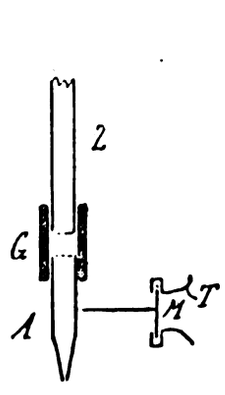

FIG. 3

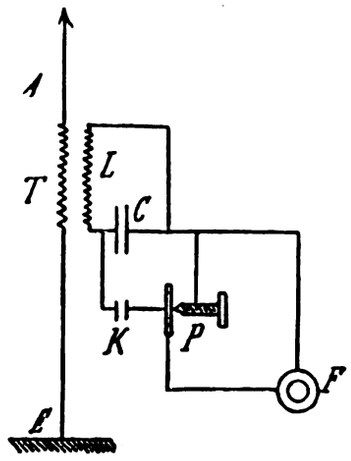

FIG 4.

the current is constantly renewed, so that there is a continued cooling of the whole apparatus. Here we have the secret of the power of the Majorana arrangement to telephone over great distances.

As regards the receiver, Majorana resorted first to a Marconi electro-magnetic detector, but found it deficient in the reproduction of the human voice. He finally resorted to a thermo-electric scheme shown in Fig. 4. A is the antenna, T an adjustable self-induction, and E our planet. The coil L is under the induction influence of T, and with the condenser C makes the oscillation circuit. Parallel with the condenser there is a smaller one K, and the thermo-electric contract P. This consists of a plate of iron pyrites, which can be pressed upon by a platinum screw. A difference of potential is caused between the two by the heating caused by the passage of the electric waves, and hence a current passes through the telephone. Majorana has also made use of Deforest's receiver, the so-called audion. This is represented in

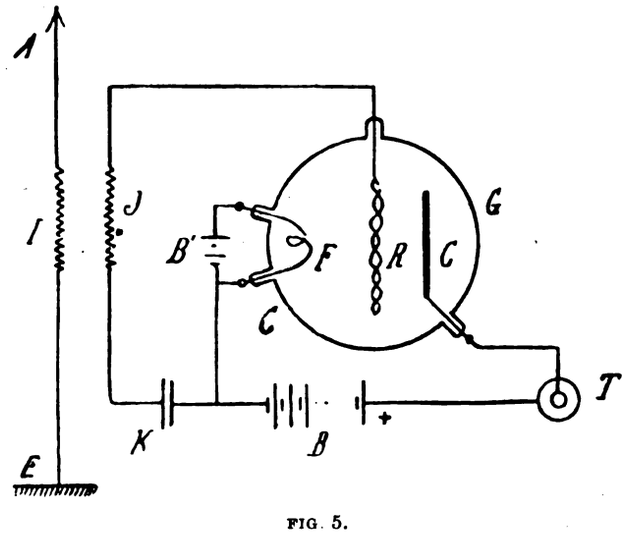

FIG. 5.

Fig. 5. A is the antenna, I the earthed self-induction of the receiving circuit. The audion consists of the exhausted glass globe G, containing a carbon light filament F, which is ignited by the battery B^1; G also contains a wire netting R, filling nearly the whole diameter of the globe. Opposite to it, and also inside G, is the metal plate C. The negative pole of F communicates with R

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through a condenser K and the coil J. The rest of the circuit includes the 30 volt battery B and the telephone T.

When no message is being received, a weak current, nevertheless, passes the telephone, for the incandescent filament F is continually emitting electrons, some of which pass through R on to C. If waves reach the antenna, the coupling of the two coils causes a difference of potential between R and F, and all the electrons emitted from F are stopped by R, so that electrical communication between F and C is suspended, and the current in the telephone ceases. In this receiving apparatus the transmission of acoustic vibrations is effected by altering the difference of potential between R and F, whereby the number of electrons passing from F to C is also changed in the same proportion as the intensity of the waves, *i.e.*, in correspondence with the acoustic vibrations from the dender of the waves.

By using this arrangement, under the patronage of the Italian Navy, Majorana has succeeded in telephoning without wires over a distance of 260 miles. It is a very important point that this result was obtained between Rome and the coast of Sicily, and in a district where there are numerous wireless telegraphy stations established, so that there was every possible chance of interference by electrical waves from them. Nevertheless, the tone and accent of the speaker were exactly reproduced. This is a characteristic property of wave voice transmission, which is effected quite independently of the acoustic vibrations, and is conspicuously absent in the ordinary wire telephony. The only part of the apparatus that might possibly affect the recognition of the voice in the Majorana apparatus is the membrane M and the outflow jet A. These might, on occasion, set up vibrations of their own which might strengthen or weaken, or even altogether drown the sounds wanted. It is said, however, that they are so dimensioned and arranged, that they cannot affect vibrations coming within the compass of the human voice.

ACOUSTIC TUNING IN WIRELESS TELEGRAPHY.

THE CUNTZ METHOD.

Among recent patents for selective wireless communication is one by Mr. John H. Cuntz, of Hoboken, New Jersey, U.S.A., which possesses distinct novelty. In this system, electrical tuning is replaced by mechanical and acoustic syntonisation.

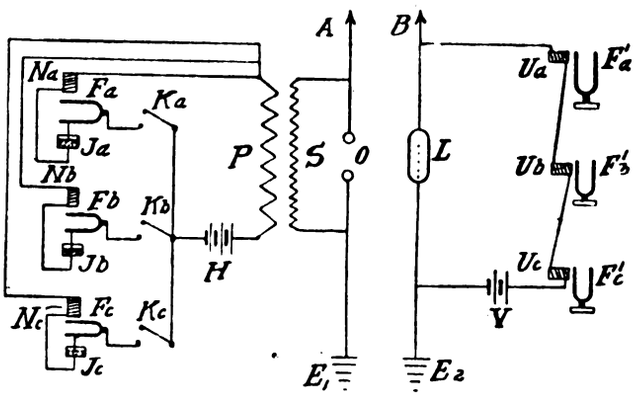
In describing his method, the inventor points out that when the customary transmitting apparatus of a wireless telegraph system is set in operation, electro-magnetic waves, with frequencies of the order of, say, 1,000,000 per second, are propagated. These waves, being started by the oscillatory discharge at a spark gap, decay rapidly, so that the number of waves due to a single original impulse is comparatively small, and the period of activity of these waves is only a small fraction of a second. If these impulses, instead of being given in a haphazard way, are regularly timed at definite intervals, groups of high-frequency electro-magnetic waves will be propagated, and by means of suitable transmitting apparatus, these wave groups may be made to have any convenient periodicity, or frequency, of a lower order than the electro-magnetic wave frequency. For instance, these groups may be given the frequency of audible tones, of the order, say, of 100 or 1,000 per second, each group being composed of a comparatively few electro-magnetic waves of the order of 1,000,000 per second.

Now, if at the receiving station there be placed a suitable acoustic and mechanical receiving apparatus which will respond only to wave groups with frequencies of a definite pitch, such apparatus will select and receive messages from only those transmitting stations which send out wave groups of this same frequency, and will not be affected by any others.

One of the methods that Mr. Cuntz has devised for carrying this out is illustrated in the accompanying diagram, the left-hand side of which shows a transmitting equipment, and the right-hand side a receiving equipment, each containing a number of corresponding selective devices. A and B are antennæ grounded, respectively, at E_1 and E_2. P and S are the primary and secondary of an induction coil, the secondary of which is connected across the spark gap 0. The primary is connected through a source of current H with a number of electro-magnetically actuated tuning forks, F_a, F_b, F_c, each having in series with it a key, electro-magnetic and mercury cup designated for the upper fork by K_a, N_a, and J_a, respectively, and by corresponding letters for the other forks.

Connected across the sensitive receiving device L at the right side of the diagram is a set of electro-magnets, V_a, V_b, and V_c, in series with a source of current V, and actuating a set of tuning forks, F_a', F_b', F_c', corresponding to those of the transmitting apparatus.

In operation each tuning fork, when it is actuated by its electro-magnet, makes and breaks its circuit by mechanical contact with solid contacts or, preferably, by means of a small rod or needle point dipping into a mercury cup. Since the forks in the transmitting apparatus are in separate parallel circuits, each one is in vibration only while signals are actually being sent. The different circuits can be operated either separately or simultaneously, without interfering with each other. When they operate simultaneously, they can send out signals to different receiving stations, or they can send a combined signal, composed of a number of tones, or a chord, or even a combination of sounds which will form articulate speech, to one or more receiving stations.



In the receiving apparatus the current in the local circuit changes every time a wave group strikes the responding device. A tuning fork is placed in proximity to the solenoid or electro-magnet, so that when the magnetic field of the latter is changed at regular intervals corresponding to the natural rate of vibration of the tuning fork, the latter will begin to vibrate and sound its characteristic note. There may be as many tuning forks, of various pitches, at a receiving station as is desired, each being of the same pitch as a corresponding tuning fork at a transmitting station. Each tuning fork is controlled by an electro-magnet or solenoid, and these electro-magnets may be in series with each other, or they may be in parallel. These tuning forks can operate singly or simultaneously. When they operate simultaneously, they can receive signals from different transmitting stations at the same time, or they can receive a combined signal, composed of a number of tones, or a chord, or even a combination of sounds which will form articulate speech, from one or more transmitting stations.

The apparatus and method described are merely typical of the general principles of Mr. Cuntz's invention. Among some of the modifications are the substitution of other means for either mechanically or electrically interrupting the transmitting circuit and of various devices for receiving the Hertzian wave impulses. In all cases, however, there is included in both the transmitting and receiving circuits a set of corresponding tuning forks or equivalent devices for separating out particular wave groups of the wireless impulses. There can also be combined with it means for graphically recording the impulses sent out and received.

BUSINESS EXTENSION.

We are asked to announce that Messrs. J. & H. Grevener have now taken over the business of the Electro-Motor and Dynamo Co., of 15, Gray's Inn-road, London. The new branch of their business is still being conducted under the supervision of the late manager of the Electro-Motor and Dynamo Co.

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GOVERNMENT BUY WIRELESS STATIONS.

POSTMASTER-GENERAL EXPLAINS THE SCHEME.

Arrangements have been definitely completed with the Marconi Co. for the transfer to the Post Office of all their coast stations for communication with ships, including all plant, machinery, buildings, land and leases, etc., and for the surrender of the rights which they enjoy under their agreement with the Post Office of August, 1904, for licences or facilities in respect of coast stations intended for such communication. The Postmaster-General made this announcement in the House of Commons, and explained that, in addition, the Post Office secures the right of using, free of royalty, the existing Marconi patents and any future patents or improvements, for a term of 14 years, for the following purposes: Communication for all purposes between stations in the United Kingdom and ships, and between stations on the mainland of Great Britain and Ireland on the one hand, and outlying islands on the other hand, or between any two outlying islands; and (except for the transmission of public telegrams) between any two stations on the mainland; and on board Post Office cable ships.

Mr. Sydney Buxton added: The inclusive consideration to be paid to the company is £15,000. The arrangement is in no sense an exclusive one. All the stations will, under the International Radio-telegraphic Convention, be open for communication equally to all ships, whatever system of wireless telegraphy they may carry; and the Post Office will be free to use or to experiment with any system of wireless telegraphy at its discretion. All inland communication of messages by wireless telegraphy will be entirely under the control of the Post Office. The company will retain the licence for their long-distance stations at Poldhu and Clifden, which are primarily intended for shore to shore communication with America. Arrangements have also been made with Lloyd's for the transfer to the Post Office of their wireless stations for communication with ships and for the surrender of all claims to licences for such communication. In return, Lloyd's will receive the plant value of their stations, and will have transmitted to them (with due regard to the secrecy of private telegrams) information received at the Post Office stations in regard to the position and movements of ships and other maritime intelligence. Lloyd's and the Marconi Co. have mutually arranged to cancel an agreement between themselves which was made in 1901, and which has proved a source of dispute, and, therefore, an obstacle to the development of wireless telegraphy. I am satisfied that it is to the public interest, both from a commercial and a strategical point of view, that the coast stations used for communication with ships should be in the hands of the Government, and should be worked as part and parcel of the general telegraphic system of the country. I think it important also that no private monopoly in wireless telegraphy should be allowed to grow up. I trust that the new arrangements will result in an even more rapid extension of the use of this important invention than has taken place in the past. I may add that the negotiations and arrangements have been conducted with the knowledge of and in consultation with the Admiralty, who consider it important that the coast wireless stations should be in the hands of the Post Office.

It may be pointed out that the transfer does not include ship-to-ship communication in any way, so that, as there are some 250 ships fitted with the Marconi apparatus, the company still stands to make considerable money from this branch of work, as well as from its operations in foreign parts.

CHICAGO ELECTRICITY DEPARTMENT.

In the Department of Electricity of the City of Chicago there were, according to the latest official returns, 486 officers and employés, and, in addition to this regular force, there were a number of linemen, carpenters, cable splicers, labourers, and teams who work part of their time on electric light circuit, conduit and lamp-post repairs, the balance of their time being employed on construction or fire and police circuit repairs. At the same date, the close of the fiscal year, the city was operating from its municipal stations 9,500 lamps. For 217 of these the city rented the current for ten and two-thirds months, the transformers, regulators, circuits and lamps being owned and operated by the city and the current furnished by the Commonwealth Edison Co. until November 21, when the lamps were connected with the R. A. Waller plant. The city also rented outright 744 arc lamps from the same Company. The average number of lamps owned and operated wholly by the city during the year was 8,602. The average number operated with rented current was 193. The average number rented outright was 678. The average cost of the operation and maintenance of the 8,602 lamps owned and operated by the city was $45·86 per lamp per year, including all cash which this department paid out by voucher or pay-roll during the year 1908 for labour and material of all kinds, superintendence, and office charges; but not including interest, depreciation, lost taxes, water rates, rent of office used by the city electrician in the city hall, rental of poles belonging to other companies and used by the city for wires and lamps, nor a portion of the cost of other branches of the city government, which do more or less work for the electric lighting service, such as the Department of Finance and the Law Department, which charges should properly be included in the cost of the city lights. The actual cost for ten and two-thirds months of each of the 217 arc lamps operated with rented current was $74·75, which would amount to a total of $84·05 per lamp for the year. The contract price of each of the arc lamps rented outright from the Company was $90.00 for the first three months and $75·00 for the last nine months, making an average annual rental of $78·75. Mr. William Carroll is the City Electrician.

TEST OF GAS ENGINES USING PRODUCER GAS.

In reference to our note on development by power gas, appearing on page 406 of our issue for September 24, it may be pointed out that few tests of large gas engines using producer gas have been made, and, therefore, the following figures relating to such a test will prove of value. Messrs. Butterfield & Swire, of Hong Kong, recently equipped a large shipbuilding yard and engineering works at that port, and the motive power used is obtained from gas engines using producer gas. Two engines drive 750 kw direct-current generators, and other two, 375 kw. generators. The larger engines are of the twin tandem type, and the smaller of the single tandem type. All the engines are, therefore, fitted with the same sized cylinders, thus reducing the amount of necessary spare gear, etc. The gas producers are designed to gasify South Chinese bituminous coal and supply gas to various furnaces as well as to the engines. The gas supplied to the engines passes through a rotary meter, and this enabled consumption tests to be made.

These tests were carried out in November and December, 1908, and were entirely satisfactory. One large and one small engine were tested, and as the results were under the guarantees the other two engines were not tested in detail.

The gas had an average heat contents of 140 B.T.U.'s per cubic foot, and the actual consumption of the two engines are given in the following table:—

Load.	Gas per b.h.p. per hour.	B.T.U.'s per b.h.p. per hour.
Larger Engine.		
1,079 b.h.p.	66·7 cubic ft.	9,330
815	72·2 do.	10,100
559	80·3 do.	11,240
Smaller Engine.		
544	64·3 do.	9,000
430	72·1 do.	10,100
289	79·5 do.	11,140

The output of the engines was measured electrically, and the b.h.p. obtained from the guaranteed efficiencies of the generators.

The engines are of the Cockerill type, made by Messrs. Richardsons, Westgarth & Co., Ltd. The generators were made by Messrs. Dick, Kerr & Co., Ltd., and the gas producers by Messrs. The Power-Gas Corporation, Ltd.

The whole plant has now been working nearly 12 months, and has given satisfaction.

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CONTENTS.

	PAGE
Notes	485
Electrical Inventions and the Training of the Electrical Engineer	487
British Standard Specification for Ammeters & Voltmeters	490
Railless Trolley	491
Income-Tax Assessment	491
Cost of Deferred Maintenance	493
The Majorana System of Wireless Telephony	494
Acoustic Tuning in Wireless Telegraphy	495
Government Buy Wireless Stations	496
Test of Gas Engines Using Producer Gas	496
Chicago Electricity Department	496
Assessing Wear and Tear	497
Correspondence	498
Copper Wire Standardisation	499
Peebles Polyphase Induction Motors	501
Hall System of Dual Ignition	501
New Type of "Intermediate" Switch	502
Smoke Troubles at Electric Station	503
Electrical Advance at Buenos Ayres	506
Electrical Communication in the U.S.A.	506
Characteristics of Dry Batteries	507
"G. B." Tramways	510
Diary of Events	510
Home Office Order	510
Technical Problems, with Solutions by Practical Men	511
Tyneside Notes	514
Midland Notes	515
American Notes	515
Companies' Meetings and Reports	516
Companies Registered	517
Contracts Open	517
Some Contracts	517
Tenders Accepted	517
Lighting & General Notes	518
Traction Notes	518
Educational	519
Personal	519
New Catalogues	520
Schäfer Method of Resuscitation	520
Patents	521
The German Electrical Industry	522
Companies' Stock & Share List	523

ASSESSING WEAR AND TEAR.

Instructions of a most important and far-reaching character relating to the assessment, for income-tax purposes, of electric undertakings and tramways have been issued by the Board of Inland Revenue to the Surveyors of Taxes. It is a document which requires very careful consideration, for it opens up many debatable questions. To begin with, as the Secretary of the Machinery Users' Association points out, the instructions disregard the provisions of the Taxing Acts, more particularly as regards allowances for depreciation conceded by the Act of 1878, and the decisions of the Courts thereon. That this may be of considerable moment the experience of the London County Council in their dispute with the Income-tax Commissioners over the question of allowances to be made for the loss involved in the conversion of their tramways from horse to electric traction exemplifies. There is no real guarantee that the deferred allowances as regards renewals can be claimed by the taxpayer. However, granting that in practice such allowances are made, many things may occur to prevent the taxpayer reaping the full benefit. Circumstances may arise either to hasten or to defer renewals, and such renewals may be partial, so that complication of accounts ensues, and then it becomes extremely difficult for the taxpayer to present a claim that would meet with the Surveyors' or the Commissioners' approval. Or large amounts on expenditure which ought to be taken into consideration may be actually overlooked. In any case, a deplorable system of estimating profit and loss is introduced, for the instructions encourage, if they do not practically enforce, the deferring of proper allowances for depreciation of plant and tools. No depreciation allowance is to be made on overhead equipment (trolley wires and connections), on conduits, or on tools, meters and office furniture. In such cases allowances are only to be made for repairs and renewals. This is

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certainly introducing a totally wrong principle in book keeping. Machines and tools, as the Secretary of the Machinery Users' Association justly observes, may last 20 or 30 years before they are cast aside, but they depreciate in value year by year, and it is bad for the undertakings that such depreciation should not be recognised. It tends to produce a false impression when the balance-sheet is prepared; and in this particular instance, gives the Income Tax Commissioners an unfair advantage, for profits are reckoned year by year on a wrong basis, and even supposing that ultimate adjustment is reached, it nevertheless remains true that in intervening years the Commissioners have been receiving more than their due, to the prejudice of the undertaking. This yearly over-payment may make an appreciable difference in the position of an undertaking, all the more dangerous as this very drain may beget carelessness and over-confidence. In these days of rapid progress, the whole problem of allowances for depreciation grows in importance. The same unsatisfactory tendency to postponement, with unfair pressure on the taxpayer, is shown in the suggestion that the estimated allowance for depreciation on the permanent way of tramways and other equipment should be brought up for revision every five years, so that a fresh estimate should be made. Five years is too long, all the more glaringly so because the Commissioners expressly state that no claims for over-payments will be allowed. Now, it is a commonplace among engineers that some improvement may be suddenly introduced which will increase revenue and gross profits, but at the expense of tools and equipment, which either become obsolete or are subjected to abnormal wear and tear as the result of such improvement and greater usage. In such cases the deferred renewal allowances, and the quinquennial revisions would tell against enterprise, for the net profit of these improvements might easily be absorbed by the over-paid income tax. The electrical industry is in a state of transitancy and can ill afford such handicaps. Apart from the direct loss—and, as we have said, the London County Council's experience proves that this may be considerable—the principle is wrong. Altogether we have little to be thankful for in this latest effort of the Inland Revenue Board, which should be looked at with the gravest suspicion.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

APPRENTICESHIP.

Sir,—Will you allow me through your columns to call attention to the valuable work which is being done by the National Institution of Apprenticeship, 39, York Place, Baker-street, in apprenticing boys and girls to trades in which skill is required, and to appeal to the public for contributions to enable the Council to continue to carry on and extend that important national work. Its value cannot be easily over-estimated, especially as it tends to diminish the number of the unemployed, who are nearly all unskilled. The institution is philanthropic and unsectarian, and is under the patronage of Her Royal Highness the Princess Christian and His Grace the Duke of Devonshire, and is administered by a council and several committees.

The Council's report for 1908 shows that the Institution has great experience and exercises a careful discrimination in the selection of trades and in the general management. The effective manner in which the arrangements for apprenticeships are conducted, and the excellent results achieved, were demonstrated at the largely attended meeting recently held at the Mansion House, at which I presided, when about 500 apprentices under the charge of the Institution were present, and 172 of them received prizes and certificates, which were distributed by Lord Avebury.

The Institution has indentured over 630 apprentices to good masters carrying on skilled trades, and those apprenticeships are supervised by the Council.

The number of boys and girls applying to be apprenticed is continually increasing, and now exceeds 60 per week, and at the present time a large number of boys who have served satisfactorily their probation are compelled to wait till the money is forthcoming to pay the premiums. For such purpose it is estimated that a sum of £13,000 will be required during the next 12 months, and the audited accounts show that the funds are now practically exhausted.

I shall be pleased to receive contributions on behalf of this excellent Institution, or they may be sent to the treasurer, the Right Hon. Lord Avebury, at 17, Lombard-street, London, E.C., or to the hon. sec., Mr. J. S. Ballin, 5, Clarence-terrace, Regent's Park, N.W. I am sir,

Yours, etc.,
G. Wyatt Truscott,
Lord Mayor.

Mansion House, Sept. 30, 1909.

LIGHTNING CONDUCTORS.

Sir,—The statement in a note on "Lightning Conductors," in your issue of the 1st inst., to the effect that sharp bends in conductors increase liability to side-flash, has been made so often that many electricians are beginning to think it true, but there is no authority for it.

In his work on "Lightning Conductors" (Whittaker), page 50, Sir Oliver Lodge says: "We have seen that a conductor is more efficient in carrying off a discharge and preventing side-flash, in proportion as its self-induction is lessened. . . . . But no conductor is able to prevent side-flash altogether, unless it is zig-zagged to and fro, so as to have practically no self-induction; in that case the side-spark is nearly stopped." On pages 47, 289 and 339 of the same book he describes, in detail, experiments showing the side-flash reducing effect of zig-zagged conductors.

Apart from financial considerations, there are reasons why it would not be advisable to adopt this as a better method than running a conductor in a more or less direct line. But that a conductor, zig-gagged backwards and forwards, and therefore having about as many abrupt bends and changes of direction as could well be crowded into the space, does decrease liability to side-flash is an indisputable fact. And what is a "neat bend in a copper tape" round a ledge, coping or cornice but a part of the zig-zag? It is true that the layers of tape above and below the ledge are too far removed from one another to have an appreciable anti-self-induction effect, but what little there is should be rather to the good in this respect than otherwise. I know of no theoretical considerations, experimental proofs, or observed effects in conductors struck by lightning that uphold the opposite view.

An engineer connected with the U.S. Navy Department recently carried out experiments with a model of a chimney shaft fitted with conductors having various kinds of abrupt bends in order to see how far such bends tended to increase side-flash, and found no increase. Apparently, he did not carry his experiments a step further and note whether they decreased it, or I think the result would have surprised him still more.

Yours faithfully,
Alfred Hands, F.R.Met.S.

91, Leadenhall Street, London, E.C.,
October 5, 1909.

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QUESTION NO. 1,200.

Sir,—I was much interested by the above question, and have carefully read through the answers contributed; that by "Multum," in your issue of September 24 particularly engaging my attention.

Being somewhat of a practical man myself, however, I am faced with a difficulty in the scheme proposed, and would be happy if "Multum" could help me to overcome it.

You will note that the fast and loose pulleys are to be mounted on the main shaft, and the pump pulley to be double width, with the fork operating on the advancing side of the belt. Assuming the pump to be at rest, I cannot quite see which is the advancing side mentioned.

I note later that "A greater force is then available to push the stationary belt on the moving pulley," and have no doubt this will be fully required.

Yours faithfully,

"PARVO."

October 4, 1909.

COPPER WIRE STANDARDISATION.

The Wire Committee of the American Society for Testing Materials has prepared the following standard specifications for hard-drawn copper wire, including round wire, grooved trolley wire and cable or standard wire. We are able to give the text of the specifications as presented and the explanatory notes of the committee, with the exception of grooved trolley wire specifications:

PROPOSED STANDARD SPECIFICATIONS FOR HARD-DRAWN COPPER WIRE.

1. The material shall be copper of such quality and purity that, when drawn hard, it shall have the properties and characteristics herein required.

2. These specifications cover hard-drawn round wire, grooved trolley wire and hard-drawn cable or strand, as hereinafter described.

3. The wire, in all shapes, must be free from all surface imperfections not consistent with the best commercial practice.

4. (*a*) Package sizes for round wire and for cable shall be agreed upon in the placing of individual orders; standard packages of grooved trolley wire shall be shipments upon reels holding about 2,500 lbs. each.

(*b*) The wire shall be protected against damage in ordinary handling and shipping.

5. For the purpose of calculating weights, cross-sections, etc., the specific gravity of copper shall be taken as 8·90.

6. All testing and inspection shall be made at the place of manufacture. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities to enable him to satisfy himself that the material conforms to the requirements of these specifications.

HARD-DRAWN ROUND WIRE.

7. (*a*) Size shall be expressed as the diameter of the wire in decimal fractions of an inch, using not more than three places of decimals; *i.e.*, in mils.

(*b*) Wire is expected to be accurate in diameter; permissible variations from nominal diameter shall be:

For wire 0·100 in. in diameter and larger, 1% over or under.

For wire less than 0·100 in diameter, 1 mil over or under.

(*c*) Each coil is to be gauged at three places, one near each end, and one approximately at the middle; the coil may be rejected if, two points being within the accepted limits, the third point is off gauge more than 2% in the case of wire 0·064 in. in diameter and larger, or more than 3% in the case of wire less than 0·064 in. in diameter.

8. The wire shall be so drawn that its tensile strength and elongation shall be at least equal to the values stated in the following table. Tensile tests shall be made upon fair samples, and the elongation shall be determined as the permanent increase in length, due to the breaking of the wire in tension, measured between bench marks placed upon the wire originally 10 in. apart. The fracture shall be between the bench marks, and not closer than 1 in. to either mark. If upon testing a sample from any coil of wire, the results are found to be below the values stated in the table, tests upon two additional samples shall be made, and the average of the three tests shall determine acceptance or rejection of the coil.

Diameter, inches	Area, circular mils	Tensile strength, lbs. per sq. in.	Elongation in 10 in. per cent.
0·460	211,600	49,000	2·7
0·365	133,200	53,000	2·4
0·325	105,600	54,500	2·3
0·289	83,520	56,000	2·1
0·258	66,560	57,500	2·0
0·229	52,440	58,500	1·9
0·204	41,620	59,500	1·8
0·182	33,120	60,500	1·7
0·162	26,240	61,500	1·6
0·144	20,740	62,500	1·5
0·128	16,380	63,400	1·4
0·114	12,996	64,200	1·3
0·102	10,404	64,800	1·2
0·091	8,281	65,400	1·1
0·081	6,561	65,700	1·0
0·072	5,184	66,000	0·9
0·064	4,096	66,200	0·9
0·057	3,249	66,400	0·8
0·051	2,601	66,600	0·8
0·045	2,025	66,800	0·7
0·040	1,600	67,000	0·7

For wire whose nominal diameter is between listed sizes, the requirements shall be those of the next larger size included in the table.

9. Electric conductivity shall be determined upon fair samples by resistance measurements at a temperature of 20° C. (68° F.). The wire shall not exceed the following limits:

For diameters 0·460 in. to 0·325 in., 900·77 lb. per mile-ohm at 20° C.

For diameters 0·324 in. to 0·040 in., 910·15 lb. per mile-ohm at 20° C.

HARD-DRAWN COPPER WIRE CABLE OR STRAND.

14. For the purposes of these specifications, standard cable shall be that made up of hard-drawn wire laid concentrically about a hard-drawn wire centre. Cable laid up about a hemp centre or about a soft wire core is to be subject to special specifications to be agreed upon in individual cases.

15. The wire entering into the construction of stranded cable shall, before stranding, meet all the requirements of round wire, hereinbefore stated.

16. The tensile strength of standard cable shall be at least 90% of the total strength required of the wires forming the cable.

17. Brazes, made in accordance with the best commercial practice, will be permitted in wire entering into cable; but no two brazes in wire in the cable may be closer together than 50 ft.

18. The pitch of standard cable shall be not less than 12, nor more than 16, diameters of the cable. The cable shall be laid left-handed or right-handed, as shall be agreed upon in the placing of individual orders.

EXPLANATORY NOTES ON PROPOSED SPECIFICATIONS FOR HARD-DRAWN COPPER WIRE.

5. The specific gravity of copper has been commonly accepted as 8·9, and this value is retained in the proposed specifications. The maximum variation from this figure in a large number of samples of wire has not been sufficient to lead one to anticipate any serious error from its use as a flat value in calculations.

7. (*a*) The use of arbitrary gauge numbers to express dimensions cannot be too strongly condemned. There are many such gauges in existence, and confusion is to be expected unless the particular gauge to be used is specified. Many of the gauges have their dimensions stated in absurd figures, such as 0·090742 in., when it is not especially easy to measure dimensions in the fourth decimal placed by workshop tools. Definite diameters in measureable units are evidently preferable.

8. Many other physical tests than those provided in these specifications are included in existing specifications. The reasons for the omission of some of the more common are given as follows:—

Twist Tests.—The wire is sometimes required to permit

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twisting through a stated number of revolutions before breaking. The results are so easily influenced by temperature, speed of rotation, method of gripping, and other variables not easily defined or controlled, that the test is at least of doubtful value. It is the opinion of the committee that it is impractical to so define the conditions of the test that a twist can be made definite and reliable; hence there is no warrant for its inclusion in specifications.

Wrap Tests.—Wire is sometimes required to permit tight wrapping about a wire of its own diameter, unwrapping and again rewrapping. It is obvious that the making of a test of this kind with wire that is already hard-drawn is exceedingly difficult. Every one who has tried to break off a piece of tough wire by bending it back and forth between the fingers knows how hard it is to confine the bend to one place, because of the hardening action of the previous bends. Hard wire which has been wrapped around a wire of small diameter is hardened still more, and it is almost impossible to straighten the wire, let alone recoil it in the opposite direction. In the opinion of the committee, it is inadvisable to include a test which at best is so indefinite as a wrap test. Furthermore, it is the opinion of the committee that wire which will meet the physical tests included in the proposed specifications will meet any properly made twist or wrap test that would reasonably be required.

Elastic Limit.—During the tension test on wire there is seldom to be observed any definite drop of the beam or increase in the rate of elongation, corresponding to the yield point commonly observed in testing steel. The only way in which the elastic limit of hard wire may be determined is by the actual plotting of the elastic curve from extensometer readings. Even such tests are difficult of interpretation, because the wire when available for tests is usually curved, due to its having been put up in a coil. There are little sets observable before the true elastic limit has been reached, owing to the fact that one side of the wire, having been stretched in coiling, is really a little harder than the other side, and the pull is, therefore, not even. Considering the difficulty of making the test and the uncertainty of the results obtained, it is the opinion of the committee that it would be inadvisable to include an elastic-limit test in the proposed specifications. It is evident that if the designing engineer requires a knowledge of the location of the elastic limit for purposes of calculation in designing, such data can be obtained by special tests on representative sizes of wire, which will fix the relation of the elastic limit to the ultimate strength for all wire which is properly made.

Elongation.—Elongation tests on wire are required in different specifications to be measured in lengths varying from 8 to 60 in. The elongation has variously been measured as the permanent increase in the length of the wire, measured between bench marks placed on the wire before fracture; as the elongation measured between the jaws of the testing machine, which are adjusted to grip the wire with a certain definite free length, and in various other ways. Perhaps the most commonly used length is 10 in., and it is a good length, because measurements may be immediately transposed into percentages without laborious calculation. Measurement of elongation in any other way than as the permanent increase in length between bench marks, in the manner customary in the measurement of steel elongation of specimens, is open to criticism. If measurements are made between the jaws of the testing machine there is included a certain amount of elongation which has taken place within the jaws, because the wire, in stretching, will have been reduced in diameter and, therefore, have stretched to a greater or less extent within the jaws themselves. If the measurement is made between bench marks on the wire just prior to breakage, there is included in the elongation a certain amount of elastic deformation.

9. Electric conductivity is usually expressed as a percentage on the Matthiesen basis, reference being made to determinations of the electrical resistivity of supposedly pure copper by Matthiesen about 1865. Since that time the methods of refining copper have greatly improved, so that to-day it is not uncommon to find copper of over 100% conductivity on the Matthiesen basis. Furthermore, what the electrical engineer requires is that the wire shall not exceed a certain maximum electrical resistance. It seems obvious that it is less laborious to express quantities in direct definite terms rather than by reference to something else which requires interpretation before the results are ready for use in calculation. Resistivity is commonly expressed in a number of different ways, all being equivalent to the resistance of some unit of cross-section, this unit being expressed either in linear dimensions or as a combination of weight and dimensions. For convenience we give a table of equivalents of the values for electrical resistance included in the proposed specifications. The values are equivalent respectively to 97% and 96% conductivity on the Matthiesen basis:—

900·77 lb. per mile-ohm. is equal to:
0·15776 ohms. per meter-gram,
1·7726 microhms per centimeter-cube,
0·69789 microhms per inch-cube,
10·663 ohms. per mil-foot.

910·15 lb. per mile-ohm. is equal to:
0·15941 ohms. per meter-gram,
1·7911 microhms per centimeter-cube,
0·70517 microhms per inch-cube,
10·774 ohms. per mil-foot.

10. It is obvious that the simplest designation of irregular shapes of similar outline is by sectional area, and the most commonly used unit among electrical engineers is the circular mil. Therefore, while the sizes of grooved trolley wire regularly used are generally known by B. & S. gauge number, corresponding to their sectional area, it has been deemed advisable by the committee to list these sizes in specifications, by their sectional area expressed in circular mils. The three sizes which are most extensively used commercially are the only ones listed; a fourth size is but little used, and the use is growing less.

11. The only way in which gauge variations are easily determinable in irregular shapes is by recourse to weights of standard lengths, and this has been the method adopted in the specifications.

14. So many variations in the construction of cable are possible, that it has been deemed inadvisable to complicate the specifications by including requirements for any other than the one type most commonly used.

16. Physical testing of cable is at best a difficult matter, and the measurement of elongation in cable has been subjected to a tensile test is uncertain, since it includes both the elastic deformation of the cable as a spring, the actual elongation of the wires, and perhaps even some elastic deformation of the wires as such. It is, therefore, thought inadvisable to include a requirement covering an elongation test.

17. The permitting of brazes in wire entering into the construction of copper cable was discussed at considerable length, and it is finally the opinion of the committee that, provided no two brazes are closer together than 50 ft., the cable has fully 90% of the theoretical strength obtained by adding together the required strengths of the constituent wires. This is due, in such long lengths, to the frictional gripping of the wires in the cable. The construction of long lengths of cable without brazes is costly, and it has been thought best, therefore, to permit their use, provided they are sufficiently widely spaced as not to be detrimental to the cable's strength.

WIRELESS STATIONS IN AUSTRALIA.

Mail despatches from Australia state that the Postmaster-General, Sir John Quick, recently defined the position of the Commonwealth Government with regard to wireless telegraphy. The Commonwealth, he explained, has by statute complete control of "wireless" in any shape or form, and no person can engage in practical or experimental use of it without a licence from the Federal Government. A recent application for permission to engage in unrestricted experiment was referred to the Defence department. That department consulted the Admiral in charge of the Australian naval station, and he reported that it would be most undesirable to allow any "wireless" station to be erected not under the control of the Commonwealth. This view is assented to by the Commonwealth authorities, and, while there is no objection to grant a licence on any reasonable application, the Government intends to retain absolute control of this means of communication.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

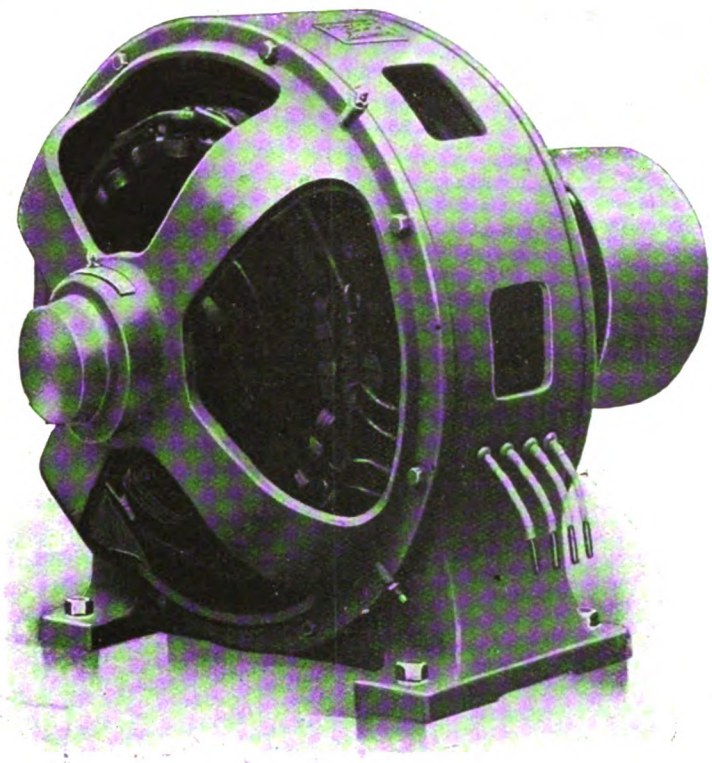
Peebles Polyphase Induction Motors.

As the advantages of alternating current for electric power purposes have become more generally recognised, there as arisen a large and constantly increasing demand for the Peebles Polyphase Induction Motors. Messrs. Bruce Peebles & Co., Ltd., Edinburgh, are now manufacturing these admirable machines in all the usual types to conform to the Home Office and Fire Insurance Rules, and also have a type of motor specially suitable for use in textile mills.

The principle of the induction motor, whether adapted for running on two or three-phase circuits, is nearly identical with that of the alternating current transformer. The motor has the usual two elements, the stationary part or "stator" carrying the primary winding, and the revolving part or "rotor" carrying the secondary winding. The alternating current supplied to the primary winding sets up a rotating magnetic field, which induces currents in the conductors on the rotor. As a consequence, the rotor is caused to rotate at a speed determined by the frequency of the supply circuit, and the number of poles for which the stator is wound; this speed is nearly constant, being subject only to a small amount of slip, varying with the load.

The squirrel-cage type has the advantage of simplicity, while the price is, at the same time, lower than that of the slip-ring motor. Its use is, however, limited by the fact that its starting torque is inferior, so that when it is desirable to start up against considerable loads the slip-ring type is to be preferred. The automatically short-circuited rotor motor has several advantages over other types, chief among which is the fact that it will start up against a fairly heavy torque, while the rush of current at starting is very small; it is started with a star-mesh switch, no auto-transformer starter being necessary. Slip-ring motors will start against full load with current only exceeding the normal by a small percentage.

The machines are of the self-contained form, having the bearings supported in substantial cast-iron brackets bolted to the frame, and so arranged that they can be turned through angles of 90° or 180°, thus enabling the machines to be fixed to the wall or ceiling, if required. The efficiency of the motors is very high, and is, moreover, maintained at a high level over a wide range of loads.



Peebles Standard Protected Type Squirrel-cage Motor.

HALL SYSTEM OF DUAL IGNITION.

We note that the Hall system of dual ignition is being adopted by a number of prominent men in the motoring world. The Electric Ignition Co., Ltd., have the patent rights of Mr. R. F. Hall's system, which gives two distinct and separate sets of permanent ignition, independently of each other, either of them capable of permanent duty as and when required, and both giving the highest possible efficiency. If the coil ignition gives the slightest trouble the coil may be returned to the manufacturers without interfering with the magneto ignition, whereas in other systems, if the coil is returned for overhaul both ignitions are disabled.

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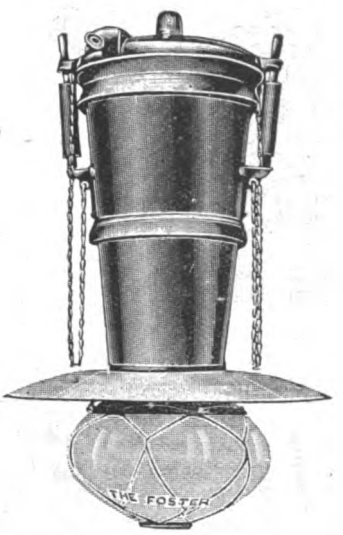
IN OUR ARC LAMPS.



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Loss of Profits following fire, Workmen's Compensation, Fidelity, Guarantee, Burglary, also undertakes the duties of Executor and Trustee.

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The Company has always encouraged the development of Electricity, and the well-known "Phœnix Fire Office" Rules for Electrical Installations are in use throughout the world. Copies will be supplied free on application to the Head Office.

G. H. RYAN, General Manager.

CANADA'S EXPORTS OF ELECTRICITY AND NATURAL GAS.

The annual report of the gas and electricity inspection branch of the Inland Revenue Department at Ottawa, Canada, shows that during the last fiscal year the total amount of electricity exported by the four companies operating under the electricity and fluid exportation act was 359,283,286 kw. hours, as compared with 135,075,680 kw. hours generated for home consumption. The Canadian Niagara Power Co. exported 221,927,240 units, and generated for home consumption 5,405,760 units. The Electrical Development Co. exported 4,680,500 units, and generated for home consumption 85,515,700 units. The Ontario Power Co. exported 131,833,782 units, and the home consumption was 44,150,580 units. The Maine and New Brunswick Power Co. generated for export 841,764 units, and the home consumption was 3,940 units. Only one company was licensed to export natural gas during the year. The Provincial Natural Gas and Fuel Co., of Ontario, exported 387,019,000 cubic feet, and its home consumption was 462,707,000 cubic feet. No renewal of licenses for the exportation of natural gas are now granted.

NEW TYPE OF "INTERMEDIATE" SWITCH.

A new and improved type of "Intermediate" switch is being placed on the market by Messrs. A. P. Lundberg & Sons, London. It is a notable advance on their well-known Pivot Intermediate Switch and should be in big demand for controlling lamps in circuit from any number of positions in corridors, staircases, bedrooms, etc. As shown in the accompanying illustrations, the switch (Fig. 1) is designed with double clip contacts, and mica insulation has been adopted in the rocking contact-arm (Fig. 2).

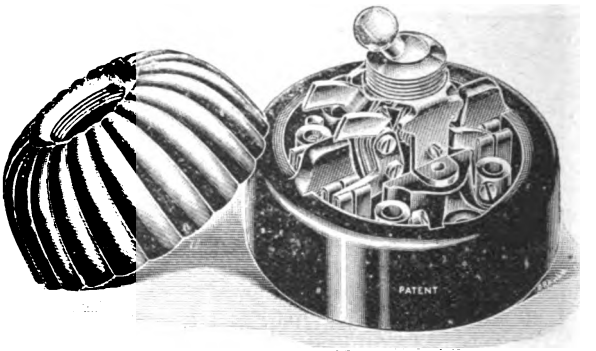

Fig. 1. Intermediate Switch.

The screws holding the various members of the rocking contact-arm together are all provided with porcelain bushes, and the construction is now proof against breakdown which might otherwise be caused by overheating or moisture.

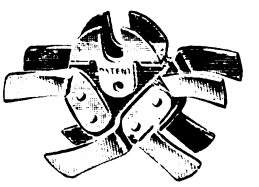

Fig. 2. Rocking Contact-arm.

The provision of double contacts is almost a necessity in this type of switch, as the current is passing through the switch in only one of the four possible ways at a time. When current is passing through the switch, it takes one of the four paths shown in Fig. 3.

The path for the current is, therefore, varied, and, as all switches in circuit are in series with each other, the need of efficient contact everywhere is an essential requirement.

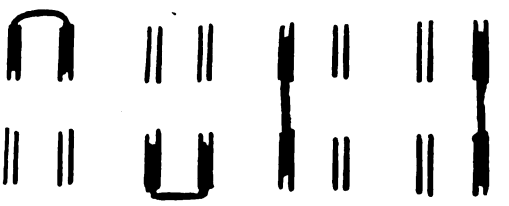

Fig. 3. The Four Paths.

The improved switch movement adopted has allowed an improved method of construction for the rocking contact-arm, and such forms the subject matter of two new patents recently granted to the firm. The switch is made for both surface (2½ in. base) and flush work (1⅞ in. base). It is easily converted, by the omission of one of the U-shaped contact-arms, into a Series-Parallel switch without an "off" position, and by the removal of two of the U-shaped contact-arms, into a Double Pole Switch. The latter type of switch, although not one in favour in this country, is a type that has considerable adoption on the Continent. The "Intermediate" Switch, without any alteration to the rocking contact-arm, also acts as an efficient reversing switch, without an "off" position.

In these three adaptations, the switch would be preferably fitted with porcelain covers, or if of metal, would have fibre linings, to avoid risk of short-circuiting.

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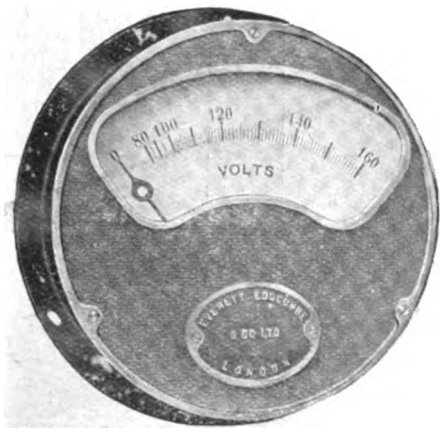
The Student's Guide to Knowledge.—*Chap. IV.*



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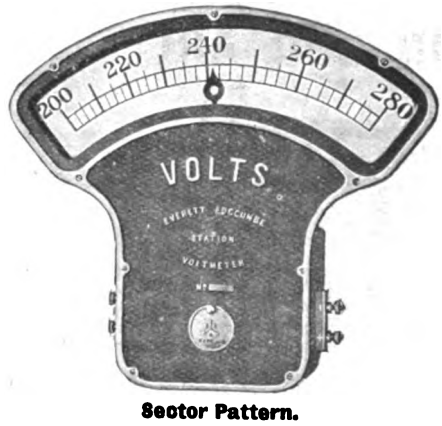
These instruments are of the moving-iron type, and are **spring controlled.** They are **unique** in that the **same scale** is **applicable** both for **A.C.** and **D.C. circuits,** the **accuracy** being **unaffected** by variation in **wave form** or **frequency.** They have a **large working force,** are **dead-beat** and are **magnetically screened.** They are made in the **Round, Sector** and **Edgewise** patterns of various sizes.

Full Particulars in Catalogue Sheet 9.



Sector Pattern.
7 in., 9 in., 12 in., 15 in. and 18 in. Scales.
Plain and Illuminated.

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SMOKE TROUBLES AT ELECTRIC STATION.

At a Local Government Board inquiry at Torquay, the Inspector (Mr. A. A. G. Malet) mentioned that the Board had received a petition from certain owners and occupiers of property, complaining of the nuisance arising from the smoke and vibration at the electric lighting station.

The Town Clerk said the Town Council, to whom the matter was reported, referred it to the Electric Light Committee. So far as the smoke was concerned, the Committee had endeavoured to place their contracts for coal with firms supplying smokeless coal or smokeless so far as it was obtainable, whilst the stokers had strict injunctions to do their best, in firing up, to prevent any possible extra emission of smoke. The Committee had also provided £150 for the installation of a smoke preventive apparatus. The particular installation was not yet decided. As to the vibration, the Council and their officers were quite unaware of the cause of this complaint.

Mr. E. T. Blackler, Chairman of the Electric Light Committee, remarked that all admitted the present was not an ideal site for the electricity station, but they hoped in four of five years to ask the Local Government Board for permission to remove it. They were now making a profit of £2,000 a year, and in four or five years they would be in a position to pay out of the revenue profit the cost of superseded plant.

The Town Clerk hoped that when the Corporation again came before the Local Government Board, at a reasonable time, and asked for permission for the removal of the electricity station, their appliaction would receive favourable consideration.

The Inspector replied that he did not see why it should not, especially as the financial position was more satisfactory.

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NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

GREAT WESTERN RAILWAY.

The Directors of this Company are prepared to receive TENDERS for the supply of the undermentioned Stores :—

No 1 Group.

For one year's supply from 1st December, 1909, to 30th November, 1910.

1.—Bricks.
2.—Lime, Plaster of Paris and Cement.
3.—Stone, Artificial Stone Paving, Slates and Drain Pipes.
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13.—Brooms and Brushes.
14.—Incandescent Gas Fittings.
15.—Rope and Cordage.
16.—Leather.
17.—India Rubber Goods.
19.—Telegraph Apparatus (Insulators, etc.)
20.—Electrical Wires and Cables.
21.—Telegraph Ironwork and Tools.
22.—Telegraph Drysalteries.
23.—Electric Light Carbons.
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26.—Tin Plates.
27.—Tin Ware and Lamp Work.
28.—Wire—Iron and Steel.
29.—Rivets, Bolts and Nuts.
30.—Fish Plates, Bolts and Nuts for Permanent Way.
31.—Nails, Screws, etc.
32.—Eaves Gutter, Stack Pipes and Fittings.
33.—Galvanized Goods.
34.—Sundries.
35.—Canvas, Felt, Sacking, Cloth, etc.

Samples and Patterns may be seen at the General Stores, Swindon, from Monday, the 11th October, to Saturday, the 16th October, at the following hours, on application at the Office of the Stores Superintendent, Swindon :—

Monday to Friday .. 10 a.m. to 5 p.m.
Saturday .. .. 10 a.m. to 12 noon.

Specifications, with Forms of Tender (upon which alone Tenders can be received), may be obtained at the Office of the Stores Superintendent at Swindon.

Tenders addressed to the undersigned, and marked outside "Tenders for Stores," will be received on or before Monday, the 18th October.

The Directors do not bind themselves to accept the lowest or any Tender.

G. K. MILLS, Secretary.

Paddington Station, London,
1st October, 1909.

CITY OF MANCHESTER.

The BATHS AND WASHHOUSES COMMITTEE INVITE TENDERS for the WIRING and Complete INSTALLATION of ELECTRIC LIGHTING at the Cheetham Baths and Public Hall. Drawing and specification may be obtained, on and after Wednesday the 6th instant, at the office of the City Architect, Town Hall, upon payment of one guinea, which sum will be returned on receipt of a *bona-fide* tender. All cheques or postal orders are to be made payable to the order of "The Corporation of Manchester." Sealed tenders, enclosed in the official envelope, to be delivered at the above office not later than 9 a.m. Tuesday, 12th October.

The Corporation do not bind themselves to accept the lowest or any tender.

WM. HENRY TALBOT, Town Clerk.

Town Hall, Manchester, 1st October, 1909.

TECHNICAL CLASSES.

THE SIR JOHN CASS TECHNICAL INSTITUTE,

JEWRY STREET, ALDGATE, E.C.

PRINCIPAL—CHARLES A. KEANE, D.Sc., Ph.D., F.I.C.

The following courses of EVENING LECTURES and PRACTICAL WORK on FUEL
will be given during the Session 1909-10.

LIQUID, SOLID & GASEOUS FUEL,
by J. S. S. BRAME, Lecturer on Chemistry at the Royal Naval College, Greenwich.
A course of Lectures, Monday evenings, 8 9 p.m., commencing MONDAY, OCTOBER 18TH.

FUEL ANALYSIS,
by C. P. BANNISTER, Assoc. R.S.M., M.I.M.M.
A course of Laboratory Work. Summer Term, Mondays 7–10 p.m., commencing MONDAY, APRIL 18TH, 1910.

TECHNICAL GAS ANALYSIS.
by CHARLES A. KEANE, D.Sc., Ph.D., F.I.C.
A course of Laboratory Work. Summer Term, WEDNESDAY, 7-10 p.m., commencing WEDNESDAY, APRIL 20TH, 1910.

The courses of instruction are arranged to meet the requirements of those engaged in Chemical and Engineering Works, or who are concerned with the use of Fuel as a motive power.
Detailed Syllabus of the Courses may be had upon application.

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NORTHAMPTON POLYTECHNIC INSTITUTE, CLERKENWELL, LONDON, E.C.

MECHANICAL AND ELECTRICAL ENGINEERING AND ELECTRO-CHEMISTRY.

FULL DAY COURSES in the Theory and Practice of the above Subjects will commence on MONDAY, 4th October, 1909. ENTRANCE EXAMINATION on WEDNESDAY and THURSDAY, 29th and 30th September. These Courses include periods spent in Commercial Workshops, and extend over four years. They also prepare for the degree of B.Ss. in Engineering at the University of London. Fees £15, or £11 per annum.
Three Entrance Scholarships of the value of £52 each will be offered for competition at the Entrance Examination in September next.

TECHNICAL OPTICS.

FULL and PART TIME DAY COURSES in all branches of this important department of Applied Science given in specially equipped laboratories and lecture rooms.

EVENING TECHNICAL COURSES

in all branches of Electrical and Mechanical Engineering will commence on MONDAY, September 27th, 1909.

The Laboratories are well equipped for both alternate (single and polyphase) and continuous current work, and for all kinds of electrical testing.

Full particulars as to fees, dates, &c., and all information respecting the work of the Institute, can be obtained at the Institute or on application to

R. MULLINEUX WALMSLEY, D.Sc.,
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UNIVERSITY OF DURHAM.

ARMSTRONG COLLEGE, NEWCASTLE-ON-TYNE.

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SESSION OF 1909/10 (COMMENCING SEPTEMBER 27th, 1909).

DEPARTMENTS of MECHANICAL, MARINE CIVIL, and ELECTRICAL ENGINEERING, NAVAL ARCHITECTURE, MINING, METALLURGY AGRICULTURE, and of PURE SCIENCE and LETTERS.
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Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions 2s. 6d.

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SALESMAN or Traveller.—Advertiser, experienced in Electrical, Mechanical, Power-house and Sub-Station work, desires post in any capacity.—Box C, c/o THE ELECTRICAL ENGINEER, 149 Fleet-street, E.C.

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FITTER.—(Englishman), age 27; experienced in repair and construction of Dynamo and Motor parts, Power-board work, Resistances, Electric Light fittings, and Railway work. Can speak Spanish and French fluently.—Box E, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

POWER Station Assistant, or Electrician on private estate; experienced in Water Turbine Installation, Gas, Oil and Petrol Engines, and test-room in instrument-makers' factory.—Box F, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

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ELECTRICAL ADVANCE AT BUENOS AYRES.

Some interesting figures relating to the development of electric tramways and lighting in the City of Buenos Ayres appear in the "Statistical Year-Book for 1908," issued by Mr. Alberto B. Martinez, Director-General de la Estadistica Municipal. The returns show that the electric tramways had 738,924 kilometers of line as compared with only 18,233 used for horse traction; and carried 254,780,627 passengers, as against 293,269. In national currency the gross receipts of the electric tramways amounted to $25,445,765.43, the takings in respect of horse traction being $22,500.00. Dealing with motor vehicles, there were 3,698 collisions and 1,308 casualties, and the figures as regards coupled cars were 748 and 520 respectively. Various systems of public and private lighting were in use in the city. Public lighting by gas cost $1,207,316.77, by kerosene $169,164.36, by alcohol $124,652.46, and electricity (for Municipal new slaughter-houses, Palermo, Flores, and Belgrano) $224,744.56 (828,671 kws.). Private lighting by gas in the city cost $7,991,691.46. The mains laid by gas, telephone and electric light companies totalled 421.648·11 metres, and by tramway companies 7,188.20 metres. Electric meters to the number of 5,288 were installed, the rents collected amounting to $38.735, as compared with $61,223 for 10,159 gas meters. The German Transatlantic Electric Co., had 52 lamps of 720 watts at $24.50, 383 of 480 watts at $19.10, and 441 of 450 watts at $24.75 per lamp per month respectively. The various tramways had 16 c.p. lamps as follows: Buenos Ayres and Belgrano, 635; La Capital, 255; Anglo-Argentine, 105; Buenos Ayres Electric, 475; Grand National, 265; and Belgie-Argentine, 125. For the lighting of the port and Riachuelo, the light was used for 3,949 hours, the average number of lamps in use every night being 482. The running expenses of the installation amounted to $59,214.86 for 886,594,400 kw. hours, the cost including a sum of $6,019.20 for the staff of inspectors. The returns furnished by the German Transatlantic Electric Co. show that during the year the total electric power consumed in kilowatts amounted as follows: Light, 25,966,133; power, 10,707,670; public lighting, 2,073,444. For traction purposes, the various companies used 45,833,257 kws. Up to the end of the year there were in use in the municipality 95 gas engines developing 475 h.p. and 6,329 electric motors developing 35,931 h.p.

ELECTRICAL COMMUNICATION IN THE U.S.A.

Telephony, young as it is, has completely outstripped telegraphy in the U.S.A. The latest United States Census Bulletin records that of 15,000,000 miles of single wire, 13,000,000 miles are used for telephonic communication. Over the wires in 1907 were sent 368,470,509 messages, of which less than 6,000,000 were telegrams. In 1880 the telephone companies had only about one-ninth the mileage of the telegraph companies.

In the amount of business done the sum paid in salaries and wages, and the capital invested in 1907, the telephone business was a little over three-and-one-half times as extensive as the telegraph industry, and during this year it furnished employment for more than five times as many persons.

Between 1902 and 1907 there was an addition of 8,098,918 miles of wire for the use of the telephone systems, as compared with an increase of 259,611 in the mileage of owned and leased wire for commercial telegraph purposes. The steam railways still use the telegraph, as they allege that there is a greater liability to mistake if the telephone is used, but the electric railways are using the telephone to a larger extent yearly. This latest bulletin is the first to give statistics for the commercial wireless systems already established. These were operated at a loss of about £9,500 in 1907. There were six commercial wireless telegraph systems in 1907, operating 122 tower stations at most of the large ports of the Atlantic and Pacific, the Gulf of Mexico, the Great Lakes, and in Hawaii. They transmitted 163,617 wireless messages.

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CHARACTERISTICS OF DRY BATTERIES.*

By F. H. LOVERIDGE.

It is not the purpose of this paper to go into a technical description of dry cells, but to give some of their characteristics, to indicate what classes of service they are best adapted to meet and to point out some of the precautions that should be taken to insure the best results in practical working. So far as the user is concerned a dry cell might be termed an "original package," sealed up tight, and must be accepted for better or worse, as received from the manufacturer. The user of dry cells cannot hope to improve or replenish them, though schemes of this nature are continually being proposed. None of them, so far as I am aware, ever proved to be of practical utility.

A dry cell is only so in name, for there is a considerable amount of moisture absorbed in the various ingredients—the moisture, however, is supposed to be all absorbed and not to be found as a liquid in any part of the cell.

The zinc containing cup used almost universally serves the double purpose of an electrode and an air tight receptacle in which are packed the necessary carbon and manganese dioxide moistened with the particular solution which each manufacturer prefers to employ.

A dry cell is classed as an "open circuit" source of electrical energy, and though this statement seems contradictory, still it is justified from the fact that the open circuit condition is the one expected during the greater part of its serviceable life.

The electrical energy of the cell is, generally speaking, a certain quantity, and so long as it remains on open circuit none of the energy is drawn out. When the circuit is closed, however, energy is given off and the sum total is diminished correspondingly. It should be explained that a "certain quantity" of energy in the cell is intended to imply definite service conditions; as these conditions vary the available energy will vary and between wide limits.

In making a dry cell the aim is so to construct it that there is a balance between the various chemical elements, and so long as this balance is maintained, the cell is inert. When this balance is disturbed, either because of a closure of the circuit through an external path, or interaction between the contained chemicals, a change will take place which cuts down the available output. This interaction takes place when cells are "on shelf," which means the period during which they are stored preceding placing in service. In the course of time it will be noted that both the electromotive force and the internal resistance have changed in such a way that less energy is available.

It seems impossible to avoid this deterioration altogether for the reason that a large number of ingredients are used, and in practice it is impossible to have them chemically pure; some of the ingredients contain more impurities than others, as for instance—manganese dioxide, a natural ore, which is a commercial article with 85% MnO_2—the remaining 15% is made of various impurities more or less objectionable. The presence of impurities explains almost entirely why dry cells are never without some degree of internal action producing harmful effects no matter how insignificant.

For a time when cells are new these harmful effects seem to be of no particular importance, but as time goes on, their effect becomes more apparent, and finally, after a considerable period, cells when tested for available energy are found to have practically none. Some cells will deteriorate more rapidly than others, and it is one of the problems of the manufacturer to reduce "shelf" action to the lowest practical minimum. Efforts along this line have met with varying degrees of success. Various expedients have been tried, the most obvious of which is to make the cells absolutely dry and supply moisture when they are put into service. This plan, however, has its serious drawbacks.

The question of providing a condition under which the maximum energy may be drawn from a cell is one which is not of practical interest, but the question does come up as to the number of watt-hours available under various service conditions. If the rate of discharge is too high then the cell will not have time to recuperate properly or depolarise when the open circuit interval occurs. On the other hand, if the rate of discharge is too low, there is a tendency for the cell to use itself up internally and thus restrict the amount available. In tests which we have made, and from which this result is simply an inference, it seems that if the energy is drawn out under ordinary working conditions at such a rate that the cell is exhausted in a period of about a month, the maximum energy is obtained, but if the work is such that the time during which the cell is in service is extended over a year the percentage of the maximum amount of energy available is considerably reduced. This fact is to be accounted for on the basis of the longer period during which internal chemical action producing no current is going on. It is not to be understood from this that a cell may not be depended upon for long periods of service. It simply means that a reduced watt-hour output (which in itself may be more than sufficient for requirements), is to be expected.

In making the above statement it has been assumed that average temperature conditions prevail. It is a well known fact that there is an increase of chemical action at high temperatures and a decrease at low temperatures. Since the chemical action in a cell may be considered of two kinds, that is, first useful action producing flow of current in the external circuit and second harmful action, which cuts down the efficiency of the cell, it will be seen that the climatic condition under which the cell is stored or worked is very important. On "shelf" a cell will deteriorate slowly at low temperature and this deterioration will increase as the temperature is increased. Cells stored in a dry atmosphere where the temperature is kept below the freezing point of water will probably show no appreciable deterioration, whereas at 100° F. or above, the effect of harmful action will be noted in a comparatively short period, hence the desirability of storing cells in cool places. Where cells are on light service, requiring only a small energy drain, it follows that the ratio of useless chemical action producing flow of current, will be low at low temperatures and high at high temperatures. Where the rate of energy drain is high, then the temperature is not of so much importance, because the time during which harmful action can take place is greatly reduced. It would be difficult to state this as a formula, but the general law is quite definite.

The internal resistance of cells does not seem to be materially affected by wide temperature variations. In one instance I have noticed an increase of less than ·1 of an ohm while the temperature changed from 100° F. above zero to 25° F. below zero. This change of ·1 of an ohm would cause a very large variation in the instantaneous ammeter, but the ordinary 2½ in. by 6 in. size is used almost exclusively in circuits requiring less than one ampere. Where the current is only ·1 of an ampere or less, it will be seen that the increased resistance would absorb less than ·01 of a volt. This would, of course, be insignificant in comparison to the total electromotive force.

There is a characteristic difference between "wet" and "dry" cells, in that the internal resistance enters as a very different factor in the two cases. The internal resistance of wet cells in general is fairly constant, while that of dry cells is a constantly varying quantity. When a dry cell is new, its internal resistance may be approximately ·05 of an ohm, and it increases from this up into the hundreds of ohms. The magnitude of the internal resistance of the dry cell determines the age it has reached in its period of useful life.

The accompanying two sets of curves bring out very strongly this factor of internal resistance. The test conditions were the closure of the circuit at certain intervals through an external resistance for a period of time which remained constant throughout the test. In the first set there is a high rate of energy discharge and in the second a low rate. The ordinates of these curves are expressed in volts and the abscissas in time. The three curves in each set marked *A*, *B* and *C* represent respectively the electromotive force on open circuit, the potential difference at the time of closure of the circuit through an external resistance and the potential difference at the end of a period, which is constant throughout the test.

It will be seen from these curves that at the start, the potential difference at the beginning of closed circuit and the potential difference at the end of the period are practically identical. The electromotive force curve is somewhat

* Paper read at the Convention of Railway Telegraph Superintendents, United States, America.

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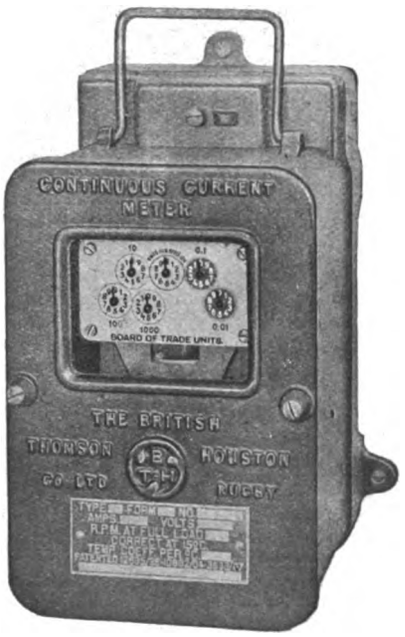
B. T. H.
MERCURY AMPERE HOUR METERS



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The British Thomson-Houston Co., Ltd.,

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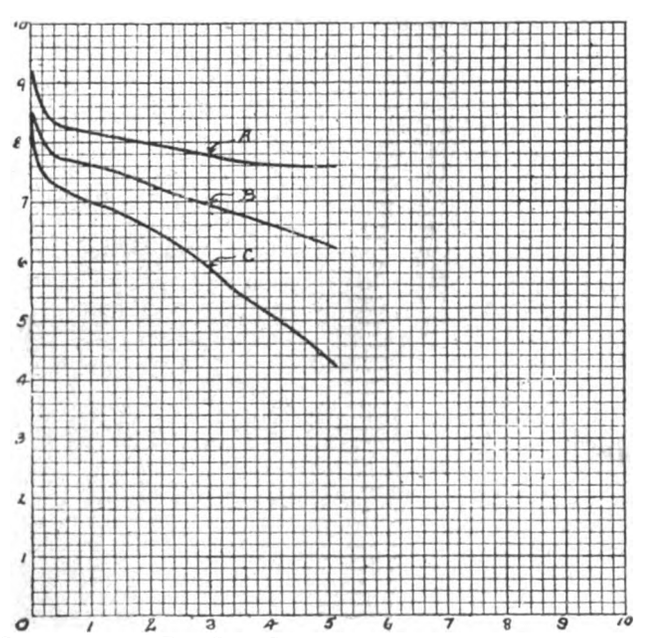
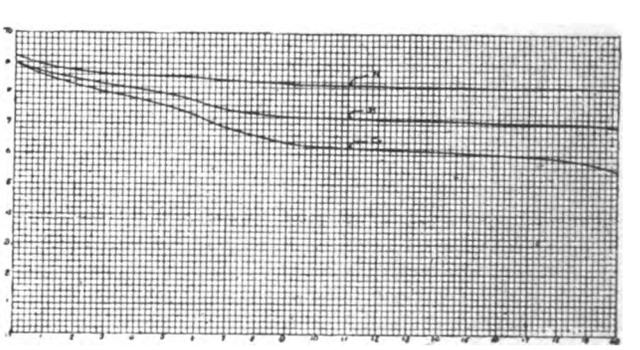
higher. As the cell is used, it will be noted that these curves diverge, and if carried far enough, the lowest curve would finally touch the line indicating zero potential. The high electromotive force on open circuit is of no particular value, because it indicates a condition where no work can be done. The instantaneous drop, when the circuit is closed shows the magnitude of the internal resistance when the current starts to flow.



CURVE SHOWING DRY CELL CHARACTERISTICS AT HIGH DISCHARGE RATE.

The difference between the potential at the beginning of the period of closed circuit and the potential at the end indicates to what extent the internal resistance increases, or the "practical polarisation." These curves give a very correct idea of the characteristics of the dry cell, and from them may be deduced most of the data which should lead to the proper use under service conditions.

As will be seen from the chart, the available energy from a cell decreases from the start. If the drain continues long enough the zero point will ultimately be reached. There is no reason why cells should not be left in circuit as long as they contribute an electromotive force to the current flowing, but if the potential of individual cells is allowed to drop to a very considerable extent, it will be necessary correspondingly to increase the total number in series so that the required potential for working conditions may be maintained.



CURVE SHOWING DRY CELL CHARACTERISTICS AT LOW DISCHARGE RATE.

The determination of the point at which cells should be taken out is something that must depend on the particular service condition. If in telegraph work there is a permissible variation in the current from 90 down to 60 milliamperes the average potential per cell could drop from 1·5 volts to 1 volt. When this point is reached the entire set must be replaced unless additions are made to the series. This expedient is often adopted and works out as follows: If there are 10 cells at the start, giving a potential of 15 volts (90 milliamperes), then when the potential is only 10 volts (60 milliamperes), the addition of one cell allows the average to come down to ·91 volts per cell. Similarly, the

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average for 12 cells would be ·833 volts, for 13 cells ·769 volts, etc. Thus, cells can be run down to lower averages and more of the total energy utilised. If, however, this plan is carried too far and cells are left in circuit until they reach the zero point they become resistances which simply increase the circuit resistance as though additional lengths of wire were inserted, additional work being thrown on the remaining cells. I believe the best practice is to set some potential difference at which the cells are to be taken out of circuit, thus preventing the number in series from becoming excessive.

I wish to call attention to the fact that if a sufficient number of cells to do the work are placed in a circuit, a large number is objectionable for the reason that too heavy a flow of current is produced. For instance, if 90 milliamperes be sufficient to operate the apparatus, then the addition of enough cells to bring the current up to 150 milliamperes would be decidedly objectionable since the flow of current in the circuit tends only to draw energy from the cells at an excessive rate. Where dry cells are used in circuits of widely varying resistance, this fact points to the desirability of determining the necessary electromotive force for each circuit and connecting the proper number of cells in series to give the required flow of current.

If the circuit resistance is known a voltmeter across the terminal of the battery will show whether or not there is sufficient electromotive force to produce the desired flow of current, or if the resistance is not known, a milliammeter will serve the purpose equally well.

I have understood that in general, for telegraph and block signal work, a current of 60 to 90 milliamperes is required. If the proper number of cells are put in circuit to produce 90 milliamperes at the start, the cells may be run down to a piont where their internal resistance will be such that only 60 milliamperes will flow. It has been found by experience that where dry cells are installed as a unit, that is, a certain number in series which are all put in and taken out together, it is highly desirable to have cells uniform in quality and condition. One defective or run down cell among fresh ones will drag the others down so that the set is unfit for service before the fresh cells have given out their normal amount. The greater the degree of uniformity, the more satisfactory will be results.

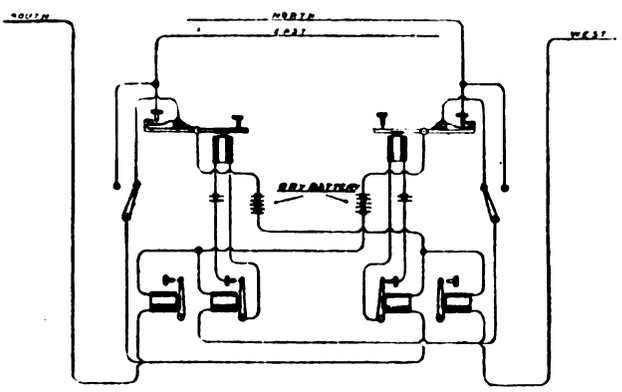
The use of dry cells in multiple is sometimes of advantage where the current drains are heavy and frequent. It may be that two sets of cells in multiple will work more than twice as long as either set by itself. A similar arrangement to meet similar conditions is to connect sets so that by means of a switch, one set is in circuit at a time, thus giving the other set or sets time to recuperate. The adoption of plans like the above must be determined by conditions.

I have mentioned the fact that after a time at average temperatures, the deterioration of cells comes to be an objectionable factor. It follows from this that cells should be put into service as fresh as possible. If renewals are to be required after a certain period, it is best to get fresh cells from the maker, rather than to order a large stock and keep them on hand for use when needed. Cells may become very old, if kept in stock following this plan, and they will not be found as satisfactory as the fresh ones. It is, of course, recognised that a number of cells must be kept in stock, but the number should be made as small as possible and they should be kept in as cool a place as is available.

Cells either in storage or service should also be protected from moisture, for the reason that short circuits may occur from the cartons, or paper boxes becoming saturated and forming conducting paths between the external surfaces of adjacent cells. They should also be protected from dust and dirt, because conducting particles may form accidental short circuits. If an accidental cross occurs between leading wires, it is apparent that there will be a very heavy energy drain, sufficient perhaps to cause the wires to become red hot. A heavy drain of this kind is so much loss to the total available energy, just as much as a leak in a tank would diminish the quantity of the contained liquid. Other drains on the energy supply may be made by connecting up buzzers, bells, lamps or signals, which, of course, will tend to decrease the energy available for the circuit in which it is desired to utilise the maximum amount.

Dry cells are liable to damage from rough handling. The wax used for sealing if cracked or broken tends to hasten the drying out of the interior. The resistance between the zinc cup and its lining may be so increased as to become a serious defect if the cell is subjected to pounding and there is also increased harmful chemical action.

My experiences with battery gauges is that they are not very reliable, and that their usefulness is confined practically to detecting cells which have reached such a condition that they should no longer be left in service. In the first place, their accuracy is no greater than should be expected where the price they bring is taken into consideration. Then, again, the method of making contact with cell terminals causes the readings to be exceedingly variable. By varying the contact in applying battery gauges, very wide variations in the readings may be made which of itself would be enough to make the instrument of questionable value. The position of the instrument and vibration are also factors which enter to determine the magnitude of the readings.



CURRENT DIAGRAM SHOWING ARRANGEMENT OF DRY CELLS WITH TELEGRAPH REPEATER FOR MAXIMUM EFFICIENCY.

There is this to be said in favour of battery gauges, and that is that where a certain gauge is used by an individual exclusively, he soon gets to understand the readings and can interpret them so as to obtain the best estimate of the condition of the cell which it is possible to obtain from the reading of the instrument.

When it comes to a question of determining the relative merits of new cells the gauge is of practically no value, unless there are "defectives" which it is desired to find. The battery gauge test, however, is much to be preferred to the method sometimes used of short circuiting cells through a wire on which an ordinary compass is placed and judging their condition by the magnitude of the deflection. A test of this nature is not only a heavy drain on the cell, but the ratio between current flowing and deflection is not constant.

The best way to test cells in service is to allow the current to flow through its circuit under standard conditions and then to apply a high resistance voltmeter of good construction, noting the potential differences at the terminal of individual cells. By this method each cell will show what it is doing under regular working conditions.

For testing new cells a high resistance voltmeter is desirable to see if the electromotive force is up to normal and the instantaneous current flowing through a low resistance ammeter will give a good indication of the internal resistance. However, it does not always follow that the cell which will give the best service has the lowest internal resistance.

The question is often asked as to the quality of new cells of various makes or of various lots of the same make as determined by instrument readings. It is impossible to answer intelligently with only the limited data to go by. The only satisfactory determination is to give cells closely observed service test and from results form conclusions. Cells must have time to show their staying qualities and these cannot be demonstrated in a moment. It is impossible to make cells that will give remarkably good initial readings, but which have no staying qualities, and the reverse is also true. The best plan for the user of dry cells is to determine by service tests the make adapted to his requirements which he knows he can best depend on as being reliable in quality and in uniformity of grade.

Mr. Fry has made a valuable investigation of actual conditions found in railway telegraph and block signal work.

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His data shows that the average time of circuit closure is less than five minutes per day. This is reckoned on a basis of 10 minutes total of telegraphing per day which would mean that there would not be more than 150 communications. As the open and closed fractions are respectively 5-9 and 4-9, the total closed period will not be over 5 minutes. The requirements as to flow of current are from 60 to 90 milliamperes, or say an average of 75. On this basis the watt-hours per cell per day would be expressed by

$$\cdot075 \times 5/60 \times 1{\cdot}25 = \cdot0078$$

or for 1 year

$$\cdot0078 \times 365 = 2{\cdot}847$$

on the assumption that the average voltage per cell is 1·25. Such an energy drain is very light and represents only a small portion of what would be obtained under ordinarily favourable conditions.

In the operation of telephones, the conditions are more severe—it is of course necessary for current to flow during the entire time of speaking into the transmitter, and though the transmitter resistance is constantly varying, it cannot be said to approach open circuit as in telegraph transmission. With high resistance transmitters a minimum of 140 milliamperes is required, and it may go as high as 320. With transmitters adapted for some railway work which have a lower resistance, a current not less than 300 nor more than 600 milliamperes would be used; we may say roughly that 500 would be about the average working strength. I have no data as to the length of time per day during which a telephone would be used, but the magnitude of current flow and its continuity indicate the severe condition of battery drain.

With the majority of telephone equipments for train dispatching now being recommended a key is associated with the transmitter and so arranged that when the user wishes to talk to the distant party, or in other words when the transmitter is in use, the key is depressed, thus closing the battery circuit. During the period when the distant party is talking the button is released, thus opening the local transmitter circuit and saving the cells from a current drain during the time it is not required. A device of this kind is also of benefit from a transmission standpoint, for the reason that if the cells are given intermittent service during conversation they will have a chance to recover during the intervals of open circuit, and will maintain a more nearly constant voltage on the transmitter.

I am indebted to Mr. Fry for a circuit diagram showing a very ingenious arrangement of dry cells used with a telegraph repeater. The arrangement is such that the current requirement of the dry cell is reduced to a minimum and the current energy is used to the best advantage. From the diagram it will be seen that only the set of dry cells on the receiving side is in service and that here the current flows only during the "space" or "open" period of the sending line. As the sending and receiving functions are alternated it will readily be understood from the diagram how the two sets of cells are alternately brought into action, thus carrying the reduction of closed circuit periods to its limit.

The numerous advantages of the dry cell for open circuit work are now being appreciated. The wet cell formerly used in telephone service has disappeared and with its exit has gone a source of annoyance and expense. The possibility of having a certain quantity of electrical energy in a form requiring no attention for maintenance, giving out its energy as demanded and so cheap that it may be thrown away when no longer useful is almost ideal. As time goes on the field of application will constantly widen until all requirements for a small amount of electrical energy used intermittently over a long period will be taken care of by the dry cell.

"G.B." TRAMWAYS.

LINCOLN'S EXPERIENCE OF THE SYSTEM.

In his paper on "The 'G.B.' Tramway System and its Results in Lincoln," read before the Eastern Counties' District Meeting of the Association of Municipal and County Engineers, Mr. S. Clegg, M.I.E.E., City Electrical and Tramway Engineer, Lincoln, recapitulated his former lecture delivered before the Institute, but bringing certain details up-to-date. He showed that the Lincoln tramways compare favourably in their maintenance cost with those on the overhead system. The working costs for the year 1908-9 were: Traffic expenses per car-mile, 2·10d.; repairs and maintenance, 1·12d.; management and general expenses, 1·00d.; power expenses, 1·38d., a total of 5·60d. per car-mile, which compared with totals of 6·10d. for 1907-8 and 6·69d. for 1906-7. Now, the average total working costs of 75 other municipalities, taking 1908 figures, was 6·37d. per car mile run, showing an advantage for Lincoln of 0·77d., which, considering the fact that only 156,190 car miles were run—the fewest of any municipal system—proves to the writer that better results might be looked for with a larger system.

In the discussion that ensued, Mr. W. Weaver, Borough Engineer, Kensington, wanted to know what was the effect of leaves and snow falling on the studs; while the President (Mr. W. Nisbet Blair, Borough Engineer, St. Pancras), pointed out that underground systems of electric traction often involved considerable and costly alterations to the pipes already in the roadway. He would like to know if there had been any accidents from live studs in the streets. The safety of the system depended upon the spring at the bottom of the stud, and whether by process of rusting or frictional resistance there was a live stud. He thought that was the weak point of the system.

In his reply, Mr. Clegg said they had no trees on the tramway route, but they had experienced all sorts of obstacles; they had tried wet and muddy paper, and had never found anything which would prevent the magnet finding the stud head. There was, however, one serious obstacle, and that was ice on the studs, and a heavy fall of snow was a difficult matter for all systems. The "G.B." system could claim to be as economical in operating expenses as the overhead. The spring which the President regarded as the weak point of the system had not proved so.

DIARY OF EVENTS.

FRIDAY AND SATURDAY, OCTOBER 8 AND 9.

HAMPSTEAD CORPORATION.—At Hampstead Baths, Finchley-road, Exhibition of Electrical Domestic Appliances.

MONDAY, OCTOBER 11.

INSTITUTION OF MECHANICAL ENGINEERS (GRADUATES' ASSOCIATION).—At 8 p.m., at Storey's Gate, St. James' Park, Westminster, London, S.W., "Invention and Industrial Progress; with a Treatise on the British Patent System," by Mr. J. E. S. Lockwood, graduate.

TUESDAY, OCTOBER 12.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION (INCORPORATED).—At 2.30 p.m., at Balfour House, Finsbury Pavement, London, E.C. A committee meeting of this Association.

WEDNESDAY, OCTOBER 13.

ASSOCIATION OF ENGINEERS-IN-CHARGE.—At St. Bride's Institute, London, "Standardisation," presidential address, by Professor Henry Adams, M.Inst.C.E., M.I.Mech.E., etc.

FRIDAY, OCTOBER 15.

INSTITUTION OF MECHANICAL ENGINEERS.—At 8 p.m., at Storey's Gate, St. James' Park, Westminster, London, S.W., "Heat Transmission," by Professor W. E. Dalby, of London.

ELECTRICAL ENGINEERS, R.E. (VOLS.).—Officer Commanding, Col. R. E. B. Crompton, C.B. Monday, October 11, "A" Co., Practice for the Hop. Cup, 7 to 9.30 p.m.; Tuesday, October 12, "B" Co., Practice for the Hop. Cup, 7 to 9.30 p.m.; Wednesday, October 13, Gymnasium, 6.30 to 9.30 p.m.; Thursday, October 14, "C" Co., Practice for the Hop. Cup, 7 to 9.30 p.m.; Friday, October 15, "D" Co., Practice for the Hop. Cup, 7 to 9.30 p.m.

HOME OFFICE ORDER.

Under an Order dated July 28, 1909, under Exemption 3 of the Regulations for the Generation, Transformation, Distribution and Use of Electrical Energy in Premises under the Factory and Workshop Acts, 1901 and 1907, the Home Secretary directs that the following special conditions shall be deemed for all the purposes of the Regulations adequate to prevent danger:—In rooms, other than electrical stations, in which no electrical energy is used except at low pressure, nor for any purpose other than lighting by means of incandescent lamps; and the floor is of wood or otherwise insulating; and there is no machinery or other earthed metal with which a person handling any non-earthed lamp, fittings, or any portable lamp is liable to be in contact; and no process rendering the floor wet is carried on; and no live conductor is normally exposed so that it may be touched.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

"If thou hast knowledge, let others light their candle at it."

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should be *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

Question No. 1202.—State the merits and demerits of worm gearing for use with electric motors. Instance examples of its use, and state the best design and materials to employ in various cases.

Answers to Question No. 1202 (*awarded* 10*s.*).—Worm gearing was very early adopted for the driving of electrically-propelled tramcars, but proved quite unsuitable for this purpose, largely, as subsequent experience showed, owing to faulty design. Though the latter reason is now generally recognised, worm gearing has not been reinstated in traction service except for light cars and electric automobiles. One of the chief reasons for this is the comparatively low speed ratio required in this connection

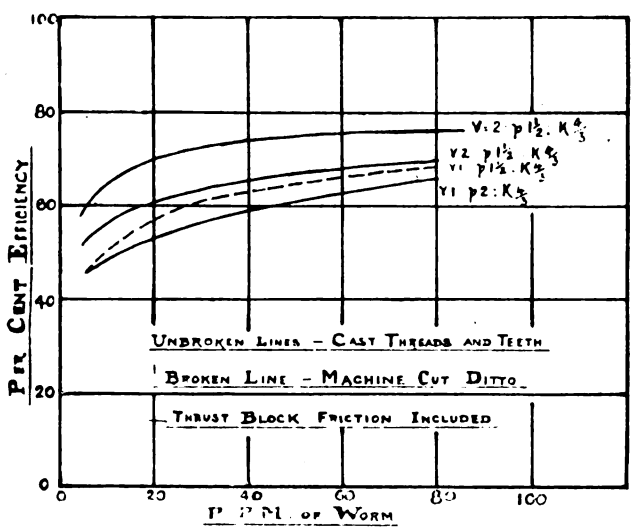

FIG. 1.

(usually only 4 or 5 : 1). In other applications, however and particularly where electric motors are employed to operate a heavy slow speed load, worm gearing is rapidly assuming a most important place. The early reputation acquired by this form of gearing, that of heavy wear and tear and very inefficient working, is entirely reversed, and in the words of an authority on the subject (Briggs), reasonable care in design and manufacture "gives a gear which, for ordinary ratios of wheel to worm, say, not greater than 60 or 80 to 1, will transmit backwards through the worm and exhibit a lower co-efficient of friction than is found in any other description of running machinery"—this tribute quite different from the ordinarily prevalent impressions.

Worm gearing is eminently suitable for high reduction ratios, enabling, as it does, a 25 : 1 reduction, with a worm wheel diameter about one-tenth, that required were the same reduction attained by a single pair of spur wheels. Worm gearing constructed on the principles mentioned below is simple, compact, reliable, quiet, and highly efficient: 85–95% efficiency is easily attained with a well-designed multiple thread worm gear. The disadvantage of the gear is that its cost of manufacture is higher than that of ordinary gearing, but this objection is overbalanced by the advantages attained so long as the ratio of reduction is not less than 8 or 10 : 1.

Each turn of the worm of a worm gearing advances the worm wheel v teeth where v = number of threads on the worm (*i.e.*, v = 1, 2, or 3, etc., according as the worm is a single, double, or triple threaded screw). Denoting the ratio

$$\frac{\text{radius p.c. of follower}}{\text{circumfl. pitch worm wheel}} \text{ by } \frac{r}{p} = K, \text{ the most}$$

efficient worm gearing is that in which K = 1 and v has as high a value as possible. This is shown by the set of

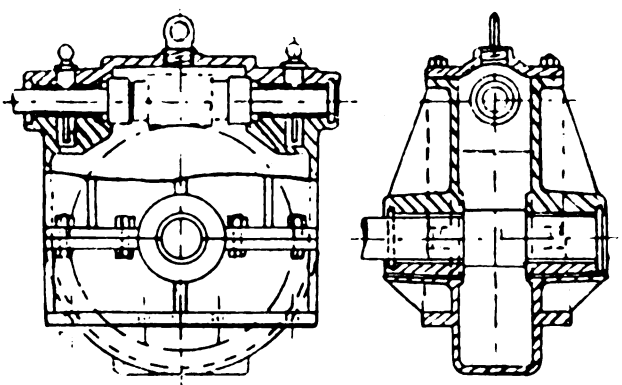

FIG. 2.

experimental curves in Fig. 1: the latter also illustrates the importance of running the worm above a certain critical speed (say, 20–40 r.p.m.) beyond which the r.p.m. has little effect on the efficiency. The great importance of the finish of the worm and wheel is also demonstrated.

Among the chief applications of worm gearing to electric motors are those in which the driven member is to run at a low r.p.m., or in which a small high speed motor is desired (the compactness of the gear being specially advantageous in the latter case). Worm gearing is now largely used where an electric motor is employed to drive haulers, cranes, lifts, pumps, planing machines, or other similar heavy loads.

Worm gearing to crane motors has been widely adopted on the Continent, and is becoming increasingly common in this country. Using ordinary spur gearing, three reductions are usually required on electrically-driven cranes (one reduction being carried on the motor itself). By using a worm and worm wheel for the first reduction, a second reduction by spur wheel suffices in most cases.

It is occasionally desirable to employ a self-locking gearing, this being especially so in pulley lifting tackle and often in lift motor gearing. In such cases, worm gearing is employed, and the helices are made so oblique as to give the friction necessary to "lock" the gearing when tending to run backwards. Only when the efficiency so sacrificed is justified by convenience or safety considerations should such a course be adopted.

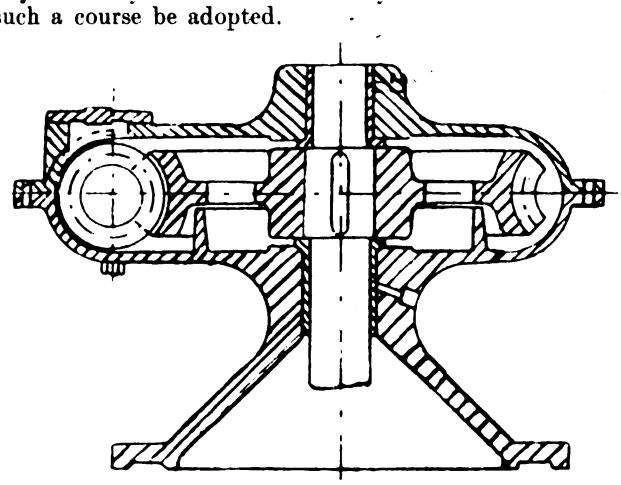

FIG. 3.

Bad design and inaccurate manufacture have been mainly responsible for the disfavour with which worm gearing has been regarded in the past. Essentially, worm gearing consists of skew bevel wheels with perpendicular

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axes, and to obtain *line* contact over the whole width of the worm wheel (a fundamental requirement for efficient running), the worm wheel teeth must be "hob" cut as follows: Every section of the worm teeth comes in turn into the median plane of the gearing, and hence every radial section of the worm teeth must be identical, and may be designed as an ordinary involute tooth (*see* Dunkerley's or Unwin's design text-books). The median section of the worm wheel tooth must be an involute tooth meshing with the worm tooth, but sections of the worm wheel tooth on planes parallel to the median plane must *not* be the same as that on the latter. In early worm gearing designs this point was neglected, with the result that mere point contact was obtained in the median plane. The gearing naturally soon wore to approach more closely line contact, and this wear led to heavy friction losses, so giving the gearing its bad character. After the gearing had worn somewhat, the friction was much less, but by that time the backlash was objectionable.

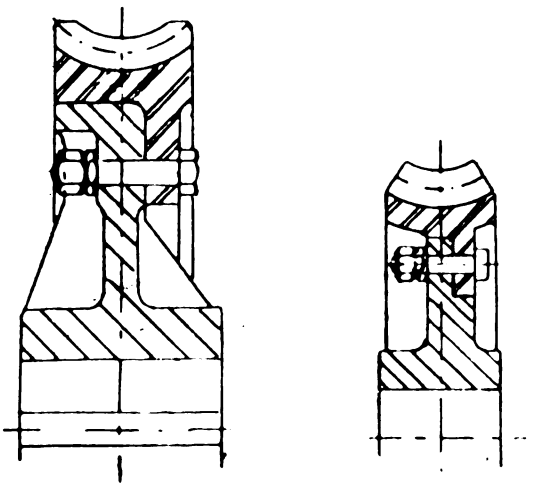

FIG. 4.

To obtain line contact, in the first place, an obvious method is to make the pitch surfaces of the worm and worm wheel hyperboloids of revolution, it being a well-known fact that such surfaces always touch along a straight line. It is more usual, however, to adhere to cylindrical pitch surfaces then employing such a geometrical construction as Unwin's to obtain the correct worm wheel teeth profile. Pattern templates can then be constructed, and the wheel cast or, preferably, a hardened steel worm, similar to the one to be used in the gearing, may be provided with cutting edges and used to "hob" out the wheel teeth round a blank disc. Wheels so constructed will give excellent life and efficiency.

To prevent risk of rapid abrasion (P V) should be not greater than 200,000 to 500,000 as a rule, or, if care be taken to have a number of worm and wheel teeth in simultaneous contact, (P V) may rise to 2,000,000 where P = pressure between teeth in lbs. and V = rubbing velocity in feet per minute. "Globoid" worms are cut by a tool swinging about a centre at the radius of the worm wheel. The pitch line of the worm thus becomes the arc of a circle instead of a line parallel to the worm axis. Though a longer contact and freer lubrication is so obtained, the ordinary worm with hob-cut worm wheel is the simplest and most satisfactory arrangement. A clear exposition of the design of worm gearing may be found in the *Practical Engineer*, 1909 (pp. 746–7 and 778–80).

During the operation of worm gearing, the worm tends to move axially, and, to prevent this motion, thrust collars and blocks must be provided to resist thrust in one or both directions, according as the worm cannot or can be driven by the worm wheel. Such thrust journals should be of liberal proportions, and fitted with ball or roller bearings. The added efficiency obtained compensates for the extra cost of such devices. A simple arrangement of worm box is shown in Figs. 2 and 3. The worm wheel face width should be such as to subtend about 60° at the worm centre, meanwhile following the worm pitch circle as shown in Figs. 3 and 4.

Materials.—The worm should be of forged steel, and cut from the solid, case hardened, and ground true to gauge. The great importance of perfect finish has been already explained. The worm wheel should be of phosphor bronze, and, except in the smallest sets, it is usual to make the teeth and rim only of p.b., using C I or steel hub, arms and supporting rim as in Fig. 4 (which also shows the two forms of wheel tooth commonly employed). The worm box casing is of C I, as a rule.

The end of the worm shaft is turned down to form a shoulder for the elastic coupling to the motor, or sometimes the worm is rigidly keyed to an extension of the motor shaft. Ample lubrication is very necessary, and (as in Fig. 2) ring lubrication of the worm shaft and bath lubrication of the worm are usual.—"L. C."

Answer to Question No. 1203 (*awarded* 5*s.*).—Worm gears are slowly overcoming the prejudice against them owing to their bad reputation for friction and rapid wear, and are finding an important place among transmission gears for a large variety of purposes. They run quite free from vibration, and are, therefore, quite noiseless, and, further, are compact and easy to enclose. In many applications the right angle transmission is an advantage, as it often lends itself to a more compact, general arrangement than is possible with parallel shaft gears. The great disadvantage of these gears (which has now been largely removed) is the difficulty of obtaining accurately cut gears. The success of such a gear depends upon the perfect accuracy as to shape of the worm and wheel, perfect accuracy of alignment in erection, and proper provision for taking the end thrust. An inaccurate gear is not only inefficient, but is incapable of working continuously without cutting and excessive heating. As regards cost, it is now possible to cut a worm wheel practically as cheaply as a spur wheel of similar dimensions, and a worm transmission works out cheaper than many of the special gears often employed.

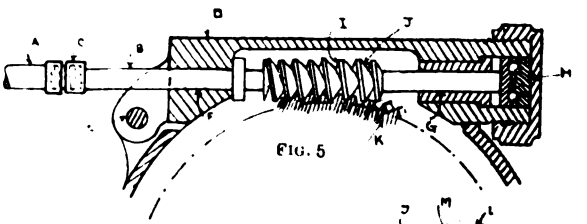

FIG. 5

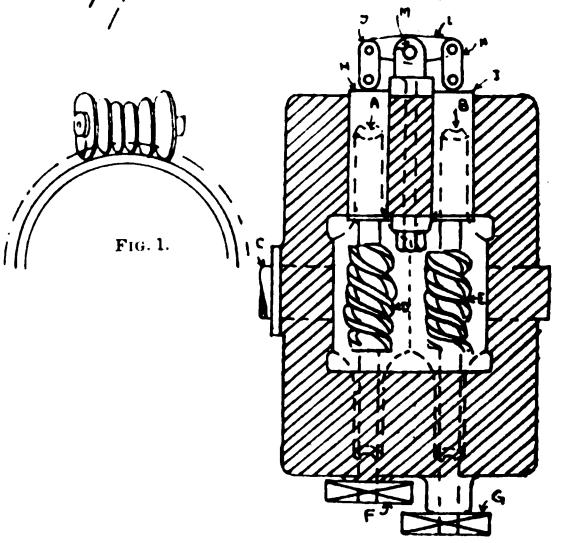

FIG. 1.

FIG 6.

The Worm.—With regard to the type of worm, it is acknowledged good practice in this country to use a parallel worm, although the so-called Hindley worm (shown in Fig. 1) is largely used in America, particularly in the Sprague lift. As will be seen, the ends are considerably larger than the centre, the idea, of course, being to obtain a larger area of contact. The advantages derived are, however, very doubtful, as with a small diameter wheel the angle of the thread at the end is much less than the angle at the centre, and, therefore, cannot work properly with a worm wheel with a constant angle. The question of worm efficiency is largely a question of pressure at the point of contact of worm and wheel, the value of which

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is given by the following expression, which should be kept as low as possible :—

$$P = K \sqrt{D} \, d \tan \frac{B}{2}$$

where P = safe end pressure in lbs.
d = dia. of worm at pitch line.
D = dia. of worm wheel at pitch line.
B = angle substended by the worm wheel at the axis of the worm.
K = a very variable and uncertain factor depending on conditions.

It will be noticed that the angle of the thread does not enter into this expression, owing to the fact that the area of contact and the load both vary as the secant of the angle, so that the intensity of pressure is not altered by varying the angle. Independently of the pressure, however, the thread angle has a large influence on the efficiency, the rise between 10° and 30° being very rapid. Where a high efficiency is desired, the thread angle should be at least 18°. In order to obtain sufficient contact area and also to use a large angle multiple, threads are employed. As regards material, the practice nowadays is to make the worm of hard polished steel.

The Worm Wheel.—With the worm wheel, the choice lies between a plain faced and a hollow faced wheel. The plain faced ones are, of course, cheaper to produce, and although the hollow faced wheel seems to offer advantages in the way of increased contact area, yet it will be observed that

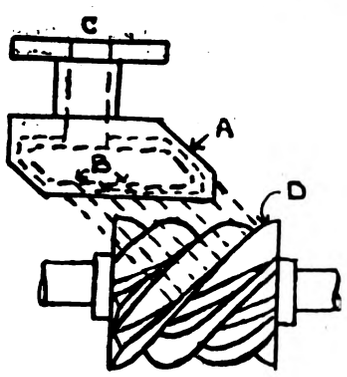

FIG. 2.

the outside of the wheel, while having the same number of teeth, has a larger diameter than the line pitch circle, and, therefore, the teeth have a larger pitch, presenting a similar difficulty to that presented by the Hindley gear. Formerly it was the custom to use phosphor bronze wheels, or for large wheels a cast-iron centre with a phosphor bronze rim. But recently it has been found that entirely cast-iron wheels give very satisfactory results. In order to obtain line contact worm wheels should be hobbed out, by a hobbing cutter, which is *not* used for rotating the wheel during the cutting operation.

The Thrust Bearing.—All such gears must have some sort of thrust bearing to take the end thrust of the screw, and as this is usually considerable, it is good practice to use a ball bearing similar to that illustrated at H in Fig. 5, in all except very small gears, when a plain collar may be employed.

Lubrication.—In all worm gears, however perfectly constructed, there is considerably more rubbing than in spur gearing, so that a quantity of heat is evolved and must be disposed of. In the majority of gears the worm rotates in an oil bath, containing a fairly heavy oil, heavy because of the considerable pressure between the worm and wheel. This bath must be of ample capacity to permit of the rapid cooling of the oil, or else it will heat up, with the result that its viscosity will be decreased, and the oil squeezed out, allowing abrasion and seizing to occur. Although up to a certain point (about 200 ft. per min.) an increase in the peripheral velocity increases the efficiency of the gear by improving the lubrication by preventing the escape of oil. Yet at higher speeds the centrifugal force drives the oil away from the bottom of the threads. In some cases this has been overcome by introducing oil through small holes at the bottom of the threads.

A satisfactory method of lubricating high speed worm gears had been patented by the Aktienselokabet Elling Compressor Co., and is illustrated in Figs. 2 and 3. The lubricator consists of a nozzle A having guide vanes B so arranged that oil pumped in at C is discharged in a direc-

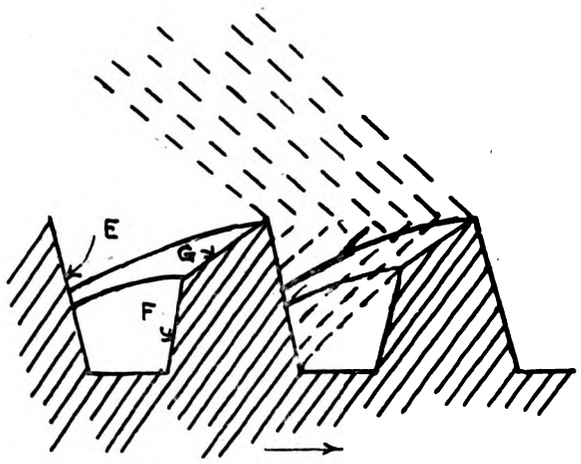

FIG. 3.

tion nearly perpendicular to the threads D of the worm. As shown in Fig. 3, the oil on striking the worm rebounds along the paths indicated, thus lubricating the working surface E, but leaving the inactive face F free. To prevent spluttering, the edge of the thread must be sharp, as indicated at G.

Settling the Proportions.—The required velocity ratio N^1/N_2 gives the ratio of the number of threads or teeth on the worm (r^1) and wheel (r)—

$$\text{for} \quad \frac{r^2}{r^1} = \frac{N^1}{N^2}$$

Then selecting any suitable number of threads r on the worm, the number of teeth on the wheel can be found. To get the best results, this should not be less than 30.

The circumferential pitch (p) of the worm wheel, which equals the axial pitch of the worm, is settled by considerations of strength.

The radius of the worm wheel (R^2) is given by $R^2 = \frac{r^2 p}{2\pi}$

the circumferential pitch of the worm $p = \frac{2 \pi R^1}{r^1 \text{ line}}$

the angle between the worm axis and of contact is $\theta = \cot^{-1} \frac{p}{p_1}$

and that (θ^2) between the worm wheel shaft and line of contact $\theta^2 = 90° - \theta_1$

The proportion and shape of a modern thread is shown in Fig. 4. The accurate designing of worm gearing, how-

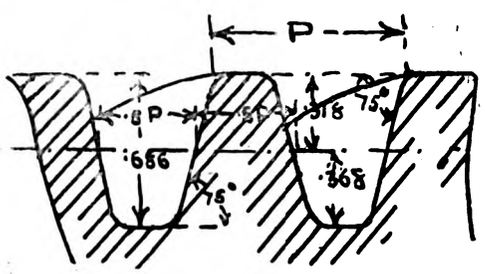

FIG. 4.

ever, is a matter of some difficulty. For description of methods, *see* Unwin's Machine Design, Part 1, pages 420-50.

Applications.—Probably more worm gears are employed for driving electric lifts than for any other purpose. This is due not only to the questions of space and silent running, but also because of the prevalent idea that a worm gear will not run back. This only occurs when the efficiency is less than 50%, so that gears for this purpose are often purposely making inefficient. This is rather a dangerous practice, as the wear may decrease the friction, and permit

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the gear to run back, thus depriving it of any braking effect, which no doubt would have been allowed for when designing the brakes. A better plan is to make the gear as efficient as possible, and regard it as for transmission only, increasing the power of the brakes to do all the retarding necessary.

Apart from lifts, worm gearing has been applied to practically every piece of apparatus to which an electric drive has been applied.

We will content ourselves by mentioning one or two cases in which the gear is more or less specially modified.

Fig. 5 shows a worm drive for operating a motor-driven, quick break switch. The motor shaft A is connected to the worm shaft B by a flexible coupling C. The shaft B is mounted in a casing D pivotted to the main casing at E by means of bearings F G and ball thrust bearing H. As will be seen, while the driving face I of the worm is radial, the opposite face J is cut away. The action is as follows: When closing the switch, which is done through the wheel K, the worm operates the wheel in the direction shown, closing the switch against the action of a spring. Immediately the motor starts to open the switch, the spring is released, to quickly operate the switch, causing the worm wheel to slip past the worm, which is made possible by the shape of the teeth and the pivotal mounting.

For Large Lathe.—Probably one of the largest worm drives ever employed is that used by Messrs. Buckton to transmit power from a 100 h.p. motor to a large lathe. In order to avoid wheels of inordinate size, two wheels A B (Fig. 6) are mounted side by side on the driven shaft C. The worms D E driving these wheels are driven by spur

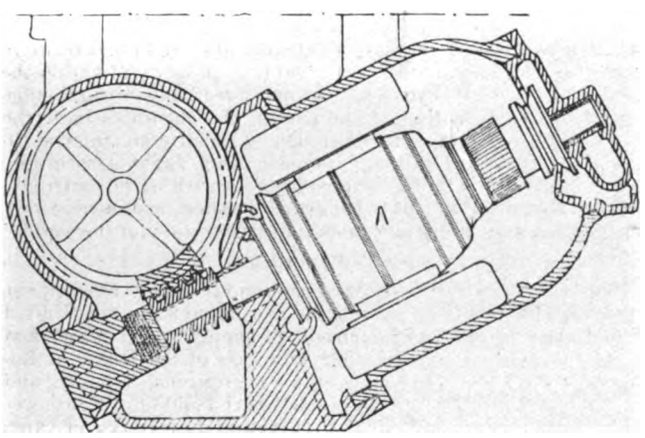

Fig. 7.

gears F G, and have their thrust bearings mounted in sliding sleeves H I sliding in the bed plate. These sleeves are connected by links J K to a compensating lever L pivotted at M to the bed plate. As each worm must of necessity use the other as an abutment, it naturally follows that each will always take a half share of the work.

In the case of pumps, compressors, and like apparatus of a reciprocating nature, provision must always be made for the knocking effect produced by the sudden reversal of pressure at the ends of the stroke.

Fig. 7 illustrates one method of overcoming this difficulty in a motor-driven air compressor, particularly for use on railway cars where little space is available. The motor A is placed on an incline, so that the back pressure on the gear is opposed by the weight of the motor, so that for the pressure to move the worm axially, assuming, of course, that there is some backlash, the pressure must be greater than the component of the weight of the armature, etc., along the shaft, a condition which can be easily prevented. Further, of course, this inclined position limits the extreme dimensions, as no part of the motor projects to any great extent above or below the worm wheel casing.

For further information, *see* "Experiments on the Transmission of Power," by Gearing (*Proc. Am. Inst. Mech. Engs.*, vol. vii., p. 273); "The Mechanism of Power Transmission for Electric Motors" (*Ints. of Engs. & Shipbuilders in Scotland*, vol. clxlvii.); "Worm Contact" (*Proc. Inst. Mech. Engs.*, 1906, p. 57).—"H. E. H."

TYNESIDE NOTES.

(From our Correspondent.)

NEWCASTLE.

An interesting sequel to my recent notes on the Newcastle Tramways undertaking is furnished by the proceedings at the Newcastle Tramways Committee meeting this week. It was reported to the Committee that the number of people travelling on the cars last week were 20,000 less than the corresponding week last year, and 40,000 less than the corresponding week of 1907. Instructions were given to the Chief Engineer of the Tramways Department to enforce economies in the running of the service in any manner he considers desirable, and one of the measures, which will probably be brought into operation, will be the cutting down of extra mileage. It is not improbable, although no definite steps have been taken in this direction, that some of the concessions which during the past few years have been made to passengers will have to be rescinded. The Manager of the tramways will in three weeks report on the measures he proposes to adopt in order to effect the necessary saving to balance the diminution of income. In this connection it may be interesting to note that an innovation has recently taken place on the City cars with regard to advertising. Up till recently, advertisements on the cars had been tabooed, but cars are now running on the lines bearing advertisements, and it is probable that, having regard to the revenue obtained by this means, the system will be extended to the whole of the available cars. Another item, which is already being carried into effect, is the reduction of the number of petrol-driven motor-cars for various purposes, which have been used in recent years for the auxiliary service of the tramways system. A reversion is now being made to horse service. At the conclusion of the meeting above referred to, Sir Joseph Baxter Ellis intimated that, owing to his advancing years, he would not be prepared to be re-nominated as Chairman to the Tramways Committee for the coming year.

Large Crane at Sunderland.

An interesting application of electric drive has just been installed at Southwick, Sunderland, at the works of Messrs. George Clark & Co., in the shape of a cantilever crane for the purpose of lifting heavy engineering plant. The position of the crane is closely adjacent to the new Alexandra Bridge. It was necessary to construct a very strong foundation and a concrete block of box formation was placed on green-heart piles to carry the crane. The ground was first excavated to a depth of 25 ft. over an area of 50 ft. by 50 ft., taken right up to the sheet piling of the existing quay front. The bottom of this hole was 14 ft. below high water mark, and the excavation was carried out in such a manner that no slips of any kind occurred, the safety of the quay in front and the buildings behind being of the greatest importance. Then 124 green-heart piles, in lengths varying from 40 ft. to 55 ft., according to their position, were driven in a cluster by a Lacour steam piling hammer to a very hard set, the average depth reached being about 70 ft. below quay level. The heads of the piles, which were left standing 3 ft. above the excavated depth, were braced together in all directions by means of chains, and 6 in. by 3 in. steel bulb angles. On this foundation a massive concrete block was then constructed and carried up to quay level, bolts 21 ft. in length being built into the block and anchored by means of channels.

Tests Entirely Satisfactory.

The whole of the foundation work was entrusted to Messrs. Brims & Co., contractors, Newcastle-upon-Tyne. On this foundation the crane, which was constructed by Messrs. Applebys, Ltd., of Leicester, was erected, and it is capable of lifting 100 tons at a 70 ft. radius, 50 tons at 100 ft. radius, and 10 tons at 125 ft. radius. The load arm of the cantilever is 133 ft. 6 in. long, the ballast arm being 70 ft., the total length of the cantilever being, therefore, 203 ft. 6 in. The depth of the cantilever over the flange plates on the tower is 30 ft. 6 in., while at the load arm end it has a depth of 14 ft., and at the ballast arm end, 16 ft. The height of the lift above the foundations is 94 ft. 3 in., and the tower legs cover an area at the base of a square of 30 ft. side. The total height from the top of the foundations to the top of the cantilever is 132 ft. Both roller paths are of cast steel, and a live roller ring has 72 rollers of cast steel, each of 15 in. diameter, the bottom roller path having teeth for the slewing gear. The crane is electrically driven, supply being obtained from the mains of the county of Durham Electrical Power Distribution Co., Ltd. The designs and execution of the steel superstructure and the foundations of the crane have been carried out under the supervision of T. Mitchel Moncrieff, Esq., M.Inst.C.E., of Newcastle-on-Tyne, as consulting engineer to Messrs. Geo. Clark, Ltd.

Institution of Civil Engineers.

On Wednesday, the 29th ult., a party representing, what is somewhat ignominiously called, the Newcastle-upon-Tyne Association of Students of the Institution of Civil Engineers, but which really includes both members and associate members in this area, visited two works which are interesting electrically. One was the place of manufacture of the well-known Sunbeam lamp, the other being the engineering works of Messrs. Clarke,

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Chapman & Co., Ltd. In common with other firms of lamp manufacturers, the Sunbeam Lamp Co., Ltd., is taking up the sale of metal filament lamps, so that the visit presented unusual features of interest. Messrs. Clarke, Chapman's works are interesting, not only because a large amount of Admiralty work in electric ship's winches, capstans, coal hoists, searchlights, and other gear is made here, but also because the larger proportion of the machinery is driven by power generated externally to the works, and supplied by the County of Durham Electrical Power Distribution Co., Ltd. Supply both on the alternating and direct current systems is given, and many interesting applications of electric drive were in evidence.

MIDLAND NOTES.

(From our Correspondent.)

BIRMINGHAM.

Enquiries among the electrical engineering firms in the Midlands show that, on the whole, business is improving. This seems to be particularly the case with regard to makers of appliances for the electro-plate trade.

Birmingham Electrical Department.

The Birmingham Corporation Electrical Department is just completing an important alteration of its premises in Dale End, formerly the head station for the city, but now, since the erection of the much larger station in Summer-lane used as a sub-station. The alterations are costing about £13,000, and consist largely in the erection in the rear of the premises of a new block of offices. The work has been done by Messrs. John Bowen & Sons. In addition to the building alterations, upwards of £20,000 is to be expended at Dale End for a storage battery and boosters, and subsidiary apparatus, in order to ensure continuity of supply in the important area comprising the centre of the city, and also for the purpose of maintaining a proper balance of the electrical pressure on the two sides of the distributing network. The new battery is to have a discharge capacity of 4,000 amperes per one hour.

University Appointment.

In the Electrical Engineering Department of the Birmingham University, Mr. T. F. Wall, from the Siemens Works, Stafford, has been appointed assistant-lecturer and demonstrator of Electrical Engineering, in the place of Dr. Lulofs, who has taken up the position of chief assistant in the Electricity Works of the City of Utrecht, Holland.

Results of Research.

Some interesting reports will be made during the coming session by the research students of the Electrical Engineering Department. Mr. R. D. Gifford, B.Eng., who held one of the scholarships for engineering, has been investigating the influence of the various cooling media upon the rise of temperature o sheet steel stampings, the object of the research having been to determine how the heating of the iron stampings of electrical machinery is affected by the external cooling conditions. The methods of cooling employed were (1) iron free in air, (2) iron enclosed in an iron case, (3) iron cooled by air blast blown through the case, (4) oil cooling. The results obtained showed the superiority of oil cooling assisted by a water-worm, over any of the other methods, although the air blast proved itself to be a very good cooling agent in comparison with cooling by natural draught alone. These researches will form the subject of a paper to be read by Mr. Gifford before the local section of the Institution of Electrical Engineers. Mr. H. R. Lavender, B.Sc., has been investigating the effect of increase and decrease of voltage on the life and average efficiency of metallic filament glow lamps. From his experiments, the most economical method of running the lamps has been found.

Additions to Engineering Department.

Some additions have been made to the apparatus in the Electrical Engineering Department. These include a three-phase dynamo by Holmes, of Newcastle, and two single-phase dynamos, one by the Electrical Co., Ltd., and the other by Brown, Boveri & Co., Ltd. Among the apparatus made by the students, for use in the department, is a very useful arc-lamp photometer, having two mirrors, each of which can be set at any angle, so as to test the intensity of the light from every point of the arc. Another is a very ingenious brake for motor testing, in which a constant torque on the brake pulley is maintained. A new auto-transformer has also been installed.

Southern Telegraph Companies.

The Engineer Units having their centre in Birmingham, and forming the three Southern Telegraph Companies, under the command of Lieut.-Colonel J. F. Lister, have just entered into possession of their new headquarters at Great Brook-street barracks. The total strength of the three companies is now 450, divided, though, of course, not equally, into the Wireless, the Cable, and the Airline Companies.

Dudley Electricity Works.

The Dudley electrical undertaking has experienced an unfavourable year. A reduction of output, which had first been noticed in January, 1908, continued throughout the past and the present financial years, the decrease in the number of units sold last year being 44,571, as compared with the preceding year. The reduction, which is attributed to the bad state of trade generally, took place chiefly on the tramway and motor supply, with a consequent lowering of load factor. There has been, however, a healthy increase in the number of units supplied for private lighting, in face of the largely extending use of the metallic filament lamp. The year's working resulted in a gross profit of £5,872, a decrease of £105, while financial charges for interest, etc., absorbed £5,748, an increase of £107, the surplus for the year being £123. The turnover was approximately 14½% of the capital employed, and this is considered a fair figure for municipal undertakings, particularly in face of the low income per unit sold, 1·573d. A great deal of trouble was experienced during the year from breakage of main cables, caused by mining. The capital expenditure now stands at £89,720, an increase of £2,913.

AMERICAN NOTES.

(From our Correspondent.)

NEW YORK.

An event of a good deal more than merely local or personal interest is the resignation of Mr. T. C. Martin, co-Editor of the *Electrical World* of New York, after more than five-and-twenty years of arduous work on that always popular and supremely well-conducted technical journal. Mr. Martin was one of the founders of the National Electric Light Association, and has long been closely associated with its work. The remarkable growth of the Association in recent years and the increase in its sphere of influence and usefulness have made inevitable the appointment of a permanent executive officer, and Mr. Martin has been offered and has accepted the post of General Secretary. The *Electrical World*, in making announcement of this fact, says: "While the answer to the call has entailed a loss to this journal, it feels in compensation that Mr. Martin in his new field of effort will continue a powerful factor in the advancement of the electrical industry, and particularly of the active branch on which he will now concentrate his great ability and rare executive talent. The field of work is vast, and with proper cultivation the results possible are beyond present measure; and we can divulge that a strong hesitation on the part of Mr. Martin to leave the journalistic field was only overcome through conviction as to the great future before the National Electric Light Association, and a desire, bred by his long connection with it, to contribute toward advancing our national central-station organisation to a leadership among the great industrial organisations of the world."

Capitol's Power House.

A few weeks will witness the completion of the central power house which has been erected at Washington by the United States Government for the purpose of supplying light, heat and power for the Capitol, the office buildings of the House of Representatives and the Senate, the Congressional Library, and (when it is built) the new Supreme Court building. The power house is located in Garfield Park, Capitol-hill, a thousand yards away from the Capitol, and the cable house, 7,000 ft. of sectionalized tunnelling, 6 ft. high, to reach the various buildings. Close on $2,000,000 will have been spent on the power plant when completed. It already includes 16 boilers, each of 500 h.p., and 46,000 incandescent lamps of 16 c.p. are now in use, in addition to 150 arc lamps.

A £16,438,000 Railway.

My Chicago correspondent reports that great interest has been excited there by a letter sent to the City Council by Mr. George W. Jackson, President of George W. Jackson, Inc., offering to submit plans for an $80,000,000 subway system for the City. Mr. Jackson says that he is ready at any time to discuss the details of the project, and states that his company is prepared to start work at once on the construction of 12 miles of tunnels in the district bounded by Chicago-avenue on the north, Michigan-avenue on the east, Twenty-second-street on the south, and Halsted-street on the west. In addition, the company declares that it is prepared to submit figures for the construction of a much more extensive system serving a large portion of the City's area and including 80 miles of subway.

Topping the 100,000 Volt Limit.

Your readers have been kept pretty well posted as to the progress of the 110,000 volt system of the Grand Rapids-Muskegon Power Co. By the courtesy of the *Electrical World* I am now able to send you the latest information concerning this great scheme. You are aware that the energy for this system is derived from the hydro-electric installation at Croton, on the Muskegon River, and is thence transmitted by suspension insulators to Grand Rapids, 40 miles distant. The generating equipment consists of two 3,000 kw. Westinghouse, three-phase, 6,600 volt, 30 cycle alternators, each of which is driven by eight horizontal shaft Leffel turbines to which it is direct connected. The speed of each generator is controlled by two Lombard governors, each of which regulates the water admitted to two pairs of turbines. The speed at which the governors tend to

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cause the generator to operate is set by means of a miniature direct current motor receiving power from the exciter circuits and remotely controlled by push buttons on the switchboard. A synchronoscope is used in paralleling the two generators for connection through 6,600 volt busbars.

The Alternators.

Each alternator is provided with a 40 kw. exciter mounted on an end of its shaft extended beyond the main ring-oiler bearing, but there are no exciter instruments and controlling devices. The exciter terminals are joined directly to the terminals of the field coils of the alternator, the only method of varying the e.m.f. of the alternator being by means of the rheostat in the field circuit of the exciter generator. The exciter is a compound-wound machine, but the series coils are not used. The switchboard for each alternator contains a single ammeter and wattmeter, two push-button devices for setting the speed of the machine, and an exciter field-circuit rheostat. The only devices in the main alternator leads are air-break disconnecting switches and series transformers. In case it becomes necessary for the attendant to open the circuit under load, the oil switches, which normally are fastened in the closed position, can be released and operated by hand or by the relay. The 6,600 volt leads are joined to the primary circuits of three Westinghouse oil-insulated, water-cooled transformers, the secondary circuits of which are connected in delta to the 110,000 volt transmission lines. The only prominent features of the transformers are the secondary bushings, which have been made extra long for the high voltage.

The Main Sub-Station.

There are at the main sub-station in Grand Rapids three 3,750 kw., oil-insulated, water-cooled transformers, duplicates of those at the generating station. No switches are used in the primary leads, which are joined directly to the 110,000 volt transmission cables, according to an arrangement similar to that used at the generating station. The sub-station is provided with the usual equipment of recording devices, oil switches, etc., for a 6,600 volt distributing system. Air-insulated busbars allow the 110,000 volt transmission system to be paralleled on the 6,600 volt secondary side with a 70,000 volt system, which transmits energy 60 miles from Rogers' Dam, 20 miles upstream on the Muskegon, above Croton. For the latter system the sub-station contains three 1,250 kw., 70,000 volt to 6,600 volt, oil-insulated, water-cooled transformers. The 70,000 volt transmission wires are carried on pin insulators arranged on wooden poles. A compartment in the station at Croton is employed for disconnecting switches for the 70,000 volt circuits, but these circuits are not interconnected with the 110,000 volt system except at the Grand Rapids sub-station.

Simplicity of the Plant.

An especially noteworthy feature of the plant is its extreme simplicity. The only automatic device in the whole system is the speed regulator for the water turbines. In the high-tension lines there are no fuses, switches, or cut-outs and no lightning arresters. Even in the low-tension side of the transformers at the generating station no use is made of regulating devices or automatic switches of any kind. The leads from the 6,600-volt generators are connected directly to the primary coils of the transformers, and the secondary coils are joined directly to the 110,000 volt transmission lines without the insertion of any device whatsoever. The system is protected from overload by circuit-breakers in the distributing circuits, while the fact that the turbines are incapable of operating the generators at a dangerous overload furnishes additional protection. Any increase in the e.m.f. induced by lightning produces an excess of corona loss, and tends to minimise the disturbance from lightning, while the high factor of safety used in the line insulators provides protection to the line, though for the protection of the apparatus at the terminals of the 110,000 volt lines, use will be made the coming season of lightning arresters of the electrolytic type.

Items of Interest.

The directors of the Niagara, Lockport and Ontario Power Co. have called a meeting to discuss plans for removing the headquarters of the Company from Lockport to Buffalo. The Company furnished power to many Buffalo plants. The power furnished by the Company is generated by the Ontario Power Co., of Niagara Falls. The Company maintains two high-power transmission lines, one into Buffalo and another down the State of New York as far as Syracuse. In connection with the removal, it is expected that an active campaign will take place to get more Buffalo patronage for the Canadian power. This will secure active competition with the Niagara Falls Power Co., and possibly cheaper rates for electric power.

Forest Commissioner James S. Whipple recently bought from private parties 13 miles of telephone wires connecting Indian Lake with Blue Mountain Lake, in the Adriondacks, and also secured a 5-mile line running to the north-east of Indian Lake. He has men putting up 13 miles of wire from Indian Lake to Lake Piseco. It is his intention to perfect as rapidly as possible the telephone system throughout the Adriondacks to fight forest fires.

The Commissioner of Public Works of Buffalo is now installing red electric globes near the fire alarm boxes, so that the people seeking to send in a alarm at night can quickly find the alarm box.

It is notified from Albany that the Public Service Commission has authorised the Cataract Power and Conduit Co., of Buffalo, N.Y., U.S.A., to issue £2,380 5% gold bonds, payable in 1927, to be sold at not less than 95. The proceeds are to be used for the extension and improvement of the Company's plant.

My Niagara Falls correspondent reports that the Water Commission has decided to accept the offer of the Niagara Falls Hydraulic Power and Manufacturing Co. to buy the property in the lower milling district on which the municipal waterworks pumping plant stands. The Power Co. will supply electric current for the new pumping station up to 800 h.p. at 37s. 6d. the horse-power for a term of 76 years, and above that amount for £2 2s. 1d. the horse-power. The Niagara Falls Power Co. offered to sell electric current at £4 4s. 2d. the horse-power. The old village of Suspension Bridge acquired the property in 1876, paying £1,000 for it, and by the contract secured it for a term of 99 years, water rights for £200 a year, and water-power for £2 2s. 1d. the horse-power.

The American Telephone and Telegraph Co. has acquired nearly £3,200,000 worth of New York Telephone stock owned by the Western Union Telegraph Co. The companies involved include the New York Telephone, Hudson River Telephone, Empire State and Pennyslvania, Central New York, Bell Telephone, New York and New Jersey, with the New York Telephone Co. as the medium of merger. The New York Telephone Co. is the largest, and in some respects, the most important of the subsidiaries of the American Bell Telephone Co. Of its £10,000,000 stock, 64% is owned by the American company. Of the £3,600,000 minority stock, about £3,200,000 has for many years been the property of the Western Union Co., and it is this stock that has at last been secured by the American company. The transaction does not involve any settlement of the long 25 years' suit between the American Telephone and the Western Union, in which judgment was recently returned in favour of the Western Union. The sum involved was approximately £1,000,000.

COMPANIES' MEETINGS AND REPORTS.

SOUTH METROPOLITAN ELECTRIC LIGHT AND POWER CO.

Warrants for interest on the 4½% First Mortgage Debenture Stock of the South Metropolitan Electric Light & Power Co., Ltd., for the half-year ended September 30, 1909 (payable Oct. 1) have been posted.

BRISBANE ELECTRIC TRAMWAYS.

The directors of the Brisbane Electric Tramways Investment Co., Ltd., have decided to pay a dividend of 3s. 6d. each on the Ordinary shares, free of income-tax, in respect of the profits for the half-year to June 30, 1909.

PARA ELECTRIC RAILWAYS AND LIGHTING.

The directors of the Para Electric Railways and Lighting Co., Ltd., announce that a dividend on the Preference shares for the half-year ended May 31, 1909, at the rate of 6% per annum, less tax, will be paid on November 1.

PUEBLA TRAMWAY LIGHT AND POWER CO.

The report of the Puebla Tramway Light and Power Co., for 1908, states that the Board considered it advisable, pending the completion of the arrangements for the acquisition of the local competing lighting company (Compania Hidro-Electrica de San Agustin, S.A.), to delay the issue of this report. During the period covered by the accounts the earnings of the tramways have been affected (as foreshadowed in the report to December 31, 1907) by the paving improvement work which is being carried out by the Municipality of Puebla, and in connection with which considerable betterment work and expenditure has had to be undertaken by the company which, when completed, will, it is anticipated, result in benefit to the tramway business. The lighting business has suffered very severely during the last two years in consequence of the fight with the San Agustin Co. The Board, however, are glad to state they have succeeded in putting an end to this competition by securing for the company the control of the San Agustin Co. as from July 1, 1909, on satisfactory terms, and they expect a material increase of revenue. The gross and net earnings of the power business continue to show a steady increase, and the results therefrom are satisfactory. The supply of power to the San Rafael Pape Mills (1,500 h.p.), mentioned in the report for 1907, commenced in October, 1908. The results for the six months to June 30, 1909, show a marked improvement over those of the previous period. The net profits for that period amount to approximately £21,500 (nearly equal to the profits earned in the year 1908), and thus the bond interest for the same period, £21,891, is practically covered. The Board consider that the outlook for the future is very promising. With the removal of the ruinous competition in the lighting business a great improvement will

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be shown in the net profits of that department. The material increase in the profits of the power business during the first six months of this year should also be further augumented during the current half-year by the revenue from the horse-power already sold or being contracted for. Being satisfied that it is now a practical certainty that the balance of the power available from the two Portezuelo Falls and the falls of the San Agustin Co. will be sold within the next two years, the directors have decided to proceed immediately with the partial development of the Tuxpango Falls (30,000 h.p., but say 25,000 h.p. to allow for abnormal dry seasons such as the last season has been), so that the company will be in a position to meet the growing demands of the City of Puebla and the district served by the company.

TOKYO ELECTRIC LIGHT COMPANY.

The report of the Tokyo Electric Light Co. states that at the end of April the number of electric lights was 368,627 in 86,078 families and the total of electric power supply 5,294 h.p. in 1,451 houses. Since then there being an increase of 6,000 in light supply and 120 h.p. in electric power, the entire supply at present is estimated to be something like 370,000 lights and 5,400 h.p. Compared with the previous term the present figures show an increased income of 260,000 yen in light supply and of 42,000 yen in electric power supply. The rate of increase in net profit is estimated to reach at least 2,550,000 yen in a year, thrice the sum in three years. To give the figures of the past three years the sum was 710,000 yen in 1906; 1,150,000 yen in 1907; 1,680,000 yen in 1908, while the present year netted the sum of 1,150,000 yen in only half a year.

COMPANIES REGISTERED.

HALESOWEN LIGHTING AND TRACTION CO., LTD.—Registered September 29, by Pemberton, Cope, Gray & Co., 5, New-court, Lincoln's Inn, W.C. Capital, £10,000, in £1 shares. Objects: To acquire the rights, powers and privileges granted to G. Balfour by the Provisional Order granted by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, in respect of the rural district of Halesowen, Worcester, as amended and confirmed by the Electric Lighting Orders Confirmation (No. 1) Act, 1908, and to carry on the business of electricians, suppliers of electricity for light, heat and power, etc.

THEROL FOREIGN PATENTS SYNDICATE, LTD.—Registered September 29, by L. Stroud, 19 and 20, Holborn Viaduct, E.C. Capital, £2,500, in £1 shares. Objects: To acquire and turn to account a certain patent; to adopt an agreement with G. G. Bell and J. St. V. Platts, and to carry on the business of electricians, mechanical engineers, manufacturers and workers of and dealers in electricity, etc. Private company. The first directors (to number not more than six) are: Sir James Clark, J. E. Spagnoletti and H. M. Bayley. Registered office, Goldhawk Works, Goldhawk-road, W.

WESTMINSTER TOOL AND ELECTRIC CO., LTD.—Registered September 30, by Cox and Lafone, 17, Tower Royal, E.C. Capital, £1,000, in 500 "A" shares of £1 each and 10,000 "B" shares of 1s. each. Objects: To carry on the business of electrical engineers, electricians, suppliers of electricity for light, heat, motive power or otherwise, manufacturers of and dealers in electrical apparatus, etc. Private company. The first directors (to number not less than two nor more than five) are: F. D. Johnson, F. W. White and A. Stewart. Registered office, Palace Chambers, Bridge-street, Westminster.

CONTRACTS OPEN.

HOME.

MANCHESTER.—Corporation Baths and Wash-houses Committee.—For the wiring and complete installation of electric lighting at the Cheetham Baths and Public Hall. October 12.

OVERSEAS.

ROME.—Italian State Railways.—Telegraph cable. (Part. Ferrovie dello Stato, Direzione Générale, servizio contratti.) (A.) October 17.

SEOUL.—Korean Government.—500 miles of telephone lines. Est. £7,100.

SPAIN.—The Ministerio de Fomento.—Tenders for a 60 years' concession for the construction and working of an electric tramway from Sans to Coll-Blanch (Barcelona). Tenders must be enclosed in sealed envelopes, bearing on the outside the name of the tenderer, and addressed to the Dirección General de Obras, Públicas, Madrid, where they will be opened at noon on November 20. To qualify any tender a deposit will be required of 1,295 pesetas (about £47), which should be enclosed in a separate envelope. An application respecting this concession has already been submitted by the Compañía General de Tranvias, who have certain preferential rights in the competition.—Tenders for a 60 years' concession for the construction and working of an electric tramway to run from the Calle Mayor del Grao to the end of the West Quay, Valencia. Tenders will be received by the Director General de Obras Públicas, Ministerio de Fomento, Madrid, up to noon on October 15. Work must be begun within three months from the date of the award of the concession. An application respecting this concession has already been submitted by the Compañía General de Tranvias Eléctricas de Valencia, who have certain preferential rights in the competition.—Tenders invited for a 15 years' concession for the working of the urban telephone system at Oviedo, the present lease expiring on October 31, 1909. Tenders will be opened by the Dirección General de Correos y Telégrafos, Madrid, at 11 a.m. on November 8, but they must reach that address not later than noon on November 2. The concessionaire is to have the right to modify or extend the present telephone system within a radius of 15 kilos. The "Gacetas," containing further particulars, may be seen by British firms interested on application to the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C. *Local representation is necessary in each case.*

SYDNEY.—Postmaster-General.—Switchboard apparatus for subscribers' premises. Particulars of all Australian contracts, 72, Victoria-street, Westminster, S.W. January 10, 1910.

TORONTO.—Motors, etc. October 14.

VALENCIA.—Harbour Board.—Six one-ton electric cranes for timber unloading. November 2.

SOME CONTRACTS.

Orders received by the D.P. Battery Co., Ltd., include one from H.I.H. Empress Eugenie, to instal a storage battery of their LS 13 type at Farnborough Hill, and another from the Crown Agents for the Colonies to supply a battery of 118 L 15 type cells for the Bahamas. They have also been favoured with orders for 16 of their specially designed 25 volt batteries for private residences.

The Brighton Corporation Lighting Committee recommend the acceptance of the tender of Messrs. Siemens Bros. & Co., Ltd., £2,380, for the supply of cable in connection with the extension of mains for additional requirements by the Railway Co. Works.

TENDERS ACCEPTED.

ABERDEEN.—The Churches Committee accepted the offer of Mr. John Jackson, Silver-street, to fit electric light in St. Clement's Parish Church for £59 17s. The other offers were:—Pratt & Keith, £79; Claud Hamilton (Ltd.), £79 14s.; Blaikie & Sons, £79 10s.; J. F. Anderson, £88 10s.; Aberdeen Electrical Engineering Co., £98 4s.; Petrie & Co., £113 17s. 6d.; and Walter Simpson, £113 13s.

BELFAST.—Out of seven tenders, that of Messrs. John Dowling & Sons, £460, for carrying out the work in connection with the lighting of the Purdysburn Asylum by electricity, was accepted.

ST. PANCRAS (London).—The Electricity and Public Lighting Committee of the Borough Council selected the quotation of Messrs. White, Jacoby & Co., Ltd., for the re-winding of the 500 kw. armature at the Regent's Park station for £130. Other tenders were: Messrs. Siemens Bros. Dynamo Works, Ltd., £214; the Westminster Engineering Co., £214. Messrs. White, Jacoby & Co., in their quotation, did not include the reinsulating of the spiral end connections or the armature core, and also specified that the whole of the existing conductors from the periphery of the armature bars after removal shall remain their property.

YORK.—The Electricity Committee of the City Council accepted the offer of Messrs. Dick, Kerr & Co. to undertake the necessary extension of the electricity mains along the routes of the light railways, with the exception of the distributors from a point opposite the *Fox Inn*, Holgate, to the city boundary on the Acomb-road, and from Lendal Bridge to Railway-street, for £2,031 4s. 1d. The cost of the distributors excluded as above mentioned will be covered by the difference between the amount of Messrs. Dick, Kerr & Co.'s tender and the loan of £2,510 which the Local Government Board has sanctioned for the mains. The Committee also selected the tender of Messrs. Cox Walkers, Ltd., of Darlington, for the new traction switchboard, etc., for the light railway, for the sum of £383 8s. 1d. Meters will be attached to this switchboard for measuring the total of energy supplied for railway purposes.

AN UNSOLICITED TESTIMONIAL.—The following letter has been received by the Edison and Swan United Electric Light Co., Ltd., from one of their customers:—"September 24, 1909. We have to-day despatched for your inspection one of your 32 c.p., 100 volt Metfil lamps. This has been in use for 5,880 hours and has only just burned out."

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BUSINESS NOTES.

LIGHTING AND GENERAL—Home.

ACTON.—The District Council passed a resolution, expressing the opinion that the maximum demand based on the load factor of the users of current for power and light would be fairer to the consumers than the flat rate now in force, and referring the question, together with the Electrical Engineer's report, to the Electricity Committee to settle the rate of charges. A motion in favour of asking the Metropolitan Electric Supply Co. whether they would take over the Council's electricity on specified terms was negatived.

BRIDLINGTON.—The Council agreed to apply to the Local Government Board for sanction to a loan of £3,000 for electricity extension purposes. On behalf of the Electricity Committee it was urged that the loan was practically forced on them by the number of new applications for light and power, and by the necessity for a new engine and generator and extensions to the buildings

BRIGHTON.—The abstract of the Corporation accounts for the year ended March 31 last shows that the liabilities on the electricity undertaking were £581,965 and on the tramways £246,784, against £595,673 and £257,185 respectively in 1907. During the year £15,000 was borrowed in respect of the electricity works as compared with £20,000 in the previous year. A sum of £835 was borrowed for the tramways.

BROMLEY.—A scheme prepared by the Chairman of the Electricity Committee to free wire and provide current for a fixed sum per lamp per annum has been referred to a sub-committee to report. To the same Committee was also referred the question of tendering for the street lighting of Shortlands.

EAST HAM.—The Chairman of the Corporation Tramways and Electricity Committee (Mr. Oakes), reporting on the past year's working, stated that the electricity accounts showed a profit, and the result was that, instead of the rates going up a penny for the half-year, they would remain the same as at present. The tramways, however, had been run at a loss, and there was a deficit of £750. This was due to the competition of the motor-'bus, the takings for the year being £5,000 less than in the previous year. At the same time, the Tramways Committee had to find a large sum for repairing roads which were chiefly damaged by the motor-'bus, and it was time that the motor-'bus companies were compelled to pay a share towards the upkeep of the roads.

LEICESTER.—The report of the Electric Light Department, as passed by the Town Council, showed that the receipts for the half-year amounted to £13,966, while the total expenditure had been £5,824, giving a gross surplus of £8,042. After paying interest on capital £3,791, and sinking fund £3,344, there was a net profit for the half-year of £907. There had been a decrease of output of the money value of about £1,800. During the year the increase in customers for light and motors totalled 209, so that the committee were hoping that very shortly they would be able to present as good a balance-sheet as they had done previously. The Council decided to apply to the Local Government Board for sanction for the borrowing of £7,000 for cables and works in connection with the supply of electrical energy from the Tramways Generating Station for power purposes.

LONDON.—The prospect of some of the principal thoroughfares in the East End of the City being pulled up by one of the electric lighting companies in order to "connect up" with Hampstead, is, the *City Press* understands, likely to be averted by an arrangement on the part of the Corporation. There is every reason to suppose that the Streets Committee will come to some arrangement with the City of London Electric Lighting Co. for the mains of the South London Co. being placed in the already constructed ducts, thus avoiding any upheaval of the streets.

LONGTON.—Mr. F. H. Tullock, the Local Government Board inspector, conducted an inquiry relative to the application by the Council for sanction to a loan of £1,740 for electric lighting purposes. The Town Clerk (Mr. G. C. Kent) explained that the loan was required for the extension of an electricity main from Trentham-road on through Dresden, in the best residential district of the borough. The total amount already raised for electricity purposes was £26,450. Of that sum there were balances unspent of £125 14s. 7d. and £369 17s. 10d. The Council asked the Board for permission to spend those balances, and the Board had suggested that that should not be done, but that a loan should be taken up for the whole sum required. Since the receipt of the Board's letter the Council had not met.

MANSFIELD.—Mr. M. K. North held a Local Government Board inquiry respecting the application by the Council for sanction to borrow £3,500 for works of mains, meters, etc., in connection with the electricity undertaking.

MERTHYR.—On the recommendation of the Management Committee, the Board of Guardians resolved to adhere to their decision to light the workhouse and infirmary by electricity, notwithstanding the representations made to the Local Government Board by Mr. John Mann on behalf of the Borough Ratepayers' Association and by certain other ratepayers. The committee stated that they were of opinion that the annual saving for actual lighting under the scheme proposed would amount to at least £100, so that in five years the Guardians would have saved a sum equal to the amount of the proposed capital outlay for the installation of the system. In addition to this, there would be a considerable saving of expense in the cleaning, painting, decorating, etc., of the buildings by the adoption of electricity, and from a hygienic and health point of view electricity was decidedly preferable to gas for lighting purposes.

SOUTHEND.—The Town Council adopted a scheme for increasing the efficiency of the electric light service at a cost of about £13,000.

SPALDING.—The question of lighting the town by electricity has been referred to a Committee of the Urban Council.

YORK.—The return for the month of August gives the number of units generated at the City Electricity Works as 100,616; last year 82,609; horse-power of motors connected nil; corresponding month last year 13½; total horse-power connected 1,167, last year 1,059½; 8 c.p. lamps connected 343; last year 518; total 8 c.p. lamps connected 66,395; last year 61,837; equivalent 8 c.p. connected—total, 95,570; last year 88,331. The total cost was £499 11s. 10d., cost per unit 1·45; last year £483 8s. 9d., cost per unit 1·43.

LIGHTING AND GENERAL—Overseas.

CRESWICK (Victoria).—An electric lighting plant has been installed at the West Berry Consols Gold Mine, Creswick; and in the half-yearly report just issued, the Mine Manager (Mr. Jos. Skewes) speaks of it as a great improvement. An electric haulage plant is also being installed.

CALCUTTA.—The Indian State Railways have decided to instal electric lighting in all new first and second class carriages.

JAPAN.—There are good openings in Japan for all kinds of electrical machinery and appliances. Latest accounts show that 177 firms and companies are engaged in electrical enterprises, 146 providing electric light and motive force; their total collective power is about 300,000 kw. Some 210,000 houses are lighted by electricity, being provided with 860,000 incandescent lamps and 910 arc lamps. The most important company is the Tokio Electric Light Co., which at present has three power stations and nine sub-stations for transformation. This company is about to enlarge its works to the extent of four generating machines and 47 transformers, and has under consideration the erection of new power stations and sub-stations for transformation, etc. Several other companies are also about to undertake improvements and extensions of a similar nature, while others newly constituted have not yet completed their installations. The number of officially recognised electric tramway companies appears at 60, but only some 20 are as yet working, the installation being generally slow for lack of capital. Some tramway companies supply also electric light and motive force, and of these, by far the most important is the Tokio Jetsudo Kabushika Kaisha, which is about to carry out considerable extensions.—In connection with the restoration work in the area devastated by the fire which occurred at Osaka recently, it is intended to construct a broad road, three miles in length, and to lay down electric tram lines, which will be linked up with the existing municipal system. The municipality incurred loss by damage to roads and tram lines.

MEXICO.—With regard to the formation in Mexico of a company to manufacture steel and chemical products by the use of electrical power, H.M. Legation in that country report that the company has been granted a concession to establish a factory for producing carbide of calcium cyanide of potassium, caustic potash, caustic soda, and chloride of lime. The company undertake to invest $200,000 (about £20,000) in the enterprise; plans for the buildings are to be submitted to the Ministerio de Fomento within a year from August 17, and the factory is to be completed within two years from the approval of the plans. Additional factories may subsequently be erected to cost not less than $50,000 (about £5,000) each. The concession is for a period of 10 years. The company may import free of duty all machinery and apparatus, building materials, etc., necessary for the construction of the factory and for the manufacture of the chemicals.

MUSSOORIE.—The damage done to the Mussoorie Hydro-electric Works at Galogi, by the recent deluge, is summed up as follows:—Two bridges entirely swept away. Twenty-seven lengths of steel piping destroyed or lost. The Pushta and terrace surrounding the power-house washed away for a considerable length on the north, and undermined slightly at the south end by the lowering of the river bed, and the drivers' quarters and workshops flooded. The damage has been temporarily repaired and pumping and lighting resumed. The Mussoorie Municipal Board have offered to instal electric light and lay water at a very moderate charge that can be liquidated on the yearly payment system in 10 years.

PONDICHERRY (India).—The plant of the electric lighting installation, the contractors for which were Messrs. Siemens

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Bros., comprises two suction gas engines, each driving by means of belting a Siemen's direct current generator, 14 k.w. 460 volts. The gas for the engine is produced by means of two suction gas plants, the fuel used being either charcoal, or Indian coke. The plant is complete with motor-driven pump for the producer scrubbers and for engine-cooling purposes. The engines, in addition, are fitted with motor-driven air compressors, complete with receiver, to enable each engine to be started with minimum trouble. As the system of distribution employed is on the three-phase principle, *i.e.*, 220 volts between each outer and neutral wire, a balancer, consisting of two Siemen's generators on one base plate is provided and a main switchboard, consisting of two generators, one balancer and two feeder panels, is designed for the simple control of the above and the various street-lighting circuits. There are 324 lights installed for street lighting purposes.

SERVIA.—The communal authorities of Velke Hradiste have applied for powers to build a large electrical works for the needs of the district.

SOUTH AFRICA.—Three generators of 2,000 kw. capacity are about to be ordered for the new Farrar-Anglo-French power station. Orders will, the *British South African Export Gazette* understands, shortly be placed for a number of electric motors for the Rand Water Board. Valuable orders may be anticipated in the near future for telephone and telegraph material in connection with extensions of the Transvaal Government services. The Monomotapa Concessions, Ltd., will be in the market in the near future for a large hydro-electrical plant.

TONGIO WEST (Victoria).—Mr. Frank J. Coote, M.E., General Manager of the Cassilis G.M. Co., Tongio West (V.), in his recently issued report, states that during the eleven months the power station has delivered to the works and mines a continuous supply for 275 days of 140 h.p. To generate 1 h.p. continuously for a year by boilers and steam engine, as they were originally doing, required 12·33 cords of wood, costing £11 13s. Allowing for stokers and other charges, this came to £5,635 for the preceding twelve months before they closed down in August, 1907. The present power is generated and delivered at the motors at a cost of £3 17s. 6d. per horse-power per year, or £7 15s. 6d. less per year than with steam power. If the demand equalled the whole capacity of the electric plant, there would be a further considerable saving on the cost of each horse-power year. As their plant had only one shut-down of less than 20 mins., it might be classed for this year as a power supply in the first class.

URUGUAY.—Official reports state that there is a good opening in Uruguay for electric motors and accessories.

TRACTION—Home.

BOURNEMOUTH.—The Town Council negatived a motion to run a service of Sunday trams.

HANDSWORTH.—The Urban Council resolved to obtain a loan of £85,563 from the Wesleyan and General Assurance Society at 3½% interest. Tramway purposes in connection with the recent acquisition of the cable route, and the Hockley depôt will absorb £80,000 of that amount. The Clerk was requested to ask the Board of Trade to appoint a referee to settle the terms of the lease to the City of Birmingham Tramways Co., Ltd., with regard to the trams in Soho-hill, Soho-road and Holyhead-road.

LONDON.—The London County Council notified the Bermondsey Borough Council of their intention to lay electric cables for the tramways through Tower Bridge-road, Grange-road, Southwark Park-road, Raymouth-road, and Rotherhithe New-road and Tooley-street to Evelyn-street, Deptford.

PADDINGTON.—The Borough Council declined to sanction the proposal of the London County Council to construct a tramway along Edgware-road, from Marble Arch to Cricklewood.

ST. PANCRAS (London).—The temporary tramway track has been laid on the last side of Highgate-road. A regular service of cars has started running from Hampstead, *via* Malden-road, Prince of Wales'-road, and Great College-street, both to Holborn and to Moorgate-street.

WANDSWORTH.—The London County Council tramways from Hackney Station to Stamford-hill, and from Nine Elms-lane to Cedars-road, Wandsworth, after reconstruction for electric traction, have been inspected by the Board of Trade, and opened to public traffic.

WOLVERHAMPTON.—On behalf of the Board of Trade, Lieut.-Col. Yorke has inspected the Victoria-street and Lea-road extension of the tramways.

TRACTION—Overseas.

ADELAIDE.—The traffic receipts of the Adelaide Municipal Tramways for the half-year ended July 31 amounted to £71,646, as compared with £55,271 for the same portion of last year, the increase being £16,375. Traffic expenses amount to £31,728, as compared with £27,250, an increase of £4,478. The gross profit was, therefore, £39,918 for the half-year, as compared with £22,021 for the corresponding portion of last year. Only four lines are being worked electrically.

ITALY.—A decree has been issued, granting to the Società Anonima "Les Tramways de Bologne," of Bologna, powers to construct and work a new electric tramway from the Alemanni terminus to the suburb of Crociali di Bologna. The new line will take the form of an extension of the Via Mazzini tramway. Another decree authorises the "Société Anonyme des Tramways de Livourne," of Leghorn, to construct and work a new electric tramway from the Piazza Cavour-San Iacopo to Via Salviano.

RIO DE JANEIRO.—The concessioner company of the Corcovado Railway, viz., the Rio de Janeiro Tramway Light and Power Co., Ltd., has been authorised to substitute electric traction for steam power on the railway in question, for which purpose the expenditure of a sum of 410,300 milreis (about £26,000) was sanctioned. The company must submit plans within three months for the carrying out of the work.

RUSSIA.—Most of the tramway undertakings in Russia are owned by Belgians. Of 40 tramway systems either at work or under construction 34 belong to Belgians, and three only to the French. Out of 1,312 versts (about 875 miles) of tramway track in Russia 1,086 versts, or over 80% belong to foreigners, and the remaining 226 versts are either worked by municipalities or by Russian concessionnaires.

SWITZERLAND.—The new Ritten Electric Railway will be over seven miles in length, and partly worked by simple adhesion and partly by rack rail. In describing the system, a correspondent states that the rack-rails on the Strub system are each 12 ft. in length, and are fixed on curved supports. Effective transmission of the pressure to the toothed wheels is secured by the use of skids, weighted with concrete blocks. The current for the motor is supplied from the Botzen Electricity Works. It is furnished at a high tension, and is reduced by a 300 kw. transformer to a tension of 3,000 volts to drive the 325 h.p. motor of the converter. The motor is asynchronous, with induced short-circuit current. Owing to the high speed of rotation (930 r.p.m.) and the high tension of the current, the continuous current dynamo is provided with four auxiliary poles. The tension of the feed-wire in contact, the battery being placed in parallel, is 750 volts. The running rails are used for the return current. The rolling stock comprises three locomotives, with pinion gear, four motor coaches, several trailers for the conveyance of passengers, and four goods trucks.

EDUCATIONAL.

MANCHESTER.

The current number of *The Journal*, published in connection with the Municipal School of Technology, Manchester, makes an attractive and interesting volume. It embodies a record of the investigations undertaken by members of the teaching staff, the abstracts of papers, etc., published relating to the Electrical Engineering Department, Mechanical Engineering Department, Physics Department, and Chemistry Department. Quotations are made from THE ELECTRICAL ENGINEER and other technical journals, the notices, in many instances, being illustrated with diagrams.

THE SIR JOHN CASS INSTITUTE.

Particulars are announced in another column of the courses of instruction for the ensuing session at the Sir John Cass Technical Institute, Jewry-street, Aldgate, London, E.C. The courses have been arranged to meet the requirements of those engaged in chemical and engineering works, or who are concerned with the use of fuel as a motive power.

PERSONAL.

Mr. L. L. Horrell (late of Walsall Electricity Department) has been appointed by the Pretoria Town Council to the position of Assistant Electrical Engineer, at a salary of £500 per annum, with £60 extra for locomotive expenses.

Mr. T. Commerford Martin, co-editor of our esteemed contemporary, the *Electrical World*, of New York, has retired from that post in order to assume to onerous duties of Secretary of the National Electric Light Association. He will carry into his new sphere of activity the goodwill of a very wide circle both at home and abroad.

Mr. T. J. West, Electrical Superintendent of the North Midland District of the Post Office, is retiring under the age limit. The district will after December 1 be absorbed by the Leeds and Birmingham districts, opportunity being thus afforded to the existing staff at Nottingham of transferring to other centres of administration.

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NEW CATALOGUES.

The latest publication of Messrs. Vickers, Sons & Maxim, Ltd., describes and illustrates the V.S.M. Automatic Forced Lubrication System, as manufactured and supplied by them, for all types of bearings, including Axle Boxes for Railway Rolling Stock. The advantages claimed for the system are that it ensures lubrication on the surfaces exposed to maximum pressure, automatic lubrication by positive mechanical means requiring no attention, and economy of oil—the lubricant working in a closed circuit for an indefinite period. Moreover there is no wear between the rubbing surfaces, and consequently no fall in alignment, it prolongs indefinitely the life of the bearings and indirectly of the machine, eliminates chances of breakdown due to faulty and defective lubrication, and with the absence of friction, the coal bill is reduced considerably.

From Messrs. James Hodgkinson comes a list dealing with their Patent Coking Stoker and Self-Cleaning Firebars. The apparatus is specially suitable for induced draft and listed as smokeless under all conditions. It is completely automatic, working from start to finish with closed fire-doors, and can be applied to any type of boiler or furnace.

Messrs. W. N. Brunton, of Musselburgh, Scotland, are sending out an attractive little catalogue bringing together the principal grades of high-class steel wire that are in every-day use. These wires are now used for small tools and all descriptions of shafts, straining wires, where a high tensile strain is required, and both tension and compression springs.

We have received pamphlets describing Kynoch Roller Bearings and Self-Oiling Bearings, manufactured by Kynoch Ltd., Birmingham. The co-efficients of friction of repose and of motion of the Kynoch Roller Bearing are ·0115 and ·0082 respectively, or about ⅛ of the co-efficient of friction of an ordinary bearing in each case. By carrying the main and counter shafting on Kynoch Patent Roller Bearings a saving of from 50% to 75% of the power used to drive the shafting will be effected. Other advantages claimed for these bearings are saving in oil and labour, in belting, and in wear and tear.

Messrs. Siemens Bros. Dynamo Works, Ltd., have sent us a copy of a new folder dealing with "Tantalum" Lamps, many thousands of which have already been supplied to electrical contractors and ironmongers, printed with their name and address.

The Empire Engineering Co., London, are issuing a new list of their "Empire" (petrol or gas) engines. They claim that the Empire is the first perfected type of two-cycle petrol engine, and will give more and steadier power, with less trouble and at less expense than any other engine of its rated capacity.

SOCIAL AND RECREATIVE.

The Anchor Cable Athletic Club, Leigh, Lancashire, held a very enjoyable tea and smoking concert under the presidency of Mr. J. Bowyer (Works Manager). During the evening Mr. A. Crooke, chairman of the Leigh and District Cricket League, presented the 2nd Division championship cup and medals to the members of the cricket team. In handing the cup to the captain (Mr. P. Wright), Mr. Crooke hoped that the club would succeed in winning the 1st Division cup next year. Mr. P. Wright replied on behalf of the members, and asked Mr. J. Bowyer, as chairman of the Athletic Club, to accept charge of the cup. Mr. Bowyer then presented the club average prizes, for batting to Mr. T. Tobin, and bowling to Mr. P. Wright.

MINING ELECTRICAL ENGINEERS.

The Home Secretary has been approached by the Institution of Mining Electrical Engineers with a view to a member of the Institution being appointed on the Committee for the consideration of the question of revision of the rules respecting the application of electricity in mines. The reply of the Home Secretary, read at the Institution meeting, at Sheffield, states that, although the constitution of the Committee will not allow of the special representation applied for, suggestions from the institution will be welcomed. Mr. W. Maurice (President) announced at the meeting that the articles of association will be submitted to the Board of Trade in order to have the institution incorporated. He hoped there would be an increase in the number of members.

EAST LONDON ELECTRICAL EXHIBITION.

At the invitation of Mr. C. Newton Russell, Electrical Engineer to the Borough of Shoreditch, a meeting of exhibitors was held at the Electricity Offices, Coronet-street, Hoxton. The following Committe received appointment: Mr. F. Pooley (Chairman), Mr. H. Harrison (Vice-Chairman), Mr. E. P. Barfield, Mr. T. Lambie, and Mr. S. Rentell, with Mr. H. Dixon (Secretary), 11, Victoria-street, Westminster, S.W. It was announced at the meeting that nearly all the available space had been taken up, and, therefore, any firms in the industry who are desirous of exhibiting and have not yet secured space, should communicate at once with Mr. Russell. The Secretary of the Exhibitors' Committee will be pleased to receive and suggestions, etc., from exhibitors which they may wish to be brought before the Committee.

SCHAFER METHOD OF RESUSCITATION.

Directions to be observed in cases of electric shock are embodied in a special chart issued by the Royal Life Saving Society. The instructions, which, by the courtesy of the Society we are able to illustrate, are in accordance with the new Schäfer method, and comprise the following:—

To free from contact.—Note carefully and quickly the surroundings; then avoiding contact with any live conductors, and using great caution if high pressures are involved, pull the patient away if practicable; if not, break the circuit. To pull the patient away avoid actual contact with the skin; use rubber gloves if at hand, or pull by a loose part of the coat (even this may be dangerous in case of high or extra high pressure), or by any non-conducting dry material available, such as a loop of rope, a broom-handle or crooked stick. If the patient is holding any portable electrical apparatus pull out the plug of the connector.

After release from contact.—Place the body on a dry floor or table, or dry straw, and, if no sign of breathing can be observed, immediately proceed to promote artificial breathing.

Artificial breathing.—1. Turn the patient face downwards. (*See Diagrams.*) 2. Kneel at his side and place your hands flat in the small of his back with thumbs nearly touching and the fingers spread out on each side of the body over the lowest ribs. (*See Diagrams.*)

Fig. 1. Expiration.

3. Then promote artificial breathing by leaning forward over the patient and without violence, produce a firm, steady, downward pressure. (*See Fig.* 1.) Next release all pressure by swinging your body backwards without lifting your hands from the patient. (*See Fig.* 2.)

Fig. 2. Inspiration.

4. Repeat this pressure and relaxation of pressure as directed in clause 3, without any marked pause between the movements, about 15 times a minute, until natural breathing is established. 5. The efforts to restore breathing must be carried out with perseverance, as life has been restored after a long period.

In all cases medical assistance should be sent for as soon as possible, and stimulants should not be administered unless advised by a medical man. The charts are issued at a small fee from the offices of the Society (8, Bayley-street, London, W.C.), and the Society's handbook contains particulars of a special drill recommended.

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PATENTS.

Electrical Relay.

4399.—1909.—M. S. CONNER, Hale, Cheshire. This improved relay of the single core type is principally applicable to telephones, cheapness in construction and facility in adjustment being the main features. Fig. 1 is a plan, Fig. 2 an end elevation, and Fig. 3 a side elevation of a relay. The relay consists of an electro magnet A, whose core B has at one end an iron back plate C, forming an extended pole to which an armature E is hinged at D. The free end is brought near to the other pole of the electro-magnet. The end of the core forming this pole protrudes beyond the coil, and the end of the armature is curved at E^1, so as to present a considerable surface to the pole, with the object of

FIG 1

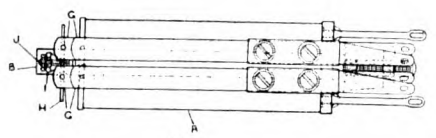


FIG.2

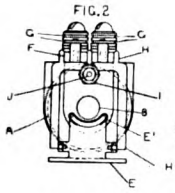
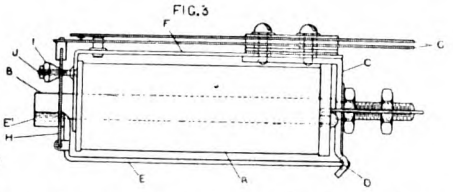


FIG.3



diminishing the reluctance of the magnetic circuit through the air gap. On the opposite side of the electro-magnet from the armature E is fixed a plate F supporting contact springs G, and the armature and a spring are linked together by a U-shaped link H. The amount of motion permitted the armature is adjusted with great nicety by means of a coned nut I, which is arranged to form an adjustable stop, and for this purpose is placed so that an edge of the link H may rest on the coned part of the nut. when the nut is advanced on its supporting screw J, the coned part of the nut I lifts the armature E. and thus by turning the nut in one direction or the other the adjustment of the relay is easily effected.

Connecting Terminals for Switchboards.

11267.—1909.—H. BRAND, Arnhem, Holland. The improved connecting terminal for switchboards is illustrated in the accompanying drawings. Fig. 1 is a front view, Fig 2 a side view in section, and Fig. 3 a back view of the connection. Fig 4 is a front view of the switchboard with the connecting terminals mounted. Fig. 5 a cross-section along line A–B of Fig. 4, and Fig. 6 a top view of Fig. 4. The terminal consists of a quadrangular casing *a*, of porcelain, adapted to receive two brass clamps a^1 for the wires which are either inserted in the bores in the ends *b* and *c* of the clamps and secured by means of the screws *i* and *i*, or fastened between the heads of the screws and the clamps. The latter are retained in the casing by the screws, the heads of which engage with apertures in the casing. The terminals are mounted on a bar *e*, which fits in grooves in the casings at the back of the switchboard *d*, and is secured by means of screws *f*. In this position, the connections for the lighting leads *g* appear as far above the top of the switchboard as the manipulation of the screws *i* requires. The lines *h* belonging to the switchboard are connected to the ends *c* of the clamps from the back. The casing may be provided with one connection only, in which case it would serve as a unipolar connecting terminal.

FIG.1. FIG.2. FIG.3.

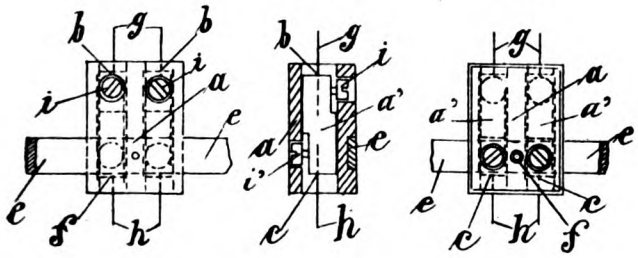


FIG. 4.

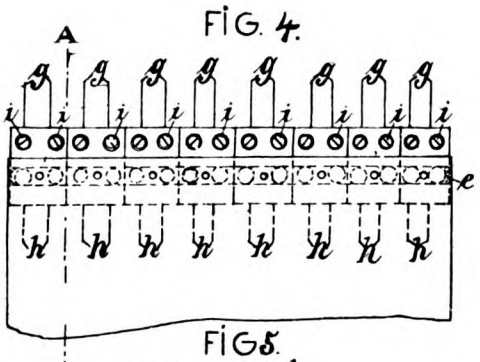


FIG5.

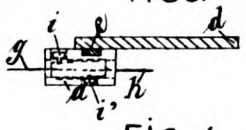
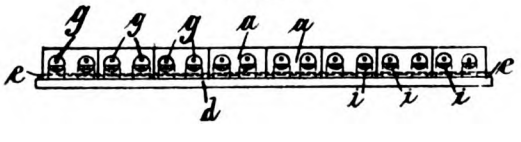


FIG. 6.



Protective Devices for Alternating Current Systems.

4705.—1909.—ALLGEMEINE ELEKTRICITATS GESELLSCHAFT, Berlin. This is an improved device for cutting out a faulty piece of apparatus in the event of the protective devices which are now commonly used, failing to operate. Fig. 1 illustrates two sections *a* and a^1 of a feeder provided with four automatic switches *i* to i^{111}. The primary and secondary windings of the transformers are indicated at *d* and *c* respectively, the former being located in the distributing main and operating to induce opposite electromotive forces in the secondary windings *e* which are connected in series through relays *h* in such a way that during normal working no current circulates through these relays. On the occurrence of a fault, however, in a section, the balance of electro-motive forces is upset, and current will flow through the relays *h* causing the automatic switches to be opened. The overload relay h^1 is connected in shunt to the transformer secondaries *e*, the contacts of the relays *h* and h^1, being in parallel in the auxiliary tripping circuits, including the coils of the automatic switches. With this arrangement, if switch i^{111} does not automatically disconnect on the occurrence of a fault in the section a^1, then the overload relay h^1 on the preceding cable operates at a predetermined current value to disconnect the healthy section, so that further working with a fault in circuit is rendered impossible. In Fig 2, the overload protection is obtained by short circuiting the terminals of the transformer primaries, the one through the fuse *s* and the other through an ordinary resistance *w* having the same resistance as the

Fig. 1.

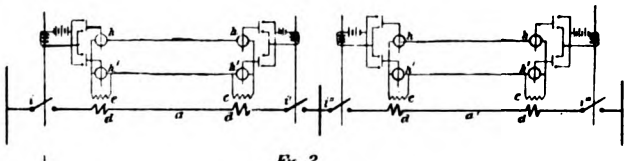
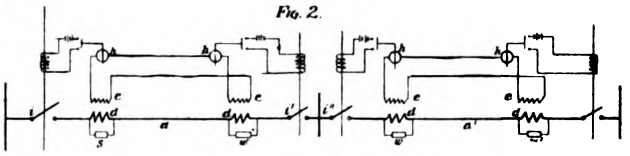


Fig. 2.



fuse *s*. In this case the overload relays h^1 are omitted, and the operation is as follows: If a heavy overload lasts too long fuse *s* melts, and the transformer potentials in the secondary windings *e* no longer counter-balance each other, and a current consequently flows in the auxiliary circuit. This current energises the relays *h*, which in turn operate the automatic switches for disconnecting the section. Instead of connecting the fuse and resistance in parallel with the primary winding of the transformer, they may be connected in parallel with the secondary windings. In this case, under certain circumstances resistances must be inserted with the fuses in order that the necessary potential may be obtained for the operation of the protective relays *h*, that is to say, in the case of a fault a sufficiently large part of the secondary current must also flow from the relays *h*. It is, however, not absolutely necessary to connect the fuses in parallel, but resistances may be used that are relatively constant over a certain range of current variation, but change when the current exceeds a certain definite value, one resistance in parallel to one of the transformer windings varies differently to the other resistance, and so causes an inequality of the secondary potentials of the transformers, and thereby gives rise to a current which circulates through the relays *h* and trips the switches. This arrangement is illustrated on cable a^1, Fig. 2 of the drawings in which the resistance *w* may be of nickel and resistance w^1 of iron.

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Controlling Electric Cranes.

23111.—1908.—E. M. Holme, Stockport. For each motor of the crane, a controller is provided in which contact devices are put into and out of use so as to close circuits, and cut out resistances in proper order by means of solenoids controlled through a flexible cable from a switchboard at a distance.

Electrical Connection with Rods of Silundum.

22627. 1908.—G. Cooper & F. C. Sharp, Lichfield. In order to obtain a good electrical connection for rods of silundum and similar materials of poor conducting quality, the connecting pieces are made of metal compressed round the rod, while in the plastic state and allowed to cool under pressure so as to constitute a thorough electrical continuity between the connection and the refractory rod.

Electric Switches.

3628.—1909.—W. H. Hood, Canning Town. The fixed contacts are mounted on the insulating block which forms the base of the switch in the usual way. The movable contact is pivotted to a lever frame which is itself pivotted to the insulating block. The elastic member is pivotted to an arm on a bell crank lever which takes the place of a tumbler lever. The other arm of the bell crank lever engages the inner end of a push and pull spindle. The connection between the bell crank lever and the spindle is insulated by means of an ebonite sleeve instead of insulating the movable contact itself.

Electrically Driven Grinding Machines.

20988.—1908.—G. Robson & F. Marshall, Sheffield. The base of the apparatus is cylindrical and provided with means for securing it to a foundation. A circular grooved pathway is provided on the upper part of the cylinder, and on this is mounted a revolving head. On the upper part of the revolving head are two V-shaped slides parallel to each other and at a sufficient distance apart to allow of their supporting two V shaped wheels from the trunions of which two side rods are carried, their rear ends being fixed to a bracket which carries the motor, and their front ends carrying a cross head which supports the front end of the driving spindle. By this arrangement the driving spindle can be actuated and adjusted so as to work either horizontally, diagonally, upwards, or downwards, or in radial lines through the whole circumference of a circle or 360°.

Electrical Commutators.

21740.—1908.—E. G. Cleverly & F. L. Anderson, London. This is an improvement in commutators used for distributing current to the electrical sparking plugs of internal combustion engines, particularly those of motor vehicles. The object is to simplify the construction and reduce the cost of manufacture as well as to obtain a completely closed distributor box, and ensure perfect security of the terminal adjustments. The distributor box is formed of a block of fibre and surrounds the rotary brush of the distributor. The various terminals consist each of a screw plug passing radially through a threaded hole in the side of the block, the distance to which the point of the plug projects within the box being adjusted by screwing the plug inwards or outwards through the hole. Each screw plug is prevented from rotating by means of a plug passing through a longitudinally extending socket hole in the block and making an interlocking connection with the screw plug. The locking plug serves as the removable terminal of the corresponding wire to which it may be attached.

Electrical Fuses.

20890.—1908.—H. J. Fuller, Leeds. This electrical fuse has a special additional fusing chamber which is applicable to all forms of electrical fuses now in use. The chamber consists of a tube of a non-conducting and heat-resisting material, large in diameter and small in length, open at one or both ends, and provided with small slots shaped to allow the easy insertion of the fuse wire through the tube across a diameter of transversely to its length, so that the expulsion of the gases will take place at right angles to the fuse instead of parallel as is now usual. In this way, sudden evolution of gases due to heavy circuit can be easily and harmlessly expelled without damaging the expulsion chamber.

Railway Signalling System.

17952. 1908. T. Macdougal & J. Chambers, Boulder, U.S.A. The object of the invention is to provide an organisation of indicatory instruments and electrical actuating means which are simple in construction and positive in operation, and by means of which the location of one or more trains in relation to one or more predetermined points on the line of a railway may be indicated at each station in a division and signalled to the engineers of following or oppositely moving locomotives. The indicatory instruments comprised in the system are divided into two classes, composite or station instruments, and unitary or track instruments, all of which operate on the same principle and by impellant means. Every station instrument is so constructed that it is possible to at once see the position of a train at any point along the line. The unitary instruments are disposed in proximity to the railway line at the stations and at the entrances and exits of switches and railway yards. If the distances between stations is large, the unitary instruments and the associated circuit closing devices, which are actuated by passing trains, are placed at intermediate points. The closing of the circuits operates the signals.

Electric Cells.

18115.—1908.—J. Spiliotopol, Berlin. This is an improved cell of the class in which electric energy is developed by heating the cell. The electrolyte contains chromium sesquichloride as its active constituent. The negative or soluble electrode contains as its active constituent a metal which is insoluble in chromium sesquichloride in the cold, but is soluble therein in heat, and is reciprocated in the metallic state from the solution in the cold. The depolarising agent at the positive electrode contains a chloride compound of a metal capable of exerting a depolarising action, and which, after exerting its depolarising action, can be re-constituted in the cell by cooling for the purposes of enabling the cell to be regenerated by simple heating and cooling.

Thermo Electric Piles.

18277.—1908.—A. Ritterhausen, Kassel. The metallic opponents of each couple comprising the series which forms the thermo-electric pile, consist of two concentric rings which are quite distinct and are connected together only by narrow or thin parts, the cross section of which depends upon the required stability and the current to be conducted through them. The several components are not connected with one another on their contact faces by the usual soldering, but are connected by electrolysis means or pressure whereby the pile can be heated in an economical manner.

THE GERMAN ELECTRICAL INDUSTRY.

The German electrical industry has been but little affected by the economic depression. Nevertheless (says Sir Francis Oppenheimer, Consul-General at Frankfort-on-Main, in his annual report), while the year 1907 showed an upward movement, which extended to the beginning of 1908, a change occurred during the second half of that year, which was largely due to the unfavourable conditions of the iron industry and of the building trades. The threatened tax on electricity also had an adverse influence. Additional difficulties arose through the contemplated Prussian company tax, and numerous electrical companies have already decided to remove their offices from Prussia to one of the Hanse towns in the event of this proposed tax becoming law. With regard to new inventions, the electrical industry holds the record for the greatest number of patents applied for during 1908, which was 2,721, and also for the number which were granted, while from 1877 to 1908 the patents applied for amounted to 30,483, and those which were granted to 11,749. Statistics included in the report show that the horse-power of motors built by the A.E.G. increased from 647,273 in 1904–5 to 1,350,327 in 1907–8, the corresponding figures relating to the Lahmeyer Co. being 265,000 and 358,000. During 1904–5 the Schuckert works built motors of 964,150 total h.p., and in 1906–7 of 1,060,150 h.p. Generating plant in power stations shows a growth from 191,645 kw. in 1900 to 730,151 kw. in 1907, since when the figures have further increased. The new capital invested in electrical companies during 1908, not including new power stations, was 78,330,000 marks (£3,966,500), as against 42,365,000 marks (£2,118,750) in 1907; and the average dividend of 45 electrical companies, controlling capital amounting to an aggregate of 573,245,000 marks (£28,662,250), is calculated at 8·1% for 1906–7 and at 8·3% for 1907–8.

TRAMWAY ACCIDENT AT EDINBURGH.

At the termini of the cable tramway system in Waterloo-place, Edinburgh, a singular accident occurred. The street was congested at the time with people on their way to the Musselburgh Races, and a large crowd had gathered to board the cars. Suddenly one of the cars got out of hand—one of the strands of the cable becoming twisted in the gripping apparatus of the vehicle—and it rushed away at top speed among the crowd, several of whom were knocked down in the stampede. Further down the street the tramcar smashed into the rear of a motor-car, the driver of which was thrown into the roadway. The tramcar broke free of the strand, and came to a standstill. Six persons were seriously injured, and a number of others, knocked down either by the tram or car, suffered from cuts and minor injuries. Three constables were among the victims,

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COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last prices. £
British Insulated and Helsby Cables, Ord. 1-100,000	5	7¼-7⅝
—— 6 p.c. Cum. Pref., 1-100,000	5	6⅛-6¼
—— 4½ p.c. Mortgage Debentures	100	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100	89-94
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 1-200,000 and 275,001-475,000	3	3/16-7/16
—— p.c. Mortgage Debenture Stock	100	38-42
Callender's Cable, Debentures	100	105-107
—— Ordinary	5	10⅛-11⅛
—— 5 p.c. Pref.	5	5⅛-5¼
Consolidated Electrical Co., Ordinary, 1-110,000	1	⅛-¼
Dick, Kerr, and Co., Ordinary, 1,260,000	1	1-1⅛ xd
—— 6 p.c. Cum. Pref., 1-305,000	1	1 1/16-1⅛ xd
—— 4½ p.c. Debenture Stock.	100	100-103
Edison and Swan United, " A " Shares, 1-99,261	3	3/16-5/16
—— " A " Shares, 01-017,139	5	1-1⅛
—— 4 p.c. Deb. Stock, Red.	100	68-73
—— 5 p.c. 2nd Debentures	100	82-85 xd
Electric Construction, Nos. 1 to 112,100	2	7/16-11/16
—— 7 p.c. Cumulative Pref.	2	1 3/16-1 7/16
—— 4 p.c. Perp. 1st Mort. Deb.	100	65-69
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100	68⅛-74⅛ xd
General Electric Company (1900) 5 p.c. Cum. Pref.	10	8-8⅛
—— 4 p.c. 1st Mort. Deb. Stock	100	83-87 xd
W. T. Henley's Telegraph Works, Ordinary	5	12⅛-13⅛
—— 4½ p.c. Preference	5	5⅛-5⅜
—— 4½ p.c. Debentures	100	106-108
National Electric Construction Co., 1-170,000	1	⅛-¼
Telegraph Construction and Maintenance	12	34⅛-36
—— 4 p.c. Bonds	100	101-103

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Bournemouth and Poole, Ordinary	10	9⅛-10⅛
Brompton and Kensington, Ordinary	5	7⅛-7⅜
—— 7 p.c. Preference	5	7⅜-8
Canadian General Electric Co., Common Shares	$100	120-125 xd
—— 7 p.c. Cum. Pref. Stock	$100	118-120
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5	4-4⅛
—— 4½ p.c. Cum.. Pref., 1-80,000	5	4⅛-5
—— 4 p.c. Debenture Stock, Red.	100	96-99
—— " City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5	3⅞-4⅛
City of London, Ordinary	10	10⅛ 11
—— 6 p.c. Cumulative Pref.	10	11⅞-12⅛
—— 5 p.c. Debenture Stock	100	121-124
—— 4½ p.c. 2nd Deb. Stk. Red.	100	100-103
County of Durham Electrical Power Distribution Co., Ordinary, 1-50,000	5	1⅛-2
—— 5 p.c. Preference, 1-50,000	5	3-3⅛
County of London Elec. Supply, Ordinary	10	7⅛-8⅛
—— 6 p.c. Cum. Pref.	10	10⅛-11⅛
—— 4½ p.c. Debentures Prov. Certs. Al pd., Rd.	100	104-107
—— 4½ p.c. 2nd Debentures, Red	100	100-103
Edmundson's Electricity Corporation, Ord., 1-80,000	5	⅛-5/16
—— 6 p.c. Cum. Pref.	5	⅛-¼
—— 4½ p.c. First Mort. Deb.	100	57-60
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100	91-94
Kalgoorlie Electric Power and Lighting, 6 p.c. Non. Cum. Pref., 1-150,000	1	⅜-27/32
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000.	5	7-7⅛
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100	96⅛-99½ xd
London Electric Ordinary	3	1⅛-2⅛
—— 6 p.c. Pref.	5	5 5⅛
—— 4 p.c. 1st Mortgage Debenture Stock, Red.	100	93-97
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	76-80
Metropolitan Ordinary, 100,001-300,000	5	4 4⅛
—— 4½ p.c. First Mortgage Debenture Stock	100	105-108
—— 4½ p.c. Cum. Pref.	5	4⅝-5
—— 3½ p.c. Mortgage Debenture, Red.	100	83⅛-86⅛
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,050 ($500) M 1-4,400 ($1,000)	—	81-83%
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb. Red	—	97-100
Newcastle-upon-Tyne Electric Supply, Ord., 1-50,000 and 57,010 to 137,500	5	4⅛-4⅜
—— do. 50,001 to 57,009	5	4⅛-4⅜
—— do., 5 p.c. Pref., 1-137,500 Non. Cum.	5	4⅛-5⅛
Notting Hill Electric Lighting	10	12⅛-13⅛
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	6-6⅛
—— 4 p.c. Debenture Stock	100	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1	1 1/16-1 3/16
—— 6 p.c. Non-Cum. Pref., 1-100,000	1	1-1⅛
—— 5 p.c. Debenture Stock, Red.	100	103-106
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5	5 1/16-5 1/8 xd
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5	5⅛-5⅜ xd
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	—	105⅛-107⅞%
Smithfield Markets Electric Supply, Ord., 1-12,000	5	⅛-¼
South London, Ordinary	4	2⅝-3
South Metropolitan Electric Light and Power Ord.	1	5/16-9/16
—— 7 p.c. Cum. Pref.	1	1 1/16-1 3/16
—— 4½ p.c. 1st Mort. Deb.	100	100-103 xd
St. James's and Pall Mall, Ordinary, 101-20,080 and 40,081 to 60,100	5	8⅛-9⅛
—— 7 p.c. Pref. Non. Cum.	5	7-7⅛
—— 3½ p.c. Deb.	100	84-88
Urban Electric Supply Co., Ordinary	5	⅜-½ xd
—— 5 p.c. Cumulative Preference, 50,001-100,000	5	1⅛-1⅜ xd
—— 4½ p.c. First Mort. Debenture Stock, Red.	100	77½-78½ xd
Westminster, Ordinary	5	8⅛-9
—— 4½ p.c. Cum. Pref., 110,101-191,379	5	5-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 5 p.c. Cum. 1st. Pref., 1-640,000	5	4⅛-4⅞
—— Debenture Stock, Red	100	92½-93⅛
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1	⅛-¼
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1	9/16-11/16
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	87-90
British Columbia Electric Railway Co., Ord. Def.	100	144-149
—— Ord. Pref.	100	120-125
—— 5 p.c. Cum. Perpetual Pref. Stock	100	106-110
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	102-104
—— 4½ p.c. Vancouver Power Deb.	100	102-105
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10	⅛-¼
—— 6 p.c. Cm. Pf., 30,001-60,000	10	1⅞-2⅛
—— 5 p.c. Perpetual Debenture Stock	100	81⅛-84½ xd
—— 4½ p.c. 2nd Deb. Stock	100	62-66
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100	98-100
Calcutta Tramways, Ord., No. 1 137,610	5	4⅛-5⅛
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5	4⅛-5
—— 4½ p.c. 1st Deb. Stock, Red.	100	99-102
Cape Electric Tramways, Nos. 1-491,222	1	3 1/16-7/16
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5	4⅛-5⅛
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100	98-102
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5⅛-6
—— 4 p.c. Deb. Stock, Red. (1985)	100	99-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12⅛-13⅛
London United Trys (1901) 5 p.c. Cum. Pref.	10	2⅛-2⅜
—— 4 p.c. 1st Mt. Db. Stock, Red.	100	67-70
Metropolitan Elec. Trams., Detd., 1,000,001-1,314,016	1	1/32-5/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1	11/16-13/16
—— 4½ p.c. Deb. Stock, Red.	100	94⅛-96⅛
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100	100½-103½
Provincial Tramways Co., Ordinary, 1-24,912	10	4-4⅛
—— 6 p.c. Cum. Pref., 1-10,000	10	9⅛-10⅛
San Paulo Tramway, Light, and Power Co.	$100	149-152 xd
—— 5 p.c. 1st Mort Deb., Red. (1929) 1-12,000	$500	101-103%
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅛-¼
—— 4 p.c. Deb. Stock, Red. (1940)	100	69-73
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5	⅛-¼
—— 6 p.c. Cum. Pref., 1-46,261	5	1⅞-2⅛
—— 4½ p.c. 1st Deb. Stock, Red.	100	81-85

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100	61-63
—— 4 p.c. Pref.	100	85-87
—— " " deferred	100	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	101-103
City and South London, Consolidated Ordinary	100	30-31⅛
—— 4 p.c. Debenture Stock	100	100-102
—— 5 p.c. Pref. Stock '91	100	108-110
—— " " " '96	100	104-107
—— " " " '01	100	100-103
—— " " " '03	100	96-100
Liverpool Overhead, 5 p.c. Pref.	10	4⅛-5
—— Ordinary, 1-50,000	10	⅜-½
—— 4 p.c. Mortgage Debentures, Red., 1-1,700	—	94-96
Underground Electric Railways of London, 5 p.c. Prior Ln. Bds.	—	102⅛-103⅛

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price £
Amazon Telegraph Co., 1-25,000	10	2⅞-3⅛
—— 5 p.c. Debs., Red., within 1-1,609 Red	100	93-96
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000	97-99
Anglo-American Telegraph Co., Ordinary	100	61⅛-63⅛
—— 6 p.c. Preferred Ordinary	100	104-105
—— Deferred Ordinary	100	21⅛-22
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100	89-91 xd
Direct Spanish Telegraph Co., Ordinary	5	3-3⅛ xd
—— 10 p.c. Cum. Preference	5	8-8⅛ xd
—— 4½ p.c. Debs., 1-600	50	100⅛-102⅛
Direct United States Cable Co.	20	13⅛-13⅜
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 p.c. Mort. Debs., within 1-8,000 (1913,	25	100-102
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	25	100-102
Eastern Extension, Australasia and China, 1-300,000	10	11⅛-12⅛
—— 4 p.c. Mort. Deb. Stock, Perp.	100	102-104
Eastern Telegraph Co., Ordinary Stock	100	129-132
—— 3½ p.c. Preference Stock	100	85-87
—— 4 p.c. Mortgage Debenture Stock	100	104-106
Great Northern Telegraph Co. (of Copenhagen)	10	26-27
Marconi's Wireless Telegraph Co., Nos. 1-394,190	1	⅛-¼
National Telephone, Preferred	100	106⅛-108
—— Deferred Stock	100	121-123
—— 6 p.c. Cum. First Pref.	10	10⅛-11
—— 6 p.c. Cum. Second Pref.	10	10⅛-10⅞
—— 5 p.c. Non. Cum. Third Pref.	5	5 7/16-5 11/16
—— 3½ p.c. Deb. Stock, Red.	100	98-100
—— 4 p.c. Deb. Stock, Red.	100	100-102
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100	100-102
West Coast of America, 1-30,000 and 53,001-53,008	2½	1⅝-1⅞
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	100-102
West India and Panama Telegraph Co., Ordinary	10	11/16-13/16
—— 6 p.c. Cum. 1st Preference	10	8⅛-9⅛
—— 6 p.c. Cum. 2nd Preference	10	8⅛-9⅛
—— 5 p.c. Debs., Red., 1-800	100	101⅛-103⅛
Western Telegraph Co., 1-207,930	10	13⅛-13⅞
—— 4 p.c. Debenture Stock, Red.	100	103-105

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1909.	1908.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Sept. 29	1,505	1,442 +	63	— 521	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940,	5·93
Ayr Corporation	Sept. 18	671	562 +	108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Aug. 7	2,770	2,650 +	120	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Sept. 26	1,063	1,099 —	36	— 441	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Sept. 25	6,683	6,570 +	113	—	56·792	58 52	—	—	—	—	—	—	—	—
Blackburn Corporation	Sept. 29	1,075	1,184 —	109	— 852	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050 +	102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,329 —	24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Sept. 26	2,422	2,274 +	148	— 168	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723 —	42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Sept. 25	5,043	4,545 +	498	+ 3,583	98	98	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	„ 19	1,113	1,050 +	63	+ 1,299	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Oct. 1	5,914	5,270 +	644	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Oct. 2	1,368	1,359 +	9	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Oct. 3	271	251 —	20	— 270	10	10	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957 +	43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175 —	5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Oct. 2	5,342	8,331 —	2,989	—31,433	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	„ 7	3,695	3,515 +	180	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Sept. 26	3,213	3,265 —	52	+ 1,168	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219 —	39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Sept. 30	522	459 +	63	—	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Sept. 17	1,716	1,397 +	319	+ 2,183	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Sept. 18	284	276 +	8	— 206	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252 —	22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Oct. 1	161	147 +	14	—	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Oct. 1	5,668	5,612 +	56	+ 1,472	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Sept. 29	1,193	1,150 —	43	— 541	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Oct. 2	987	960 +	27	+ 3,571	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Sept. 25	17,290	17,341 —	51	— 2,210	185½	179	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Sept. 29	359	458 —	99	+ 565	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Aug. 7	4,430	4,480 —	50	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Sept. 25	1,726	1,833 —	107	+ 1107	28½	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	Oct. 2	2,579	2,473 +	105	+ 1,143	26	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Sept. 25	493	470 +	23	+ 895	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Sept. 29	135	151 —	16	— 247	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 8	259	266 —	7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Sept. 29	1,338	1,423 —	85	— 446	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624 +	272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130 +	32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Sept. 11	11,070	10,784 +	286	— 2,149	104	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Sept. 26	1,389	1,395 —	6	+ 166	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Sept. 18	37,982	36,908 +	1074	+ 33,694	124½	122½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	„ 17	216	258 —	42	— 743	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Sept. 25	205	239 —	34	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297 +	334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Oct. 2	9,933	9,680 +	253	— 5,451	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Oct. 3	16,326	17,713 —	1,387	— 3,382	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 2	143	140 +	3	— 21	2½	2½	Mar. 31	7,362	2,060,712	204,710	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Sept. 25	3,898	4,006 —	108	— 1,198	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Sept. 25	667	642 —	25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516 +	262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809 +	237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Sept 30	614	641 —	27	— 143	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126 +	114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587 —	32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,596	4,662 —	66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Sept. 26	5,643	5,617 +	26	— 921	68½	66½	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Sept. 15	1,151	1,090 +	61	— 388	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug. 21	995	557 +	438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336 —	26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Sept. 22	169	156 +	13	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647 —	17	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Oct. 2	958	962 —	4	—	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Sept. 23	2,391	2,225 +	165	+ 3,881	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Sept. 22	879	804 +	75	— 784	22½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train miles. *h* Half-year's figures.

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THE
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NOTES.

TRANSFORMERS.

Great as is the increase of the use of transformers in general practice, many problems connected therewith still remain obscure, and give much trouble, at all events to the younger generation. Bearing this in mind, the first of a series of papers intended mainly for students, and written by the chief of the Electrical Department of one of our leading working Universities, will be devoted to this question. This first course, as one may term the series of articles, will be divided into a set of three papers entitled "Transformer Notes and Calculations." These papers will be found eminently practical and suggestive, and should prove helpful to many. Where doubts arise in the minds of students, free use of our inquiry columns should be made. With a view to complete this matter, it is proposed to follow the first paper, which will appear in our pages next week, October 22, with brief descriptions of some leading types of transformer. This should give special value to the issue, which will have a considerable circulation in the Colonies, where transformers are greatly in demand.

MINERS AND ELECTRICITY.

The Miners' Federation of Great Britain, at their meeting at Newcastle-on-Tyne, displayed a somewhat exaggerated phase of the opposition to the use of electricity in coal mines. It must be remembered that miners—and a finer body of men it would be difficult to gather together—are but human, and there lies under their opposition a dislike angered through the fear that electricity will mean less work. In this they are right enough in a sense, for electricity, notably so in the matter of coal-cutting machines, means economy of labour, but this cheapening of labour in the long run will mean more employment; for, among other things, it will make it possible to work mines that hardly pay under existing circumstances. This not altogether unnatural prejudice, however, must be borne in mind, when we come to consider the common-sense proposition, that the additional inspectors required should be drawn from the miners' foremen. Many of these men would make excellent inspectors, if subject to the supervision of the scientifically trained engineer. That the opposition is by no means universal is shown by the straightforward and enlightened speech of Mr. John Johnson, M.P., and perhaps even more strikingly so by the letter, which we publish in another column, of Mr. J. Reklats, himself a working miner.

DIRECT ELECTRICAL PRODUCTION OF STEEL.

In connection with Herr Ljunberg's paper on production of iron and steel by the electric smelting process, we were pointing out only last week that it behoved our iron-masters to consider the problem seriously, and not to take too long over the pondering phase. That there is need for action is brought home daily to those who keep in touch with the progress made in this direction. Not only is the iron smelting and steel production by electricity progressing rapidly outside these realms, but now the problem of direct production of steel from iron ores has been silenced by means of the electrical furnace. At Dommeldingen, in the Duchy of Luxemburg, low-grade ores containing an abnormal amount of phosphorus have been tested in the electrical furnace and yielded excellent steel, said to compare with that obtained from high-class Swedish ores. The furnaces used are of special construction, the invention of two German electricians, Herren Ruechling and Bodenhauser. The furnaces are being built in Berlin for a company organised to exploit them. Of course, this is a conquest of immense import to our German friends, for they possess in Loraine and Luxemburg huge deposits of these low-class ores, which hitherto have been regarded as practically valueless, but the principle involved has an interest reaching far outside the German frontiers.

INSULATED WIRE FOR CANADA.

A letter from Mr. F. A. Cambridge, City Engineer for Winnipeg, Manitoba, is worth noting. He says that there is being placed on the Canadian market rubber covered wire manufactured in the United States. Although it is on the approved list of the American Underwriters, it does not bear a factory inspection label, and he states that he and his committee are afraid that some inferior grades of wire are being dumped on the local market. This is a serious matter, as few of the municipal and other bodies in Canada possess the necessary facilities for satisfactorily testing insulation before actually installing the wires. It appears that Canadian manufacturers also neglect to send out insulated wires with factory inspection labels and guarantees. It would appear, therefore, that here is a good opportunity for British enterprise, with its soundness of practice, to step in. What is mainly required is reliability, which we can surely give better than our American friends. As we have said before, Canada is worth cultivating from the electrical engineers' point of view.

SILUNDUM AND ITS USES.

One of the most promising products of the electric furnace is silundum, a silicon carbide evolved by causing carbon to absorb silicon in the form of a vapour at 1,600°C. Unlike carborundum, which is met with both in the amorphus and crystaltine forms, silundum is a hard mass, retaining the original form given to the carbon before it is exposed to the silicon vapour. Silundum does not oxidise at any temperature below that requisite to vaporise silicon, and is proof against acids and alkalies. This interesting alloy, which is due to the discovery of Herr F. Bolling, is capable of many uses; among others it will make capital bars for electric grills, plates for electric cooking stoves, and for laboratory furnaces and autoclaves. It will also replace the more expensive platinum in the working of brass, aluminium, etc., for although it is attacked by high temperature molten metals, it can be effectually protected by a very thin deposit of platinum.

ANTICIPATING LOANS.

Local authorities, when they have studied some scheme thoroughly, finally adopted it and applied for a loan, are rather apt to take for granted that such loan will be sanctioned without restrictions, and so, borrowing from a bank or otherwise, proceed merrily to carry out the work before the Government inspectors have begun the necessary local inquiry. It is a bad practice, one which is causing inspectors to jib, and Government Departments to make cutting remarks. It must be remembered that it is quite possible for the right to borrow to be refused, or only granted subject to considerable modifications. Some fine day a municipality will be pulled up short, and then either be saddled with a truncated scheme, the expenses of which have to be met out of the rates, or the responsible members may find themselves surcharged. These anticipations of loans occasionally crop up in connection with electrical schemes. When such an event is pending, the electrical engineer should act as a restraining force, for he comes in for some of the odium attaching to so mischievous and decidedly impertinent proceeding.

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COOKING IN THE COLONIES.

The decision of the Cape Town City Council to import electrical cooking appliances as a trial outfit in connection with the City Electricity Department should open the eyes of manufacturers to the great prospects the Colonies offer. As a rule, electric current in the colonies compares favourably with gas, so the question of cost does not hamper experiments. On the other hand, the advantage of being able by merely turning on a switch or two is likely to be keenly appreciated, where labour saving is assuredly such a matter of importance, and where often peat radiating stoves are such a soreness to the flesh. Properly pushed, electrical cooking appliances should go well in most of our colonies.

GIRDLING OUTER LONDON.

We already possess an inner and outer circle of electrical railways, but that this does not meet the needs at the present day most dwellers in, and visitors to, London know by bitter experience. Busy as are the promoters of tube and other railways, these are mostly of the radial character, useful enough in their way, but hardly giving that needful link between the outer fringes of this huge Metropolis. The scheme for an outer girdling of London suburbs by an electrical railway, crossing the Thames at Walton and having a ferry at Woolwich by way of link between North and South, as described at length in our Correspondence columns, is bold in the extreme. Many will wish it success, but will sigh to think that it is scarcely for our generation. There are certainly many difficulties in the way, yet it must not be overlooked that such a railway would be of immense service for goods as well as for passenger traffic, and therein lies the hope of its feasibility.

EDUCATION OF ENGINEERS.

Our recent note on the importance of a high standard of education for electrical engineers is confirmed by the striking lecture by Professor J. A. Fleming, M.A., D.Sc., F.R.S. (printed in THE ELECTRICAL ENGINEER last week), and endorsed by the practical experience of Mr. W. M. Mordey, President of the Institute of Electrical Engineers. Mr. Mordey, in presiding at the lecture at University College, London, confessed that the results of the education of engineers were often very disappointing and, particularly in certain cases, might be still more disappointing in the future. The training of the electrical engineer in some ways had been rather in advance of the times, but he believed an improvement was taking place, largely because the field itself was expanding in so many new directions. Discussing the difficulties in training, he remarked that in the College the students learnt principles and, to a great extent, the application of those principles. At the works, however, young men often entered with quite wrong ideas of what they ought to do. His own advice to young men was, "Aim at qualifying in the shops, so that if necessary you can do work as a workman and earn your pay as a workman." Moreover, he impressed upon young engineers the importance of obtaining a thoroughly sound commercial training, of understanding the calculation of estimates, and so on. As one who had had some experience of inventing he urged them not to run after inventing with any great hope that they were going to make fortunes. The fortunes that had been made by even very great ingenuity in connection with inventions were very few, and certainly in 97 or 98 cases out of a 100 the patent agent was the only man who made anything out of the invention.

SILICON AND CARBON RESISTANCE.

Some firms employ special materials; for example, Ferranti, Ltd., use blocks of silicon for their motor starters. Silicon has an electric resistance many times greater than cast iron, and it is also, of course, very refractory. An extremely high resistance can, therefore, be packed away in small space. The objection to it is that the resistance varies considerably with the temperature. The Reyrolle starter has a carbon resistance, and the material has the special characteristic of producing its temperature as it heats up. In the Reyrolle starter the switch arm is moved to the first contact, and the current gradually builds up to a valve that enables the motor to start. It may be interesting to recall the fact that the well-known lecture-table resistance, consisting of a number of carbon plates which can be pressed together by a screw, was invented by the workshop instructor at the Finsbury Technical College. If he had taken out a patent, it would have been valuable.

MOTORS FOR GASEOUS MINES.

It is extremely doubtful if there is such a thing as a perfectly gas-tight motor, for even if the shaft works in stuffing boxes the breathing of the air will in time be sure to make the inside atmosphere the same as outside. When a motor heats up to say 70° F. above atmosphere, some 15 or 20% of the enclosed atmosphere must find its way out or else the pressure inside must rise. If the air, or a part of it, gets out, then when the motor cools down air must go in again or there will be a vacuum. It is this alternate tendency to a pressure and a vacuum which causes the breathing action to be so powerful. Motors which may have to work in an explosive atmosphere are now being built by one of the leading firms with a casing able to withstand any explosion which is likely to occur inside. In other words, the designers have assumed that sooner or later a gaseous mixture will find its way inside.

UTILIZATION OF NATURAL LAWS.

In his paper on "Invention and Industrial Progress; with a Treatise on the British Patent System," read before the Graduates' Association, Institution of Mechanical Engineers, London, on Monday, Mr. J. E. S. Lockwood, Graduate, of Wolverhampton, observed that the utilization of natural laws undreamed of by our forefathers had created wide scope for the application of the inventive faculty, and has resulted in inventions of a revolutionary character. New industries had in consequence been created almost within our own time. The most important of the natural laws which had been utilized for practical purposes were the expansive force of steam, and the explosion of mixed gases; the attractive force created by electricity in soft iron, and the disruptive force in the deposition of metallic and other substances; the action of vacuum in evaporation, and in the temporary adhesion of contact surfaces; the action of electricity as a generator of light, heat, and power, and a transmitter of sound; the action of light upon sensitive films in the production of photographic images; the combined use of the vacuum and the electric current in the production of the incandescent lamp; the combined use of photography with the deposition of metals for the production of printing surfaces. It was possible that the patent records might be regarded as a barometer of the trend in which progress was being made in the various industries. Take, for instance, the steam-engine. In the year 1896 the number of patents granted in connection with steam-engines was 180, and 10 years later the number was 145. These numbers were entirely in keeping with the industrial progress of the branch of engineering with which the steam-engine was connected. Since the invention of the steam-engine, gas-engines, oil-engines, turbines and electrical power had been invented, and these under certain circumstances were in many ways preferable to steam engines. Latterly, turbine and reaction wheels had directed the attention of inventors, and are now becoming more widely used. In 1896 the number of patents granted was 47 while in 1906 the number was 226. The motor car industry has, within the last decade or two made very rapid progress. The number of patents granted in 1896 in connection with motor road vehicles was 360, while in 1906 the number was 547. In this industry carburetting apparatus and vaporizers may be specially mentioned as having taxed the ingenuity of many inventors. In 1896 the number of patents granted was 63, and in 1906 the number was 187.

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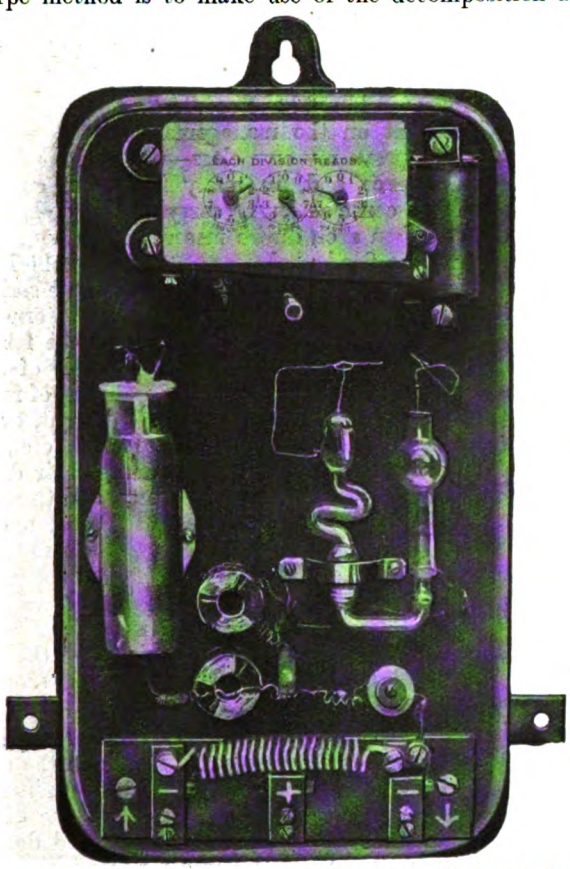
ELECTROLYTIC WATTMETERS.

A notable advance was made in engineering practice when electrolytic meters were introduced, but, successful as several types of these are, they all possess the drawbacks of having no dial and requiring resetting, even refilling. Now, with instruments of precision and computation, such as meters, the great desirata are simplicity of construction and automatic working. It was, therefore, felt that "the last word" in electrolytic meters had not been said, and many engineers have been studying the subject with a view to improvement.

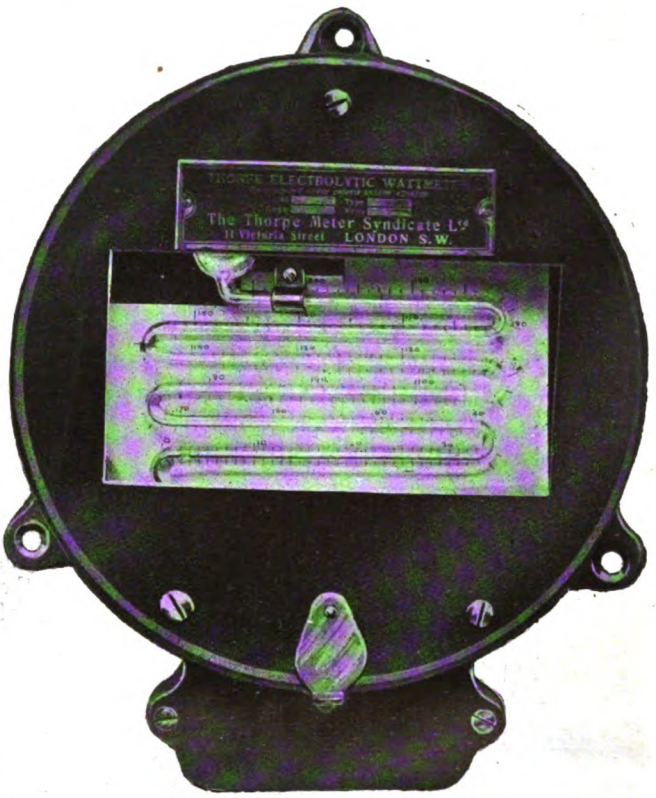
Mr. Thorpe, by patient research and experimentation, has succeeded in giving us a very simple, perfectly automatic dial electrolytic wattmeter. Like many another inventor who has introduced an instrument marking an epoch in the history of an industry, Mr. Thorpe has chosen the shortest cut to solve the problem, a straightforward way which, now that it is pointed out, seems quite obvious. In outward appearance the electrolytic wattmeter is very much like a motor wattmeter. It has the usual recording dials, is of the shunted type, so can be made in any size, and is compact. But, as regards the principle involved: the Thorpe method is to make use of the decomposition and



re-combination of an electrolyte, but placed in hermetically sealed tubes, so that no mischief can be done and no refilling is required. Moreover, the electrolyte is merely a caustic soda solution, and by this simple means chemical reaction is avoided and the life of the instrument enormously prolonged. As we have said, it is automatic in action, requiring no attention, shows records direct in kw. hours, has at full load from half to one volt drop, and very small shunt loss. It is evident that we have here a reliable instrument, whose very simplicity, and consequent inexpensiveness, should make it popular with all concerned.

Good evidence of the soundness of Mr. Thorpe's invention is shown by the adaptability of its principle. While we dwell specially on the dial wattmeter, his method is equally applicable to scale reading instruments, thus bringing his invention to the aid of the very cheapest types of machines. Even here, however, we find improvement, for these instruments, while requiring resetting, do not need to be refilled, and they give their records in B.O.T. units, not in ampere hours.

Other adoptions of the principle are the Thorpe time log circuit breaker and the motor starter. The first-named appliance can be fitted to any existing circuit breaker, but controls the operation until the time fixed has expired, and even should the overload cease, the tube automatically resets itself. The main coil can be placed in any position necessary. The motor starter is much like others, with the important exception that the radial arm is moved forward step by step by the action of the sealed electrolytic tube. If any fault occurs, the overload and shunt-winding release are so arranged as to ensure the contact arm starting from the initial stage.



It will be seen from the above brief account and the accompanying illustrations, that Mr. Thorpe has contributed valuable additions to the electrical engineer's equipment. He has given us something that is safe, accurate, automatic, and adaptable within wide limits. Which are the qualities that go to make permanent success.

It may be mentioned that these various instruments are being manufactured by the Thorpe Meter Syndicate, Ltd., Mr. Hayden Harrison, of 11, Victoria-street, Westminster, being the sole commercial agent.

ELECTRICAL PLANT AT DURHAM MINES.

The introduction of electrical plant is making steady progress in the Durham collieries. The Lahmeyer Electrical Co., Ltd., are to instal for the Blackett Coal Co., Newcastle-upon-Tyne, a main shaft electrical winder. The motor will be of the Lahmeyer standard three-phase type, running on a 500 volt, 40 cycle circuit. It will raise 78½ tons of coal per hour from a depth of 124 ft. The winding gear will comprise a cast-iron drum, driven by a motor through double induction spur gearing. In addition to the working brake, operating on a brake disc mounted on the side of the drum, there will be an emergency brake fitted on the second motion shaft. We understand that arrangements are being made by the Consett Iron Co., Ltd., for the installation of a single motor haulage plant at their Chopwell Colliery. It will be operated by a Lahmeyer standard three-phase asynchronous-induction totally enclosed motors. The specifications provide for a continuous output of 500 b.h.p., voltage, 625, three-phase, 50 cycles; full load speed, 182 r.p.m.; and maximum output of motor, 1,000 h.p. The controller will be of the Lahmeyer standard type, with oil-immersed reversing switch, both operated by one common lever. The motor is to be coupled up direct through flexible coupling, and one set of reduction gears to the haulage drums. At the Kimblesworth Colliery, the Charlaw and Sacorston Collieries Co., Ltd., propose to have installed a low pressure turbine plant for lighting, pumping, and general purposes. The plant is to include a Rateau patent heat accumulator, a 250 kw. Rateau mixed pressure turbine coupled to a direct current generator, and a multi-jet Leblanc condenser.

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MINES' INSPECTION.

NEWCASTLE CONFERENCE AND ELECTRICITY.

The necessity for additional inspectors of mines, men with a practical experience at the coal face, was the important subject of discussion at the Newcastle conference of the Miners' Federation of Great Britain, under the presidency of Mr. Enoch Edwards, M.P.

Three resolutions bearing upon this subject were on the agenda. The first was introduced on behalf of the Lancashire and Cheshire miners, and was moved by Mr. J. Butler in the following terms :—

"Seeing the great amount of work which H.M. Inspectors of Mines have to perform, we move that our Labour members of Parliament, also our agents, press the Secretary of State to appoint more inspectors. Such persons appointed shall have five years' practical experience at the coal face, and their salaries to be paid by the Treasury."

An impression was created by the speech of Mr. W. E. Harvey, M.P. (Derbyshire), who seconded the resolution. With regard to the West Stanley disaster last February, Mr. Harvey said it was now generally conceded that electricity in the mines had created a danger which had to be very carefully watched. It must be watched by the Federation, in order to protect the lives of the miners, and all possible legislation should be passed through the House of Commons. He hoped the recommendations of the Royal Commission would be adopted.

Mr. H. Dunn, Northumberland, introduced a resolution bearing on the same subject; but somewhat more definite in its application. The proposal was :—

"That in each mines inspector's district we seek to have a working miner inspector appointed."

It was mentioned by the mover that 1,340 lives were lost in the mines last year, and the average over five years was 1,219.

In seconding the Northumberland resolution, Mr. Manson (Midlands) emphasised the need for more frequent inspections, more particularly in the dangerous seams of the Black Country. They must induce the Home Secretary to appoint practical inspectors.

Mr. John Johnson, M.P., moved the resolution in the name of the Durham miners :—

"That this conference urges upon the Government the absolute necessity of the appointment of a large number of working miners as inspectors of mines."

The West Stanley disaster disclosed how much there was to be done on the question of electricity. In Durham there were 208 collieries, and there was one chief inspector and two assistants. Under the Mines Act of the country there were 3,227 mines, and the ratio of inspectors would be found to be about the same as he had quoted for Durham. In 1907, 757,887 miners were employed, and their output reached 282,000,000 tons. The two great dangers in the mines at present were coal dust and electricity. The Stanley explosion was a great revelation, and though at the inquest the verdict was that they could not say what had caused the accident, they, at that conference, need not be so "mealy-mouthed."

"I am definite in my opinion that the Stanley disaster was caused by electricity," declared Mr. Johnson, "and I think that everything possible should be done to minimise the dangers of electricity." He did not say that electricity should be eliminated entirely, but he did say that such precautions should be taken that the miners on leaving their homes might have reasonable anticipations of returning at the end of their day's work.

"We want workmen inspectors as far as possible—men with a technical knowledge, commensurate with their duties," he concluded, amid cheers.

In connection with the above report, the letter printed below, which was addressed to the Editor of the *Newcastle Chronicle*, should be read, as it emphasises the position taken up by Mr. Johnson. It is signed by J. Reklats, of Earsdon :—

"In perusing your issue of October 2, I was not a little surprised to find that one of the questions on the agenda is the important one of electricity in mines, and that, in view of the Government's Inspectors' reports on the West Stanley explosion in February last, the Executive Committee have brought before Parliament the dangers arising from the use of electricity in dry and dusty mines, and press for its immediate removal from such mines.

"Although as a working man in full sympathy with the general aspirations of the class to which I belong, I think in this instance that the Executive are not justified in demanding that the whole of the electrical plant should be immediately removed from the mines of this country because of the West Stanley explosion. Any one with a technical knowledge of mining who ascertains the opinion of many of the miners of that colliery and read the reports of the explosion in the various mining and engineering journals, in conjunction with the report of his Majesty's Chief Inspector of Mines, cannot but conclude that much of the evidence given at the inquest on the victims of that disaster was a perversion of facts, and can form no reliable data for future guidance and action in mining legislation. Furthermore, such an enactment would impose a burden and a hardship upon mining engineers and owners of other collieries, in no way responsible for the West Stanley catastrophe.

"It is quite evident that if the provisions in the Coal Mines Regulation Act as to watering in dry and dusty mines had been carried out in their entirety, the West Stanley calamity would not have occurred. I have no desire to sit in judgment on the management of the colliery, rather would I reprove my own class—the working men—for their indifference and, in many instances, culpable negligence in not conscientiously carrying out daily their ordered duties, when such duties mean the safety of their fellow workmen. I firmly believe that much of the hardship and suffering (not to speak of anything more serious) of our fellows is largely due to these causes. An alternative and better mode of procedure, I think, would be for the Federation Executive to impress upon the whole of their members who may have to attend to the watering of roads, the firing of shots, the switching of electric current, or the actuating of any part of such an installation, etc., the imperative necessity of conscientiously doing their duties for the general safety of their fellow-workers, and to report at once to the management, their lodge official, and, if need be, to the Government Inspector for the district, any danger that they may have noticed arising from accumulation of gas and coal dust or of insufficient watering, or ineffective insulation of any electric plant. They would thereby assist the management in carrying out the provisions of the Coal Mines Regulation Act and in securing the safety of life and property.

"To my mind, electricity in mines, whether used for coal-cutting, haulage or other purpose, stands in the same category in relation to dry, dusty, and gaseous mines, as do blasting explosives. And yet there is not one of the associated districts in the Federation that would dare to demand that explosives be not allowed for blasting in such mines. Why? Because they realise the hardship that would be placed on the producer, consumer, and the owner.

"Another question which is to occupy the attention of the conference is, that they urge upon the Government the necessity for the appointment of additional inspectors, including the working miners. If this demand should become a legislative enactment, there would be created such an anomalous precedent as has not been in the history of the coal trade, unless and until such appointed miner possessed a technical knowledge of mining equivalent to that required by the law for a certificated manager of mines. Otherwise it were an absurdity to expect a practical working miner to prosecute, maintain or adjudicate on a point of danger or insufficient ventilation against a person with a technical knowledge and high intellectual attainments. We have practical proof of that in connection with the periodical inspection by the workmen under General Rule 38 of the Coal Mines Regulation Act., which is at many collieries neither more nor less than a farce, and in many instances there required ascertainment of the work to be done for safety has been a useless burden of cost on production, which must inevitably come off the pick-point. I know that this is not the prevailing opinion, but I speak from personal observation and experience. I have crossed the Rubicon."

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STANDARDISATION IN ENGINEERING.*

By HENRY ADAMS, M.Inst.C.E., M.I.Mech.E., F.S.I., F.R.San.I.

Although I am not new to the Presidential Chair of engineering societies, this Association is unique in its membership. Other societies contain engineers of all kinds: some who are good talkers—commercial engineers; some who are good schemers—who can get up a limited liability company to float their projects; some who are good designers—who can prepare plans for any work for which money is forthcoming; some who are specialists—who devote their time to carrying out one class of work; but you, gentlemen, are the engineers who have to maintain the work originated by others, who have to make it a practical success, who have to make good the shortcomings of the theoretical men, to remedy the defects of their designs, and to maintain everything in working order and in the highest state of efficiency. This is responsible work, but it is very interesting, and I have no doubt that you all feel a pardonable pride in the positions you occupy.

I claim to have been an Engineer-in-Charge long before I joined your Association. From 1865 to 1877 I was assistant manager and afterwards manager of the outdoor department of Sir William Armstrong's firm, and was in charge of the erection of dock gates, bridges, hoists, cranes, hydraulic machinery of all kinds, and the fitting out of ironclads with guns. At the time of the construction of the Millwall Docks I was responsible for the daily work of fourteen foremen and four hundred men, and these are my credentials for associating myself with you to-night.

In casting round for subjects upon which to address you, it seemed to me that "Standardisation" was the keynote of the present age, and that a few remarks upon it might be useful. The earliest standard was probably the unit of length, but down to 1824 the only legal measure of length was "three barleycorns round and dry make one inch, twelve inches one foot, and three feet one yard." The first standard worthy of the name was a yard length marked on a brass rod by a mechanician named Graham, employed by the Royal Society in 1742. Two copies of Graham's yard, made by Bird in 1790, were legalised by Act of Parliament in 1824. Ten years after this the standards were destroyed by a fire which burnt down the Houses of Parliament; but the Royal Astronomical Society had an accurate copy, and at least one other was also in existence. From these, four Parliamentary copies were made and deposited respectively in the Royal Mint, with the Royal Society, in the Royal Observatory at Greenwich, and the Houses of Parliament. In form they are all bronze bars 1 in. square, each being 38 ins. long. Near the ends of each bar there are two holes, in which are inserted gold plugs with fine lines engraved upon their surfaces, which lines are exactly one yard apart at a certain stated temperature. The Act legalising these standards was passed in 1855. The accuracy of the measurement adopted may be inferred from the fact that a change of temperature of only one-hundredth of a degree Fahrenheit was found to produce a sensible effect in the length, and this yard is now the British Standard of Length.

Approximate standard measures for public use will be found on the north terrace inside the balustrade of Trafalgar-square, where the Westminster engineers check their surveying chains before and after use; and also in the Guildhall of the City of London, which surveyors in the City find more convenient. A 100-ft. steel tape may generally be found to be within $\frac{1}{8}$ in. of accuracy, a steel chain from $\frac{1}{2}$ in. to $1\frac{1}{2}$ ins., according to age and condition; while a corrected 66-ft. Chesterman wired tape, after being used on wet grass and wound up again, was found two days later to be 65 ft. 4 in. long; and three weeks later, when tested again before use, was found to be 65 ft. 9 in. long, or still contracted 3 in. owing to getting wet.

The method of estimating length by lines engraved across a bar is known as "line measure," and comparison in the case of the standard bars was effected by means of two micrometer microscopes reading to one twenty-thousandth part of an inch. Sir Joseph Whitworth, however, showed that the principle of "end measurement" was more accurate, and that the sense of touch, aided by mechanical means, was so much more reliable than that of sight, that he was able to detect by his measuring machine a difference of length of one-millionth of an inch. This remarkable feat was rendered possible by the means then available for producing true planes, which enabled apparatus to be constructed with almost absolute precision.

In 1840 Sir Joseph Whitworth introduced the method of scraping surface plates, instead of grinding them, to produce a true plane. He showed that to originate a surface plate it was necessary to obtain exact agreement between any two in a set of three, two only not being sufficient, as they might be respectively concave and convex, and be parts of a true sphere.

I have not found any record of the first introduction of plate and wire gauges, but 50 years ago there were in existence the Birmingham wire gauge, the Birmingham plate gauge, the Lancashire gauge, the music-wire gauge, the needle-wire gauge, and the Whitworth decimal gauge. The latter is the only one upon a rational basis, and as each number represents so many mils, or thousandths of an inch, it could have been made of universal application. The Birmingham wire gauge (B.W.G.) was the best known; but this gave way on March 1, 1884, to the Imperial Standard wire gauge (S.W.G.). This and the Standard Sheet and Hoop Iron gauge, which came into use at the same date, are merely fixed sizes corresponding to certain dimensions, but proceeding by irregular intervals. For galvanised iron roofing the old B.W.G. is still largely in use, but for sheet zinc there is a special gauge which bears on relation to anything else. For sheet lead the weight in lbs. per foot super gives the designation, *e.g.*, 5 lbs. lead, which is simple and satisfactory.

The first notable and practically successful effort at standardisation, as we now understand it, occurred when Sir Joseph Whitworth introduced his standard screw threads for bolts and nuts (1841–57). When I was an apprentice it was a very common thing to find that the bolts and nuts by different makers were not interchangeable, and a broken stud in a cylinder-end meant not only drilling out, but tapping a larger hole, because there were no dies to make the same thread as before. Only a few of the best shops were at that time supplied with Whitworth stocks and dies and screw taps; now, as you all know, they are universal—in Great Britain, at least. The Whitworth standard is, however, not the only one we have in use at the present time for screw threads. That was for mechanical engineers, and may be called the "bolt" standard. In addition we have the Whitworth gas threads adopted by the tube trade generally, and the British Association gauge for apparatus screws, which is adopted by the Post Office Telegraph Department and most large electrical firms.

Mr. H. F. Donaldson, in a recent lecture to the Graduates of the Institution of Mechanical Engineers on "Interchangeability and Methods of Securing it in Screw-Threads," said:—"It is impossible to overstate the value, not only to this country but to the world at large, of the work of Sir Joseph Whitworth. By his means standard length pieces, and machines of great precision for measuring and comparing them, were brought into practical use, and within the reach of anyone desiring to improve the quality of his work. He not only put these, but he put also upon the market plug-and-ring gauges nominally of true dimension, and, I believe, he also actually produced the equivalent of limit gauges, though he did not press this method of working upon the public view, perhaps because the general methods of engineering at that time were not sufficiently advanced, and did not seem to require it." In case there should be any present who are not acquainted with the object and use of limit gauges, I may explain that the system consists of having, for every true dimension required, two gauges called "go" and "not-go" gauges, so made that one is larger by a defined amount than the desired dimension of the piece of work, and the other smaller also by a defined amount. There are two important terms used in connection with these gauges—"allowance" and "tolerance." "Allowance" is the intended difference in measurement between the diameter of a shaft and its bearing, or a bolt and its hole; and "tolerance" is the difference that may be tolerated in good work between the dimension desired and that achieved.

The economical advantages of standardisation must have occurred to every manufacturing firm very early in its career, although it may not have got beyond the elementary stage where the parts could be cast from the same pattern, and marked off from the same templates. The firm of

* Presidential Address before the Association of Engineers-in-Charge.

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Willans & Robinson may occur to you as one that carried this principle to its extreme limit of usefulness, where every part of an engine was gauged to the thousandth of an inch to be perfectly interchangeable at any time; and many of you probably know that our friend, Capt. Riall Sankey, was largely responsible for this happy state of things. While I was working as an improver in a piecework gang I was very fond of introducing marking-off gauges, self-adjusting lathe carriers, and other standardising and labour-saving appliances, leaving me with spare time which, I am afraid, was spent in "larking about"; at any rate, it led to my being reported by the ganger, who said he and the other members of the gang were "keeping me." This led to an investigation, when it was found that I had earned more than any others in the gang, and then they turned face and said I was "bringing down the prices." It did not, however, prevent me from endeavouring always to find the shortest road to efficient completion.

One of the most hotly discussed questions of standardisation was known as "the battle of the gauges." It referred to the gauge of the rails for railway traffic, and ended in the permanent adoption by Act of Parliament (1846) of the standard of 4 ft. 8½ in. between the rails for Great Britain, and 5 ft. 3 in. for Ireland. The 4 ft. 8½ in. was called "narrow gauge," to distinguish it from the "broad gauge" of 7 ft. adopted on the Great Western Railway, but discarded in May, 1892. A similar battle was fought over the gauge for the railways in India, where we have the broad gauge of 5 ft. 6 in., and the narrow gauge of 1 m. = 3 ft. 3⅜ in., and now the battle ground has shifted to Australia, where there are about 7,000 miles of 3½ ft. gauge, somewhat less of 5 ft. 3 in. gauge scattered over several divisions, and 3,472 miles of 4 ft. 8½ in. gauge in New South Wales. Besides this, there are 82 miles of 2½ ft. gauge, and 23 miles of 2 ft. gauge. Standardisation has been proposed, but no action has yet been taken. It has been generally stated that the 4 ft. 8½ in. gauge was originally adopted because it agreed with certain existing colliery tram lines; but my idea is that no one would fix upon such an irregular measurement, and that it is more likely derived from a 5 ft. over-all measurement of the rails.

The formation of the Engineering Standards Committee by the Institution of Civil Engineers, at the suggestion of Sir John Wolfe Barry in 1901, was the first combined effort at standardisation, and the success of that body has been very marked. The main committee was reinforced by representatives of the Institution of Mechanical Engineers, the Iron and Steel Institute, the Institution of Naval Architects, and the Institution of Electrical Engineers; but besides the main committee, 12 sectional committees and 24 sub-committees have up to the present been formed to carry on the work. Some 280 engineers and others representing the cream of the experts in each branch have given their services freely to the work. They turned their attention first to rolled joists, and produced a very good list; up to that time the sizes and proportions of the various sections depended upon individual judgment, and there was on sort of agreement between the various makers. Besides rolled joists, all the common forms of section, angles, tees, zeds, channels, etc., were included, and later on, tables of their properties were given, viz., areas, weights, moments of inertia, section moduli, radii of gyration, etc. All this very much simplifies the work of designing, and has proved a great advantage to manufacturers. Those of you who may be acquainted with Skelton & Co.'s broad-flanged beams may have wondered at their exclusion from the standard list, seeing that their undoubted economy for many purposes is beyond all question. The reason given is that they can only be manufactured in a "Grey" mill under licence from the patentee, and that they are, therefore, at present not suitable subjects to include under a public standard, but there is nothing to prevent them from being adopted in suitable cases.

The British Standard Specification for Portland cement, which is No. 12 of the Reports, has been of very far-reaching importance, and has done more than anything else to raise the quality of Portland cement. Formerly every architect and engineer had his own ideas, or borrowed some, with regard to the tests and other details mentioned in his specification, frequently providing the manufacturers with difficulties, but, perhaps, quite as often giving them a loop-hole for escape. If the Standard Specification had not appeared just when it did, the spread of reinforced concrete building construction would have been attended with much greater risk, and probably failures also.

The standard specification for structural steel for ship-building, boilers, and bridges, and the forms of standard tensile test pieces, have all been extremely useful. Then we have the specifications for tramway rails and fishplates, bull-headed and flat-bottomed railway rails, tubular tramway poles, pipe flanges, and pipe threads, and various electrical matters. Stoneware pipes are not, perhaps, of such importance as many subjects that have already received attention; but there is a general concensus of opinion that they should be standardised, and it is probable that they will shortly receive the attention of the Engineering Standards Committee.

The *Engineering Record* points out that the standardisation of sections of iron and steel or the quality of cement is by no means all that has been desired in Great Britain, for there has been a certain degree of pressure brought to bear to standardise machinery. Early in the committee's work it was recognised that when the movement was extended to the form of structures or machines, there was risk of encroaching upon the domain of original thought and design. It was at first decided that only materials and sections should be dealt with, leaving to the engineer the decision as to how the standards should best be applied to solve the problems which he might have under consideration. In a rather strange way, however, a departure from this general decision was made quite soon. The Secretary of State for India requested the committee to prepare standard types for locomotives for the Indian railways. The consulting engineers of the Indian Government and the chief locomotive builders were accordingly associated with the proper sub-committees, and eventually a number of standard types of engines were designed, which have proved very satisfactory. This instance of the standardisation of complete machines, while not absolutely unique in the work of the committee, is nevertheless still looked upon as *open* to question as a regular policy, and no action has yet been taken on the request to standardise dynamos and prime movers. The danger of adherence to a standard after it is no longer serviceable has been recognised from the outset of the work of the British committee, like that of the American Society for Testing Materials, and consequently provisions are made for the reconsideration of every standard section or specification when the time is ripe for such action. Care has been taken, however, to safeguard this work of revision: for standards which are revised every year or so, are hardly standards at all. It is believed that by having each of them prepared by a sub-committee composed of men representing engineers, purchasers, and manufacturers, all engaged in their daily work with the subjects in which they are dealing, the standards will be so well drawn originally that the necessity for their revision will not arise quickly.

Those who have to carry out construction in brickwork know the difficulty that exists in bonding bricks of different quality, or from different sources, as although each group being made from the same size mould will not vary much, the different groups show considerable variation. A London brick averages 8⅞ in. by 4⅜ in. by 2⅝ in., but a Midland or Northern brick will be approximately 9 in. by 4½ in. by 3 in. The Royal Institute of British Architects, in consultation with the Brickmakers' Association and the Institution of Civil Engineers, framed conditions which came into force on May 1, 1904, fixing the average size of bricks and joints which may be summed up as giving the standard size of the bricks as 9 in. by 4·375 in. by 2·6875 in.

The use of co-ordinates in the production of curves is of extreme value in the case of any standard which consists of a series of values or dimensions. Numerals can only be grasped consecutively, but curves can be observed as a whole, and any irregularity is self-evident. So far back as 1860 I was using curves in this way, and have constantly adopted them for checking experiments and tests, and tabulating proportions. The "uniformity of Nature" is a very definite fact, and there would be less irregularity in the records of tests if it were the general practice to plot them to curves.

Some years ago an elaborate series of experiments was made upon riveted joints, under the auspices of the Institution of Mechanical Engineers; but although I gave con-

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siderable time to their elucidation, I was not able to formulate them into any general standard for my own use. It is a subject that would well repay the trouble of casting into a popular form, so that given a material of standard quality one might know the best pitch and diameter of rivets for mere strength in girder and bridge work, and to resist fluid pressure in addition in boiler and tank work.

Eye-bars, or eyes for the ends of links, for bridges, roofs, cranes, etc., was another matter to which considerable attention was given some 40 years ago, with the result that there were many suggested forms, but not one that could be called a general standard. We cannot say that mild steel represents finality in structural material, but it would be useful to have a standard form of eye-bar in this material.

Having been brought up as a mechanical engineer, I seem to drift generally to that aspect of any subject, but under the head of standardisation we have many branches to consider. I have only to mention the words "candle-power" to call to your mind a standard that we have heard a very great deal about since the introduction of the electric light. The standard candle, or, as it is sometimes called, the British Parliamentary candle, is a sperm candle, six to the lb., $\frac{7}{8}$ in. in diameter, and burning at the rate of 120 grains of spermaceti per hour. The "One-Candle Pentane Air-Gas Flame," invented by Dr. A. Vernon Harcourt, represents the true average value of the light of the legal standard sperm candle, but it is actually equivalent to 1·001 sperm candles. A similarly constructed 10-candle lamp was made permissible in 1898 for the official testing of London gas. The standard gas burner used for testing the illuminating power of all qualities of gas is the Sugg "London" (No. 1) argand burner, consuming gas at the rate of 5 cubic ft. per hour, with a chimney 6 in. long and $1\frac{7}{8}$ in. internal diameter. In France the standard illuminant is the Carcel lamp, burning 648 grains of pure oil per hour, and equal to about $7\frac{1}{2}$ candles. The German (Hefner) standard c.p. is only 88% of the English standard; German lamps are, therefore, rated too high compared with English. The Hefner lamp was adopted in 1896 as the practical international unit measure of light.

Other countries besides our own have given much consideration to the question of a standard of light, and there are many difficulties still to be overcome: the latest information is from the Bureau of Standards in the United States. Mr. Nutting, of the Bureau, brings forward an entirely new standard in the light emitted by a body of glowing helium gas. Helium, it will be remembered, says the *Engineering Record*, is an extremely light gas which produces a well-known bright line in the yellow of the solar spectrum that puzzled the astronomers for many years. Found first terrestrially in mere spectroscopic traces in the gases occluded in certain specimens of lava, it was finally found in the rare mineral cleveite, isolated and examined, and has since been discovered to be an almost infinitesimal normal component of the atmosphere. One of its many peculiarities is that it glows when electrically excited at reduced pressure with an exceptionally bright yellowish-white colour, much nearer the hue of ordinary artificial illuminants than the colour given by any other permanent gas. It was next found that a capillary tube, say a couple of inches long and one-tenth of an inch in diameter, could readily be so excited as to give an extremely steady light of 1 to 2 c.p. per inch of length, and that the tubes could apparently be readily duplicated to give concordant results. Bringing the tube to standard condition means merely applying a definite and very easily measured electric current. The life of the helium tube is not yet determined, but there is reason to think that it can be made reasonably good, especially if it should prove feasible to make a capillary tube of quartz.

Here, then, one has a standard light which seems to be capable of ready reproduction, and which is of good colour and fairly satisfactory magnitude. With quartz tubes the available magnitude could probably be increased to 5 or 10 c.p., which would be still better for the comparison of secondary standards. The light is entirely free from atmospheric conditions, and in steadiness leaves little to be desired. It is too early in the investigation to pass judgment on the true value of the helium tube as a standard; but it certainly looks very promising indeed, and is especially interesting on account of its novelty and simplicity.

The application of a standard of illuminating value to coal gas, although originated for that purpose, is felt to be somewhat of an anomaly, since incandescent mantles have been so widely adopted. It is the calorific value that is now the main consideration, and gas companies are consequently endeavouring to improve this by reducing the illuminating power. The South Metropolitan Gas Co., so far back as 1900, obtained permission to reduce their gas from 18 to 14 c.p., and last year the Edinburgh and Leith Gas Commissioners reduced the c.p. of their gas from 20 to 14. It is probable that a combined test will ultimately be substituted as a standard for the present test of the c.p. of the naked flame.

James Watt, at the latter end of the eighteenth century, introduced the first standard for the rating of engines and machinery, viz., the h.p. of 33,000 foot-lbs. per minute. He knew that the actual power of a horse was about 22,000 foot-lbs. per minute, but he wanted his engines to be well ahead of their specification, so he allowed a 50% margin. The various kinds of h.p. that one hears about—indicated, brake, nominal, actual, etc.—only refer to the mode of measuring or expressing it, and not to any intrinsic difference in the standard. Only two of them are really needed—the "indicated," which is the h.p. in the cylinder; and the "brake," which is the h.p. given out at the crankshaft. In fact, it would be an advantage to use the term brake-h.p. alone as being the actual power the engine can give out. Nominal h.p. is a useless commercial term, which may mean anything, and should be entirely abolished. In passing I may say that James Watt missed a grand opportunity in not making the circular inch the standard upon which steam pressure should be measured.

Just now there appears to be some stir about the proper mode of standardising the power of small petrol motors. They cannot very well be "indicated," and various proposals have been made to establish a comparison by the dimensions. The Royal Automobile Club (1906) gave the rule for power rating as $\frac{2}{5} D^2 n$, where D is diameter of pistons in inches, and n the number of cylinders. H. Sturmey gave a horse-power formula as follows: $\frac{D^2SNR}{12{,}600}$ where D is diameter and S stroke, N number of cylinders, and R revolutions per minute, to be taken as 1,000 if the actual number is unknown. This formula is practically the same as the oridnary h.p. formula for steam engines, assuming a mean pressure of 42 lbs. per sq. in. throughout the stroke.

Explosives are so largely used in certain engineering work that the need of standardising them has been suggested, and a start has been made by the American Society for Testing Materials. For some 500 years gunpowder only was at the command of the engineer, but since 1845 many other materials have been invented or discovered and used for blasting purposes. It is calculated that over 1,000 different explosives have been offered for use, and as their precise composition and mode of using are of vital importance, it is fit and proper that they should conform to certain standards.

The standardisation of catalogues has been talked about for many years, but makes little progress. The Architects' Technical Bureau are issuing to their members special covers and uniform sheets illustrating building materials and sundries supplied by the various manufacturers, but these are too much in the manner of displayed pictorial advertisements to be of real value. The Engineers' Standardised Publications Association appear to be doing similar work for engineers. The handiest sizes for catalogues and circulars are 8 in. by 5 in., 10 in. by 8 in., and 13 in. by 8 in., corresponding with note, letter, and foolscap sizes of writing papers, but printed papers generally run a trifle larger.

Standardisation is not confined to engineering matters; the Quantity Surveyors' Association have commenced to standardise the modes of measurement for builders' quantities, and have issued No. 1 of their "Uniformity of Measurement" pamphlets, which deals with the measurement of slating and roof-tiling work; previously Leaning's book, entitled "Quantity Surveying," was the nearest approach to a standard that was available. There is every advantage upon the score of uniformity of procedure in producing such works, but the publication of a good text-book in any

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subject tends to standardise the work in that subject, and to some extent to cramp the minds of the students by giving the impression of finality. Although there are undoubted advantages in standardisation, it chiefly helps the average man, and aids economical production; while the man of intellect is more or less hampered by having a rigid model set up for him beyond which he may not pass. The whole tendency of modern education and official regulation is to make one man as much like another as possible, to stamp out individuality and to discount common sense. I have had not a little to do with technical education, and in a small way have attempted to stem the tide of the current reliability on rules and formulæ. I have always advised students to try to understand the principles, and then the formulæ would follow of their own accord without being a burden to the memory. My remark to a student on one occasion shows what I mean: He was troubled about a formula for some simple thing, and in remonstrating I said "If you were in a stokehold when a gauge glass burst, you would want a formula to help you out of danger."

Reference may be made here to the proposal of standard notation for algebraic formulæ, which was taken up by the Civil and Mechanical Engineers' Society, and a discussion opened by the President, Mr. W. Noble Twelvetrees, on January 2, 1908. The same subject was considered by the International Commission on Reinforced Concrete at Bale on October 12, 1908, and a resolution was proposed that: "A uniform mathematical notation for the most important magnitudes occurring in the specifications and statical computations should be drawn up," and early in 1909 an interim report was issued, which was a distinct step in advance, but the result was somewhat crude. The Concrete Institute took up the matter at this stage, and after several meetings of the Science Standard Committee and Special Sub-Committee on Notation, of both of which I was a member, a draft report was prepared which is published in the Concrete Institute *Transactions*, Vol. I., Part III. Although all members of the sub-committee were assiduous in their labours, the chief credit must be given to Mr. E. Fiander Etchells, who was most enthusiastic. Briefly, the proposed notation is based upon what is called the "three-alphabet system," in which initial letters in "Latin smalls" are used for lineal dimensions, intensities, of forces, loads and stresses, constants, etc.; in "Latin capitals" for areas and volumes, moments, total forces, loads and stresses, angles, constants, etc.; and in "Greek smalls" for angles, constants, etc. The reduction of half a dozen of the best known but apparently dissimilar ferro-concrete formulæ to the standard notation, causes all their differences to disappear, and there is no doubt that much advantage would accrue from the general use of the same letters to represent the same things.

Recently I have been assisting the London County Council in framing and passing their Building Act Amendments through Parliament, to permit of steel frame construction and reinforced concrete buildings being erected without the hampering restrictions imposed by the 1894 Act, and I am reminded that this is only another form of standardisation. If architecture and engineering had been close professions like law and medicine there would be little need for Building Acts, as only competent persons would be registered, while such Acts now have to be framed to regulate the incompetent designers and keep them within safe limits.

By a little expansion of the idea it may be said that the laws by which the country is ruled are only standardisation applied to actions; but, gentlemen, we must not get into politics, and I think I have occupied sufficient of your time if I have not been able to give you much instruction. I trust, however, that I have been able to arouse a little interest in the subject which may lead you to give it further consideration.

ELECTRIC SMELTING IN CANADA.

According to the Director of Mines in Canada (Dr. Eugene Haanel) arrangements are in progress for establishing the first electric smelting plant in Canada at Sault Ste. Marie. The Lake Superior Co. is arranging for the construction of a number of furnaces similar to those now in successful operation in Sweden. A second electric smelting plant is about to be erected at Chat Falls, for the treatment of iron ores. Mr. Louis Simpson, of Ottawa, is interested in the latter scheme.

PROTECTION OF ELECTRICAL EQUIPMENT.*

By P. M. LINCOLN.

The question which I wish to discuss in the following is that of the protection of electrical apparatus and transmission lines from the danger of breakdown to which such apparatus is subjected by electrical "surges." The most frequent and severe source of electrical surges is lighting. There are other causes, arising from operation of transmission line and the electrical apparatus that goes with it to make up a complete plant. For instance, switching, particularly on the high tension side, may give rise to surges. Also grounding of high tension transmission lines particularly if the ground be an arching one such, for instance, as would occur when the limb of a green tree comes occassionally into contact with one of the conductors of the line. Also a short circuit on the transmission line or other electrical apparatus may give rise to an electrical surge.

The question which I wish particularly to discuss in this paper is, therefore, the manner in which such surges may arise, and the best protection to supply in order to prevent them from damaging either the apparatus or service. I do not expect in this discussion to bring out anything new. The most that I could possibly expect is to bring a new viewpoint to some who are interested in long-distance power transmission, and the protection of transmission circuits from damage and interruption.

What is meant by the term "surge"? This is a fair question, and should have a straightforward answer. If this question were to be asked of Steinmetz, he would fill pages with differential equations and long ess signs of integration, and finally give an answer (as he has already done), in the form of mathematical formula. Such an answer, although it tells the story, is, unfortunately, useless to the mind of the average long-distance transmission line operator, since it requires the mind of a trained mathematician to interpret such an answer as well as to make it.

For my own part, I have found that a proper conception of the phenomenon of electrical surges can be much better conveyed to the mind by using an analogy. The use of a proper analogy conveys a concrete idea rather than an abstract one, and the mind can much more readily grasp the idea in that shape that when it is merely abstract ideas which must always be associated with such electrical terms as volts, ohms, henrys, microfarads, etc. Any analogy must be used carefully, since in many points of comparison it is apt to fail. If improperly used, it may lead to conclusions entirely wrong, but if properly applied it will lead the average mind to a much clearer conception of what is going on than can be obtained by any consideration of merely abstract quantities.

The following hydraulic analogy, in many respects, is similar to the electric circuit, and I trust that its description will be of assistance to some in gaining an idea of an electric "surge."

Suppose we replace a three-phase a. c. generator transmission line and receiving apparatus with a hydraulic arrangement shown in Fig. 1. In this figure, "A" is the piston pump with the three pistons 120° apart. "C" is a duplicate of pump "A," whereby the work done by "A" is transferred to "C" and "B" are pipes connecting "A" with "C." The likeness to an a. c. power transmission system is accentuated in our analogy by the fact that the water or other liquid in the system simply oscillates back and forth through the pipes "B" from generator pump "A" to motor pump "C." In order to endow this hydraulic system with the functions of an electric circuit we will have to imagine that the walls of pipes "B" are perfectly flexible—for instance, to be made of pure India rubber. This introduces into our hydraulic system the analogy of static capacity in the electric system. If we imagine that water is to be used in the hydraulic analogy, the weight or inertia of this water introduces into the hydraulic system the equivalent of inductance or reactance in the electric system. Since the water in passing back and forth will have certain losses due to friction against the walls of the pipe and pumps, the idea of ohmic resistance of the electric current is transferred to the hydraulic analogy.

* Paper read at convention North-Western Electric Light and Power Association, Seattle, September.

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If we wish to imagine the effect of increasing static capacity we might do so in our hydraulic analogy by imagining the walls of the pipe to become more flexible; for instance, to be made of thinner walls of rubber. For a

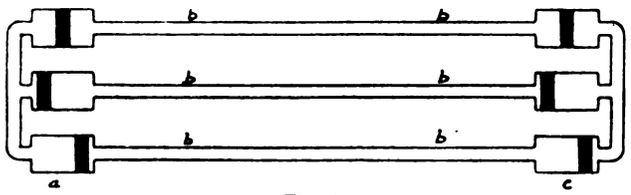

Fig. 1.

transmission line without capacity, we would have to substitute a hydraulic system with perfectly rigid and inflexible pipes. Increasing inductance or reactance may be represented in our analogy by increasing the weight, and, therefore, the inertia of the liquid pumped; for instance, by substituting mercury for water. Increasing electric resistance may be represented by smaller, rougher or longer pipes, thus increasing the frictional resistance. It is further necessary to assume that the volume of the pump cylinders is large compared to the volume of the pipes connecting the two pumps, and to gain a proper idea we would have to imagine further that the speed of the pumps is slow, say one stroke per minute or so.

Now if we can keep our imaginations under proper control and can carry this hydraulic analogy in our minds, we are prepared to investigate the nature of an electric surge by means of this analogy. Suppose we suddenly inject into one of the flexible pipes "B" at some point between pumps "A" and "C" an amount of liquid which will instantly swell the pipe at that point to some three or four times its normal diameter for a length of some eight or ten diameters. This would be analogous in the electric system to the effect of lightning. A cloud discharges in the neighbourhood of a high tension transmission line. The area of the transmission line which has been covered by the cloud is relatively small. The discharge of that cloud releases in the transmission line a certain amount of static electricity in addition to the normal amount of current present due to the action of the generators and receiving apparatus. What happens next? It is much easier for the imagination to follow this in the analogy than in the actual transmission line. If the pipe is not strong enough, the wall breaks—that is, an insulator punctures or "slops over," and the accumulation of water, electricity—in part at least escapes. If the walls of the pipe are strong enough to stand the strain—that is, if the insulators do not break down—a wave or surge begins to be propagated in both directions. The distended walls of the pipe bring their elastic force to bear upon the enclosed liquid, and the accumulated "lump" of water begins to be dissipated in both directions. Inertia of the liquid, together with the pressure on it from the elastic walls, will cause it to assume successive forms which are probably very much like those shown in Fig. 2. The accumulation of liquid will become longer and thinner, and it finally divides into two separate "lumps" as it travels from the point of disturbance in both directions. At the point of disturbance the tendency to break the walls is the maximum, and this tendency becomes less and less

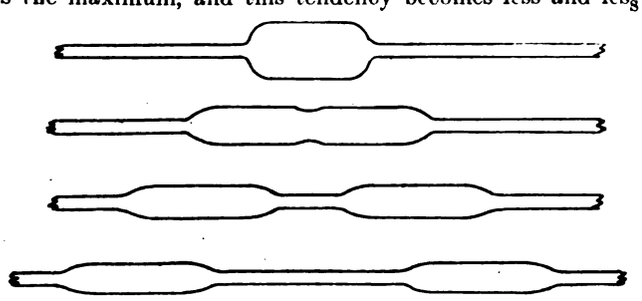

Fig. 2.

as the wave or surge proceeds from the point of disturbance. However, should the surge encounter a weak place in the walls, a break may occur in some place comparatively remote from the point of disturbance.

Now, what happens when this wave or surge reaches the electrical apparatus at the ends of the line? For the purpose of considering this question, we would have to replace our pumps with something that will behave like a transformer or generator in an electric system. Now, generator and transformer windings have two important differences from an equal length of transmission line in that both the capacity and inductance per unit length are largely increased. In our hydraulic analogy the increase in capacity per unit length may be represented by imagining a much thinner walled pipe for the generator. The increase in inductance per unit length may be represented in the analogy by an increase in the specific gravity of the liquid—say by substituting mercury for water. I have endeavoured to give a graphic representation of these modifications in Fig. 3.

B–1 is the transmission line with relatively heavy walls, although still flexible and a light liquid contained therein, say, water.

B–2 is the generator which has relatively thin, but still perfectly, elastic walls containing a heavy liquid, say, mercury.

When the wave or surge that has been started out on the line B–1 reaches the point "P," that is, the terminal of the generator or transformer, it is obvous that the following things will occur:

First.—A part of the energy of the incoming wave will be reflected, and will, therefore, travel back through the line B–1 from the point "P."

Second.—The remainder will begin to travel through part B–2, the generator or transformer, but the speed of its propagation will be very much reduced because the liquid being set into motion is very much heavier, and also because the forces acting upon it through the elastic retaining walls are much smaller.

Third.—The steepness of the wave front during its propagation through B–2 will be very much increased over that obtaining in B–1 on account of the action of the same forces as noted in the above paragraph.

I have allowed my own imagination rather free play and give in Figs. 4, 5, 6 and 7 my idea of how the wave will modify itself when being propagated from medium B–1 to medium B–2. Probably the most noteworthy modifications during this transfer of the disturbance from B–1 to B–2 is the abrupt increase in the steepness of the wave front. For instance, consider the points P-1 and P–2 in Fig. 5. At P–1 there is a tendency to burst the pipe, that is, breakdown the insulation to ground; but there is also a heavy stress tending to break through from point P–1 to point P–2. Suppose that the portion B–2 of our pipe, instead of being straight as indicated by our diagram, were to be coiled upon itself, and that one complete coil took place in the distance from P–1 to P–2, then there would be a tendency for the liquid at point P–1 to break through the walls of the pipe into the neighbouring coil at P–2. This is exactly what occurs in the electric system. An incoming surge, in penertating the turns of electrical apparatus, causes an excessive voltage strain between adjacent turns. The momentary breakdown or snapping across of this surge from one turn to the next will do no particular damage unless such breakdown is followed by the dynamo current, and an arc is thereby established. If this latter event occurs, then the break does tremendous damage. In my opinoin, practically all of the failures in generators, transformers, etc., which can be traced directly to lightning or other surges, are due to a breakdown between turns rather than to a break of the insulation from conductor to the ground. There, is, of course, due to the normal operation of the apparatus, an insulation strain from conductor to ground, and also one between adjacent turns. A surge momentarily increases both of these strains. The strain and ground may be thereby increased 20%, 50%, or perhaps 100%, or even somewhat more; the strain between turns may thereby be increased 20 times, 50 times, 100 times or even more. A surge, therefore, throws a tremendously larger increase on the insulation between turns than it does on the insulation to ground. From certain observations that I have made, it is my opinion that the momentary strains between turns, particularly near the terminals of the apparatus, may approximate a considerable percentage of the terminal pressure. This is a danger in electrical apparatus which has not been sufficiently appreciated in the past.

It is evident that the protection of electrical apparatus from such dangers as are outlined in the above consists in:

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First.—Making the apparatus so that it will stand large momentary voltages between turns. This consideration shows the great advantage possessed by transformers, particularly oil insulated, over generators. It is possible to insulate transformers between turns to a much higher degree than any generator can be, particularly where oil is used.

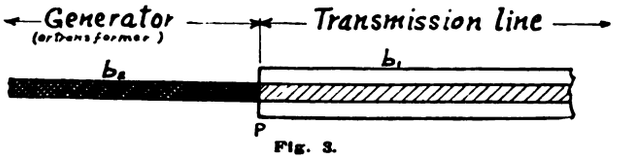

Fig. 3.

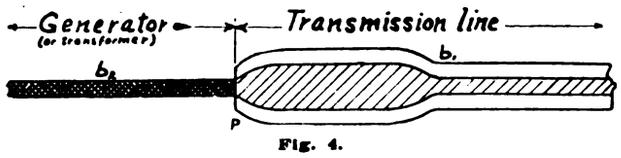

Fig. 4.

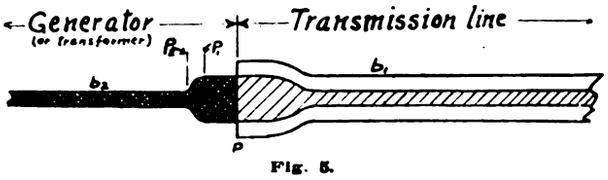

Fig. 5.

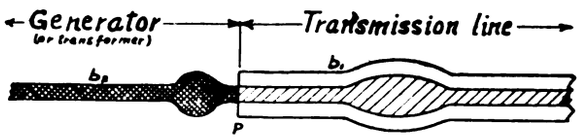

Fig. 6.

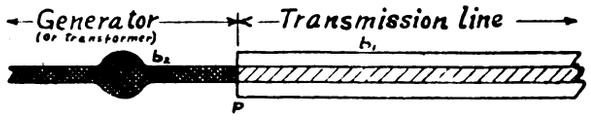

Fig. 7.

Second.—Limiting, by use of proper lightning arresters, the size of the wave or surge that may enter the electrical apparatus. Reverting to the hydraulic analogy, if we should provide a hydraulic relief valve at the point "P," Fig. 5, it would have the effect of removing at least a part of the excess liquid at the instant the strong pressure on the walls occurs. If this relief valve were to be set so that it operate at pressure of, say, only 20 to 30% above that caused by the pumps while in normal operation, then this relief valve would not affect the normal operation and would also limit a surge or wave entering part B-2 to an amount which could not exceed 20 or 30% above normal pressure or voltage. This indicates the function of the ideal lightning arrester. It prevents any electrical surge which has a value of 20 to 30% greater than normal voltage from entering the electrical apparatus. This is the utmost that any lightning arrester can do. The electrical apparatus itself must be so designed that it will take care of an entering surge which is not more than 20 or 30% above line voltage.

Reverting again to the hydraulic analogy, suppose our relief valve has a relatively long discharge pipe of, say, 1-100th the area of the incoming pipe "B" in Fig. 1. The time during which the excess pressure exists at "P," Fig. 5, is relatively small. Such a pipe attached to the relief valve would be utterly unable to discharge a sufficient amount of the liquid to relieve the pressure. As a consequence, the size of the surge entering part B-2 would be but little reduced by such a relief valve. This is analogous to what occurs with a lightning arrester having a large ohmic resistance in series with it for the purpose of preventing the dynamo current from following. This indicates in general why this type of arrester is inferior to the electrolytic. The electrolytic type of arrester, once broken down, has almost a zero resistance to ground, and, therefore, allows the maximum possible reduction of the surge before it enters the electrical apparatus.

Another method of protection that has shown itself of considerable value both in theory and practice (as a protection from lightning) is the overhead grounded guard wire. The theory of this kind of protection is as follows:

Any conductor that is entirely enclosed or surrounded by another conductor cannot have induced thereon a static charge which originates from any action going on outside the surrounding conductor. For instance, a lead covered electric cable cannot be directly subjected to lightning disturbances because of the protection action of the surrounding lead sheathing. The overhead ground wire acts, to a certain extent, in the same manner. Although it does not entirely surround or enclose the high tension wires which it protects, it does so partially, and to the extent that it does enclose or surround the high tension wires it provides the same protection as does the lead sheaths to the underground cable. In the electric transmission circuit the voltage of the charge which would otherwise be induced upon the transmission line is kept down by the presence of the guard wires.

Still another method of protecting high tension transmission lines is to ground the neutral of the lines. This grounding may be done either by connecting it solidly to the ground or by putting in a greater or less resistance between the neutral point and the ground. To just what extent this grounding of the neutral either completely or partially is of value, is a mooted question among engineers. As I see it, the question of grounded neutral *versus* ungrounded may be considered from two view points: first, from the view-point of protection of the apparatus or equipment, and second, from that of the protection of the service.

First.—Protection to apparatus. The advantage in a solidly grounded neutral, so far as protection to apparatus is concerned, is that the normal voltage to ground can under no conditions rise to more than about 58% of the normal voltage between conductors. This advantage is, of course, of the utmost importance, when considering insulation strengths to ground of the various apparatus involved.

On the other hand, the disadvantages of a solidly grounded neutral is that every ground which occurs develops immediately into a short circuit, and these short circuits in turn cause severe mechanical stresses to be set up in the windings of the transformers and the generating apparatus.

With a grounded neutral, therefore, it is reasonable to expect that the windings of the transformers and generators will be subjected to much more frequent shocks than without such a ground. Also, owing to the fact that every ground immediately becomes a short circuit, and that at points of short circuit the arc will cause considerable destruction, the system with the solidly grounded neutral will be subject to more frequent destructive arcs both on the line and in the apparatus where there is probability of such arcs developing.

It is my own opinion that, so far as protection to apparatus is concerned, the advantages of grounding the neutral very much outweigh the disadvantages, and if protection to apparatus alone were to be considered, I would have no hesitation in making recommendation for a solidly grounded neutral.

Second.—Protection to the service. As mentioned above, the disadvantage of a solidly grounded neutral is that every ground develops immediately into a short circuit. With a voltage such as is always used in high tension transmission (say, 44,000 and above), there will always be a sufficient voltage at the point of arc to cause that arc to continue until power to that particular section of line is cut off. This fact almost invariably will cause an interruption of power whenever a ground occurs on any point on the transmission system.

This would not be so materially a disadvantage were it not for the fact that experience has again and again demonstrated that lightning storms will very often cause insulators on the line to arc across or puncture. With the neutral solidly connected to ground, each one of these punctures and flashovers means an interruption of service. If the line were not solidly grounded, it is probable that many of these flashovers would not interrupt the service, since a flashover involving only one conductor might simply mean that the other two conductors on the transmission line would momentarily rise to a potential nearly double normal, while the arc at the defective insulator, as well as the voltage to maintain the arc, disappears.

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In view of the difficulties which the line is apt to encounter with a solidly grounded neutral, many engineers prefer to ground through a resistance instead of connecting the neutral solidly to ground. In order to be of use the resistance between the neutral and ground must be relatively high, and it, further, must be able to carry a considerable current for at least a short period of time. In other words, it must be capable of dissipating a very considerable amount of energy for a short period. A satisfactory type of resistance for this grounding service is difficult to secure. Cement columns have been used, but these are unsatisfactory owing to the extreme variability of their resistance. Also, if the current through them is maintained for an appreciable time the heat developed is apt to crack or even to burst them. After studying the questions from various angles, I have come to the opinion that a metallic form of resistance is the proper one to use for this purpose. The main disadvantage of this form is its cost, but its advantages are sufficiently great to overcome this disadvantage.

To recapitulate briefly the protection against surges of electrical equipment, including both the apparatus and transmission lines, may be furthered by adopting some or all of the following methods:

First.—The overhead guard wire. This has the ability of keeping down the quantity of electricity which a given lightning discharge is capable of superposing upon a transmission line. In practice it has shown itself to be a valuable device in many instances of high tension transmission.

Second.—The use of efficient lightning arresters is essential. They should be of a type which will allow a free discharge of static electricity from the transmission line whenever the voltage of the charge exceeds normal by a certain predeterminable amount. With a proper equipment of such lightning arrester, the size of the surge which may enter electrical apparatus is limited.

Third.—The grounded neutral. Grounding solidly prevents the potential of a neutral point of a transmission line from departing from ground potential. This in turn will prevent the normal operation of this line from causing more than about 58% of line voltage appearing between any conductor and ground. Grounding through a resistance has the same effect to an extent depending upon the amount of resistance used.

Fourth.—Insulation between turns. The analysis in the preceding discussion shows that it is highly essential to insulate electrical apparatus between turns, so that it will stand a momentary potential which is many times that normally put upon that insulation. The consideration of this point shows at once the enormous advantage of using transformers upon a transmission line in distinction to connecting generators direct. The amount of insulation that can be used between turns in a generator is limited by the necessity of placing the winding in relatively small slots. In a transformer this consideration does not operate to nearly so great a degree, owing to the fact that the space occupied by the windings is, so to speak, in one piece instead of being divided up into a large multiplicity of small slots. Also, the presence of oil in the case of the transformer gives it an advantage which the generator cannot have under any conditions.

MANCHESTER ELECTRICAL EXHIBITION.

We have received from the Secretary, Mr. W. Davenport, a copy of the balance sheet of the Electrical Exhibition, Manchester, 1908. The receipts came to £19,393 4s. 8d., the chief items including: £10,061 13s. 2d. from exhibitors (space account), £4,750 16s. 5d. in gate money and tickets, £1,133 7s. 2d. donations from Corporations, and £929 14s. 11d. electric current and meters. After defraying expenses there remained a balance of £6,317 15s. 2d. Of this sum £1,989 5s. 2d. (20% on space money) was returned to the exhibitors, £113 6s. 4d. (10% on donations) to the donators, £2,842 19s. 9d. went to the International Trade Exhibition (under the agreement), £631 15s. 6d. was paid to Messrs. C. S. Northcote and W. Davenport, and £740 8s. 5d. to various charities (including £364 19s. 3d. to the Electrical Trades Benevolent Institution). The Committee are to be congratulated on so satisfactory a result of their efforts.

ENGINEERING STANDARDS COMMITTEE.

British Standard Specification for Keys and Keyways.

The question of standardising keys and keyways was first brought to the notice of the Engineering Standards Committee in June, 1906, and the subject was considered sufficiently important to justify the formation of a sub-Committee for the consideration of this question. The present report (No. 46) is the outcome of the sub-Committee's deliberations, during which engine builders, millwrights and others were consulted and the merits of the various forms and sizes of keys and the formulæ for determining the same were carefully considered.

The report is divided into two sections, the first being a specification for the steel bars from which the keys are to be cut, and the second dealing with the proportions of keys and keyways recommended. The specification requires a minimum tensile breaking strength of 36 tons per sq. in. with an elongation of 12% on the test piece specified. A list of standard sizes is given and the margins of manufacture to be allowed on merchant bar are defined.

With regard to the second section of the report, the information which the committee obtained from engine builders and others was supplemented by the results of their own experimental work and the standard sections for sunk keys given are based on the data obtained from these two sources.

The engineering industry should largely benefit from the introduction of the committee's standards, though at present only sunk keys (taper and parallel) are dealt with. Recommendations as to tolerances on the finished key and keyway are included.

The experimental work for the sub-Committee was carried out by Mr. P. A. Ransom, and it is to be hoped the data obtained during these experiments may at some future date form the subject of a communication to one of the Technical Societies. The information should prove of great interest, as it is bound to throw considerable light on a subject on which there is a paucity of experimental data.

By the issue of this report it should become possible to order standard steel bars from the stock of the various rolling mills by merely quoting the designating numbers from the schedule given in standard specification.

The price of the specification is 2s. 8d. post free, and it may be procured from any bookseller, or direct from the Offices of the Committee, 28, Victoria-street, Westminster. Like all the other reports, it is published for the Committee by Messrs. Crosby, Lockwood & Son, 7, Stationer's Hall-court, Ludgate Hill, E.C., and 121A, Victoria-street, S.W.

A LINESMAN ELECTROCUTED.

Climbing a girder to reach an iron clip, a linesman named George Younger touched a "live" suspension wire and was instantly killed on the newly electrified London, Brighton and South Coast Railway, at Peckham Rye.

At the inquest, held at the Camberwell Coroner's Court, Frederick Charles Kerr, of James-street, Lambeth, who was also engaged at the spot, said he did not know that the suspension wires were alive. At the request of the deceased, witness placed a ladder against a girder carrying the live wires, and the deceased climbed the ladder and began to walk along the girder. He got near to the wires, and witness saw him put his hand up. Almost immediately a flame a foot long shot up, and the man fell to the ground.

Dr. Robert Govan stated that the right hand and wrist were charred and severed from the body. In falling the head was fractured in many places. One of the legs, the backbone, and the windpipe were completely burned away. Death was due to shock from electrocution.

The jury returned a verdict of "Accidental death."

The Electrical Engineers' Territorials (London Division).—Officer Commanding, Col. R. E. B. Crompton, C.B. Orders for the week ending, October 23: Monday, 18, "A" Co., Practice for the Hop Cup, 7 to 9.30 p.m.; Tuesday, 19, "B" Co., Practice for the Hop Cup, 7 to 9.30 p.m.; Wednesday, 20, Gymnasium, 6.30 to 9.30 p.m.; Thursday 21, "C" Co., Practice for the Hop Cup, 7 to 9.30 p.m.; Friday 22, "D" Co., Practice for the Hop Cup 7 to 9.30 p.m.—(Signed) P. H. Campbell, Capt. R. E. and Adjutant, for O. C., E. E., L. D.

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ELECTRIC PUBLICITY CAMPAIGN.

HAMPSTEAD CORPORATION'S OCTOBER EXHIBITION.

The Hampstead Corporation conducted for four days, beginning on October 6, an interesting publicity campaign in the form of an exhibition of electrical domestic appliances, held at the Public Baths in Finchley Road.

The first exhibition, under municipal auspices, was held at the Hampstead Town Hall two years ago; this, the second, proved a much more important venture. The Council's principal object is to sell their current. The electric light is, of course, used in this wealthy district more than ever; but it appears that metallic filament lamps have reduced the consumption by 70%. Electric lighting bills in Hampstead are upwards of half what they were two or three years ago. Thus the municipal revenue has been reduced, and the Council are taking all possible steps to bring it up again. October's exhibition may, therefore, be regarded as a scheme of educational advertising for the ratepayers—especially the women-folk—in the uses of electricity as a competitor against coal and gas for heating, cooking, and all kinds of domestic purposes, besides those of lighting, bells, and telephones. The Council, as long as they supply the current, are perfectly willing that firms and companies should do business in the borough with their various kinds of apparati and utensils. The greater the demand for these utensils, the cheaper in time will become their cost, in that there will be an increase in their output.

A large number of prominent firms took stands in the building, and, thanks to the fact that the Council supplied the current free of cost, scope for demonstrations was practically unlimited.

The exhibits by the Berry Construction Co., Ltd., of Charing Cross House, London, W.C., were much in consonance with the aims indicated. This company showed its "Tricity" cooker, for use with which special grills, saucepans, and other appliances have been designed and arranged. The cooker can be used for boiling—a "Tricity" will boil a quart of water in 7 mins.—for grilling, stewing, toasting, and frying. Then it can be employed for such household purposes as ironing and airing clothes.

Messrs. Spagnoletti, Ltd., of Goldhawk Works, Goldhawk-road, London, W., showed at their stand the "'Therol' Electric Water Heater," which gives hot water the instant the tap is turned at any temperature required, according to the position of the handle, and it may be drawn off at the same temperature from the first to the last drop.

Mr. Eric Rivers-Smith, electrical engineer, of 13*a*, Heath-street, Hampstead, showed the Ediswan heating and cooking apparatus.

The Dowsing Radiant Heat Co., Ltd., of 24, Budge-row, London, E.C., showed their radiators and sunbaths. The "Solarium," or electric light cabinet, is an electric light bath fitted with special electric lamps. Light and heat rays are thrown upon the body by the special electric heaters fixed in the cabinets.

Visitors were also attracted to the stand of the Regent Electric Co., Ltd., of 52, Regent-street, at which were to be seen the "Sunbeam" folding electric light bath cabinets, manufactured in London by Mr. C. M. Holmquist, who pleads for them efficiency comfort, durability, and safety.

The "Holmquist" electric heat pads shown succeed in the sick room the use of hot water bottles, hot fomentations, and hot compressors. It is a flexible asbestos net into which is woven an electrical conductor, the whole being covered with asbestos cloth on both sides, with an outer cover made of flannel.

Messrs. Eastman & Warne, manufacturers and patentees of electric heating apparatus, of Acton-vale, W., were represented by their "H.P." electric, strongly built, boiling stoves, supplied for various degrees of heat according to the purpose of which they are required—hot for boiling purposes, and moderately hot for keeping dishes and plates warm. They also demonstrated their "Hot-Point" electrically-heated flat irons and soldering irons.

Another of the stands of interest to women was that at which the Alert Electrical Co., Ltd., of 202, West End-lane, West Hampstead, N.W., showed "The Pulvo" portable air suction dust lifter, which can be taken from room to room without requiring any special apparatus or fixing. Provided with a substantial English electric motor, it can be worked from any electric light plug.

The electric vacuum cleaners of the British Vacuum Cleaner Co., Ltd., of Parson Green-lane, London, were also working.

Messrs. O'Brien, Thomas & Co., of 17 and 18, Upper Thames-street, London, E.C., exhibited Boyd's patent electric radiators, of which they are the patentees and manufacturers. The invention consists in the provision in such a heater of a hot-air trap forming a hot shelf above the lamps.

The Phœnix Electric Heating Co., who gave special demonstrations of cooking by electricity in a part of the buildings especially reserved, showed at their stand their apparatus for that purpose, including grillers, stew pans, frying pans, milk boilers, and porridge saucepans.

Interesting from an advertising point of view were the exhibits of the Multi-Color Sign Co., of 4, Denman-street, Piccadilly-circus, these including the "Ken-Laur" Magic Mirror, which shows at intervals illuminated designs in original colours. It has a very great power of attracting the attention of passers-by, at a minimum prime cost and working expense.

Messrs. John Barnes & Co., Ltd., of Finchley-road, revealed enterprise by showing the General Electric Co.'s "Archer" system of heating and cooking. Kettles, curling irons, shaving pots were amongst a host of articles, and ladies were especially charmed by hosts of many coloured shades of electric lamps.

Another popular feature was the piano shown by the "Harper" Electric Piano Co., Ltd., of 258, 260, and 262, Holloway-road, London.

Other exhibitors included Messrs. Gillespie & Beales, of Amberley House, Norfolk-street, Strand, who exemplified the "Bastian" system of heating and cooking; the Calux Electric Co., of 7 and 8, Great Winchester-street, E.C., whose electric-heating stoves were on view; and Messrs. Siemens Bros. & Co., Ltd., of Caxton House, S.W., who showed the "O.S." wiring system.

DIARY OF EVENTS.

FRIDAY, OCTOBER 15.

INSTITUTION OF MECHANICAL ENGINEERS.—At 8 p.m., at Storey's Gate, St. James' Park, Westminster, London, S.W., "Heat Transmission," by Professor W. E. Dalby, of London.

JUNIOR INSTITUTION OF ENGINEERS.—At 7 p.m., visit to the Model Engineering Exhibition, Horticultural Hall, Westminster.

SATURDAY, OCTOBER 16.

INSTITUTION OF MECHANICAL ENGINEERS (GRADUATES' ASSOCIATION).—At 3 p.m., visit to Messrs. David Kirkaldy & Son's Testing and Experimenting Works, Southwark-street, London, S.E.

MONDAY, OCTOBER 18.

EAST LONDON ELECTRICAL EXHIBITION.—At 3 p.m., at Pitfield-street Baths, Shoreditch, N., opening of East London Electrical Exhibition, by Mr. W. M. Mordey, M.I.C.E., M.I.E.E., President of the Institution of Electrical Engineers.

JUNIOR INSTITUTION OF ENGINEERS.—At 7 p.m., at Royal United Service Institution, Whitehall, annual general meeting, followed by annual general meeting of the Benevolent Fund. At 8 p.m., "The Re-inforced Concrete Construction of the New General Post Office Buildings, London," by Mr. T. A. Watson, Assoc.M.Inst.C.E.

WEDNESDAY, OCTOBER 20.

DRAKE & GORHAM, LTD.—At 2 p.m., at the Company's Offices, 66, Victoria-street, Westminster, S.W., annual meeting.

FRIDAY, OCTOBER 22.

MANCHESTER SECTION OF INSTITUTION OF ELECTRICAL ENGINEERS.—At 7.30 p.m., at the Midland Hotel, Manchester, address by the Chairman, Mr. S. J. Watson.

ELECTRO-HARMONIC SOCIETY.—At 8 p.m., in the King's Hall, Holborn Restaurant, London, first smoking concert of the season.

PHYSICAL SOCIETY OF LONDON.—At 5 p.m., at the Imperial College of Science, South Kensington, "On Cadmium Amalgams and the normal Weston Cell," by Mr. F. E. Smith, A.R.C.Sc.; "The Production of Helium from Uranium and Thorium," and "The Production of Radium from Uranium," by Mr. Frederick Soddy, M.A.; and "Note on a Gravitational Problem," by Dr. C. V. Burton.

SATURDAY, OCTOBER 23.

JUNIOR INSTITUTION OF ENGINEERS.—At 7 p.m., at Caxton Hall, Westminster, conversazione.

OBITUARY.

MR. CHARLES ROBERTSON.

We regret to record the death of Mr. Charles J. Robertson, inventor of the Robertson electric lamp, who passed away at his residence at Ealing, at the early age of 49 years. Mr. Robertson was associated with Mr. St. John Lane-Fox from 1879 to 1881, and later had control of the factories of the Gatehouse Lamp (Pilsen Joel Co.), and the Bernstein Lamp (Bernstein Electric Co.). Afterwards he equipped and carried on a number of factories on the Continent and became thoroughly versed in European and American practice, besides undergoing a useful training in one of the keenest schools of commercial competition. When the Edison patents lapsed in 1893 Mr. Robertson's opportunity came. He became allied to the General Electric Co., Ltd., and the now famous Robertson Electric Lamp Works were inaugurated at Hammersmith. It was not till early in 1895 that the first marketable glow-lamp was turned out from the factory, but since then an enormous business has been built up. The funeral of Mr. Robertson took place on Saturday last. The first part of the service was held at St. Peter's Church, Mount Park-road, Ealing. The interment was at St. George's Cemetery, Hanwell, in the presence of a large concourse of people, principally consisting of workers from the Robertson and Osram factories. In addition, there were representatives from several Societies with which Mr. Robertson was connected, including the Hammersmith Lodge of Freemasons.

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THE

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Secretaries and Managers of Companies are asked to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers.

Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

Contractors can make use of our columns to obtain the names of the makers of any specialities they require in their business.

TO ADVERTISERS.

Advertisements should be addressed to the Manager, 149, Fleet Street, E.C., and should reach him by the first post on Wednesday. SPECIAL TERMS *for a series can be arranged on application.*

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CONTENTS.

	PAGE
Notes	525
Utilization of Natural Laws	526
Electrolytic Wattmeters	527
Electrical Plant at Durham Mines	527
Mines Inspection	528
Standardisation in Engineering	529
Electric Smelting in Canada	532
Protection of Electrical Equipment	532
Manchester Electrical Exhibition	535
Engineering Standards Committee	535
A Linesman Electrocuted	535
Electric Publicity Campaign	536
Diary of Events	536
Obituary	536
Agricultural Co-operation and Electricity	537
Correspondence	538
Railway Carriage Lighting	539
The Willans-Victoria Turbo Pump	541
"Union" Insulation Testing Set	542
Fittings and Accessories	544
Electricity for Gold Mines	545
Electric Signalling Devices	546
Twenty Hours for One Penny	546
Electro-Magnetic Clutches	547
A New Monthly Review	547
Electrolytic Disinfecting Fluid	548
Reviews	549
Mining Inspector's Views	549
Diminishing Fuel Capital	549
Technical Problems, with Solutions by Practical Men	551
Tyneside Notes	553
Midland Notes	553
American Notes	554
Companies' Meetings and Reports	555
Contracts Open	556
Some Contracts	556
Tenders Accepted	556
Lighting & General Notes	556
Traction Notes	558
Personal	559
Educational	559
Catalogues and Lists	559
Institution of Mining Electrical Engineers	559
Publications	560
Patents	560
Companies' Stock & Share List	563

AGRICULTURAL CO-OPERATION AND ELECTRICITY.

In France, the benefits that electricity is capable of conferring on the agricultural community have been widely recognised. We are not for the moment referring to the cheap supply of nitrogen, fixed in convenient compounds from the atmosphere for fertilising purposes, or to the various experiments in utilizing electricity to force growth, but to the use of the current for lighting and power purposes. In comparatively few cases existing, large central stations have come to the assistance of outlying villages or large establishments. As a rule, however, the electricity used in the rural districts is generated locally, hydraulic power being nearly always obtainable. The general method hitherto adopted is for the local agricultural co-operative societies to take up the matter of setting installing generating station and supplying electricity. Two forms of procedure are in vogue. A limited liability company may be run as a branch of the co-operative society, in which case the current is sold at a profit, ordinary customers being charged at a higher rate than members of the society. This, of course, broadens the basis of supply. More commonly, however, the co-operative society both generates and supplies the electricity, and only to its own members. In this case the charge is only a little above cost price, in order to allow for depreciation and the formation of a reserve fund. When a co-operative society adopts this course, not being a profit-making concern, assistance is often secured from the Government, generally from the Ministry of Agriculture, whose Department for the Amelioration of Agriculture has considerable funds at its disposal. A typical example of the first mentioned system is seen in the Société de Maison-Neuve, Aisne, which is co-operative and limited, with indeterminate membership and capital, though it was started in 1905 with a capital of only £400. The electricity is generated by water-power,

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derived from a branch of the Oise. Electricity is supplied, both for lighting and power purposes, to its members at a rate calculated only just to cover cost and leave a small margin to form a reserve fund. For customers other than members a special tariff prevails. An annual charge is made of one franc (10d.) per candle power lamp, with a surcharge of half-a-franc (5d.) for lamps of 5 c.p. and under. The meterage charge is at the rate of 38 centimes (say 3·8d.) per k.w.h. for lighting, and 18 centimes (say 1·8d.) per k.w.h. for power purposes. These prices are far lower than those generally prevailing, and it may be open to doubt whether this duality of co-operative society and trading limited company is quite fair to the purely industrial concern. The Government policy, however, is to encourage such undertakings in order to benefit agriculture, especially in the matter of utilizing electricity for driving stationary appliances, such as chaff-cutters, mills, churns, etc., as well as ploughs and reaping machines. All this reveals a phase of rural economies of which we know nothing, but which is familiar enough in Italy, especially within the sphere of operations of the great hydro-electric undertakings. Our own agricultural societies appear to have paid little attention to such possibilities. What little electricity is to be seen in our farm and dairy work is a matter of private enterprise. Whether the development of electrical industry along the lines shown in rural France is likely to be imitated it is difficult to say, for though our farmers and landlords are deplorably slow to avail themselves of new ideas, electricity is a great awakener, conquering fresh fields every day.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

A GREATER LONDON RAILWAY.

Sir,—The agitation for a tramway between Eltham and Woolwich is invested with a fresh importance by its receiving consideration from the Admiralty, as well as the Board of Trade and London County Council. The proposed line ought, however, to form a part of a greater scheme which the writer has had in mind for a number of years: that is, for an electric railway to encircle London at about 10 to 15 miles distance from Charing Cross. Anyone who has lived in the suburbs of London knows how difficult it is to get from one suburb to another, owing to nearly all the present lines being radial, and how it is necessary to run up to town and out again, along another radius line, to get to some place which may be only a few miles distant. Also on arrival in London it is frequently necessary to go by tube, omnibus, or cab from one station to another, and, if the passenger has luggage, this is both awkward and expensive. If Woolwich and Eltham want connecting, so also do Eltham, Bromley, and Croydon. Beyond Croydon the line might go a little further out so as to touch Epsom, and then, turning northward, cross the river, say, somewhere about Walton-on-Thames. From there the line could go through Hounslow, Wembley Park, Harrow, to Enfield. Continuing eastwards, it might strike out into the country again at Epping, and then pass across an untapped district to Romford and so to North Woolwich.

By connecting Woolwich, Hounslow, and Enfield, and being near to, and inside the line of forts round London, this proposed circular railway would have a strategic value, and on that account the War Office and Admiralty would no doubt be interested. It would also provide a means, at present badly wanted, of connecting the railway systems of the North and of the South, and also those of the West of England, with East Anglia and the main Continental highway through Kent. Passengers would thus be able to pass round London without changing, instead of having to travel by some other means of transit from one railway terminus to another. On this account, some of the railways running into London would most likely welcome the scheme.

A large proportion of the population which such a railway would tap would be the middle class, who are accustomed to take full advantage of quick transport facilities. They would appreciate such a line as a means to get about and see friends in other suburbs, and also on account of its business facilities. The line would also be largely patronised by the working classes, because of its connecting several industrial centres together, and providing a means whereby the artisan and his family could quickly and without any changing of trains, etc., get to the upper reaches of the Thames, the pretty country round Bromley and Croydon, or to Epping Forest, Wembley Park, etc.

The system of working the railway would be one that Londoners are already well accustomed to, namely, trains running in a circle, the only difference being the Ferry at Woolwich, or wherever else the river was crossed. It goes without saying that the line would be electric throughout, and it would have frequent stops and quick acceleration, which, with cleanness and economy of working, are the special features of electric traction. If the railway had its own electric power houses, they would be at the two points where the railway crossed the Thames, but it does not at all follow that two power houses or even one would be necessary, for there are plenty of public suppliers near the line of route who would sell current cheaply. Buying from them would ensure their support when the Bill came before Parliament.

The great handicaps of railways and tramways in this country are the great expense in getting necessary powers from Parliament, fighting the various opposing authorities, etc., and also in the purchase of land. By enlisting the support of the War Office and Admiralty on account of its strategic importance, and the various County Councils because of the opening up of new country, the Bill should have a good chance of getting through. Ten or twenty years ago the necessity for such a railway was not so evident, but with the steady expansion of London it is now absolutely necessary; and it will easily be seen that when once built, every year would make it more and more valuable. A good name for it would be the Greater London Railway. The writer would be glad to hear from anyone who may be interested in the matter.

Yours, etc.,

E. Kilburn Scott, A.M.Inst.C.E., M.I.E.E.

Vale House, Burnt Ash Lane, Bromley, Kent.

LIGHTNING CONDUCTORS.

Sir,—I am surprised that Mr. Hands says there is no authority for the statement in your note that sharp bands increase liability to side-flash. Surely we have a high authority in the Report of the Lightning Research Committee!

Rule 10 of this Report is rather vague in saying "The straighter the run the better," for this might imply that if not convenient to run the conductor in a direct line deviations would do no harm, but a direct reference is made to another part of the Report by the addition of the words "See Fig. 6." Here two illustrations are given, A. showing the method recommended by the Committee, and B. (in which the conductor is dressed carefully round mouldings) "is the old method *which is condemned*."

The three words I have put in italics are most definite, and it appears obvious to me that their being placed at the end of the Report in place of what would seem to be the proper place, together with an illustration showing the exact method that is so strongly deprecated, and immediately over the signatures of the members, is an intimation that the Committee desire to draw especial attention to the fact that the old method *was* condemned.

The quotation made by Mr. Hands certainly does seem to be in direct opposition to this, but as Sir Oliver Lodge's

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name appears among the signatories to the Report, we may presume he was in agreement, notwithstanding his previous pronouncement.

I have found this Report vague and even conflicting in other respects, but in this the opinion is, I think, very definite. I presume Mr. Hands has not seen it, or he would not have written his letter. It would be interesting to hear whether he will not now modify his views.

Yours, etc., A. W. P.

CONTROL OF PUBLIC SERVICES BY COMMISSION.

Sir,—America has developed a method of controlling gas, electric light and power, tramway and railway companies by means of Commissions of experts. These Commissions work exceedingly well, and an example of the absolute fairness of their decisions has come up recently in connection with the electric light and power supply of Fitchburg, Mass. It appears that a Company operating a steam power plant had been at work for some years, when the Connecticut River Power Co. built a hydro-electric station of 20,000 h.p. The latter now seeks authority to supply light and power in Fitchbury, and this the older Company opposes. On the matter being referred to the Gas and Electric Light Commission, they decided that the original Company should continue to supply the small customers, but that the hydro-electric Company should have the right to supply large consumers. They also advised that the hydro-electric Company should sell power to the original Company at specially favourable rates.

The way in which these American commissions conserve and protect private enterprise, and at the same time ensuring that advantage is taken by new developments, whilst the consumers also are protected from undue monopolistic charges, is worthy of all praise. To live and let live seems to be their policy, and it is a pity that we do not have permanent public commissions to protect and foster private enterprise in public services in this country. —Yours, etc., M.I.E.E.

RAILWAY CARRIAGE LIGHTING.

CANADIAN PACIFIC PRACTICE.

The Canadian Pacific Railway Co. recently placed in service 22 combined compartment sleeping and observation cars, one of which will be attached to the rear end of all through trans-continental trains, says our smart little contemporary, *The Canadian Electrical News*.

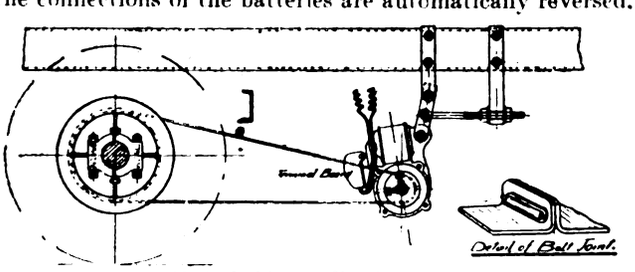
These cars are lighted throughout by electric lamps, the generating apparatus being a dynamo of the "Stone" type, which consists of a 24-volt, 40-ampere, bipolar dynamo driven by a belt running over a driving pulley attached to inside axle of rear truck, and two sets of storage batteries of 320 ampere hour capacity.

The lighting fixtures, finished in oxydized brass to harmonize with the remainder of the metal work of the cars, are of special design to conform to the interior decoration. The use of shades has been dispensed with, on account of constant breakage due to continual cleaning and vibration to which they are exposed in such service. To prevent glare on passengers' eyes, consequent to the absence of shades, all incandescent lamps are acid-frosted, and to prevent loss of light by lack of a reflector, bottoms of socket husks are designed with reflecting surface sufficient to give proper distribution of light. All lamps are kept high and divided into many small units, so as to give as soft and uniform an illumination as possible. For control purposes by car attendant, lights are divided into two circuits, *i.e.*, a half light or all night circuit and a full light circuit. On the former are included lamps on outside platforms, in corridors, lavatories, staterooms, and part of smoking room fixtures. In addition, circuit switches are provided inside staterooms, so that passengers may throw lights on or off as desired. Two smaller independent circuits are also installed to allow buffet attendant to control lamps in his compartment, and the fans placed at either end of the main observation room.

Tungsten lamps of an efficiency of 1½ watts per c.p., and varying in strength from 8 to 16 c.p., are used throughout. Each lower berth in the staterooms is provided with a lamp at the outside end of each seat. The appearance of this berth fixture is novel and differs from any heretofore used, being designed by the company's engineer. The fixture consists of a main casting set on a wood panel carrying on its back a reflector, lamp and miniature flush push type switch, with a half opalescent glass shade projecting from the front of the fixture, covering the lamp and giving a soft diffused light of sufficient intensity to permit the reading of fine print.

The most prominent feature in connection with the generating apparatus is the lack of the usual more or less complicated regulator. In order to simplify the apparatus, the electrical efficiency of equipment has been to a certain extent sacrificed, low cost of maintenance and reliability being considered more essential than high efficiency in railway car lighting. With the "Stone" equipment a mechanical method is used for the regulation of the voltage at various speeds above predetermined value. The dynamo is specially hung, as shown in the diagram. It is attached by a loose hinge to an adjustable link, which is held in position by two nuts on a tension screw. The dynamo is thus free to swing towards, or away from, the driving pulley on the axle. The suspending link and belt are adjusted so that the latter draws the dynamo out of the position in which it would naturally hang, thus putting a definite tension on the belt just sufficient to absorb power equivalent to the electrical power required. Thus, when the pull on the belt (owing to the increase in the speed) exceeds the weight on the belt due to the one-sided suspension of the dynamo, the latter will be automatically drawn towards the driving pulley on the axle, thus allowing the belt to slip, while the armature will continue to revolve at its normal speed. The belt tension can be regulated to suit requirements by means of the tension screw.

This system uses two batteries, and the switching is so arranged that one battery serves to regulate the voltage at the lamp terminals, whilst the other receives a small charge. When the coach runs in the opposite direction, the connections of the batteries are automatically reversed.



Method of Suspending Dynamo.

the battery last charged becomes the regulating battery and the other one receives the charge. The batteries are placed in two boxes, one on either side of the car. Boxes are provided with half-hinged doors to permit of easy inspection of cells at terminals. This, in conjunction with a float on each cell, permits inspectors at terminals to note height of electrolyte in cells. In addition, by means of an ebonite tube projecting through the cover of each cell, the test for the specific gravity of the cells is easily made. By attaching a small syphon with a rubber tube connection to the ebonite tube and by squeezing and releasing the rubber ball of the syphon tube the acid rises in the tube containing a hydrometer. Should gravities be found low, the inspector has only to regulate position of dynamo for greater output, by adjustment of a screw.

All wiring of cars is placed, so far as possible, with a view to being easily accessible. Mains are carried on outside of top of car in wood moulding suitably protected by metal covering. Standard double-braided rubber covered wire is used throughout, and where concealed is protected by circular loom.

The belt used is a three-inch, four-ply, copper riveted one, and is made of canvas impregnated with balata. The average life of a belt is about a year, or 60,000 miles. When necessary, belts are protected by belt cases, which, though lengthening the life of belts by protecting them from sand or grit in summer and ice in winter, are not always easy to install nor to be advocated, since they render frequent inspection of belts difficult.

Through the regulation of voltage being almost perfect, the life obtained with the tungsten lamps used is most satisfactory, their life averaging over 1,000 hours. No flicker in lighting is perceptible when the generator cuts into or out of service as the train starts or stops. Needless to mention, the convenience of the lighting in these cars adds greatly to their popularity with the travelling public.

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WARNING.

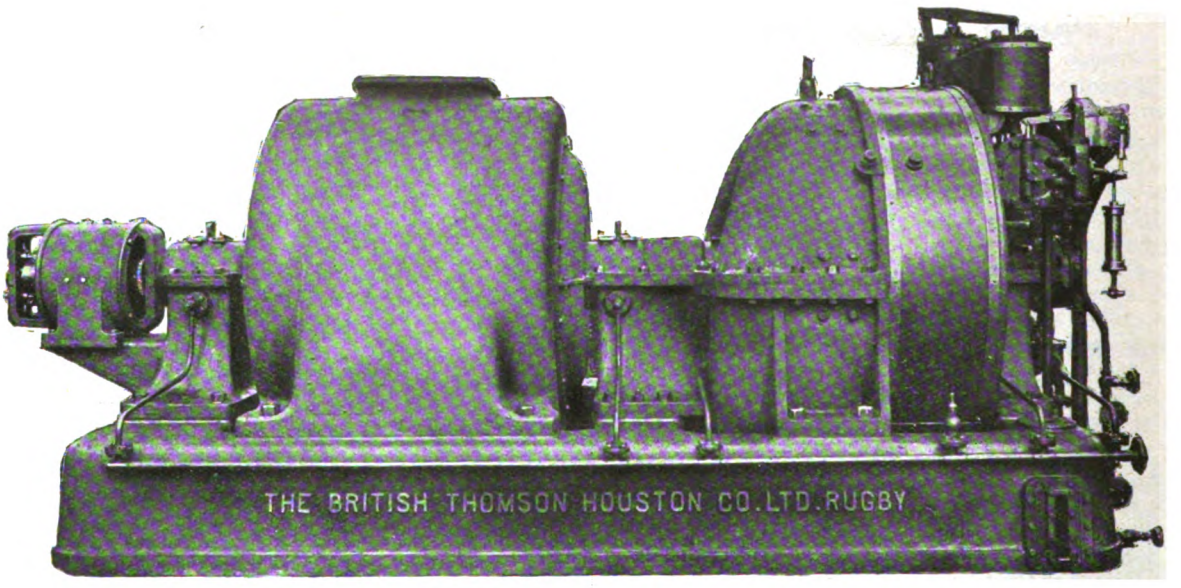
B.T.H. IMPULSE STEAM TURBINES.

CURTIS PATENTS.

The well-known Curtis Turbines are Impulse Turbines in which the steam is expanded in a series of stage nozzles with abstraction of the velocity acquired in each expansion by intervening stage wheels.

These Turbines have been manufactured in Great Britain exclusively by The British Thomson-Houston Company Limited for many years.

Sellers and Users of infringing Turbines are hereby notified that they will be proceeded against.



1000 KW. CURTIS TURBO-GENERATOR.

THE BRITISH THOMSON-HOUSTON COMPANY LIMITED have sold a total of 67 Curtis Steam Turbines aggregating a capacity of 85,000 Kilowatts.

All of these Turbines have been manufactured or are now in course of construction at their Rugby Works.

Supplied in all sizes—either vertical or horizontal.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

THE WILLANS-VICTORIA TURBO PUMP.

The enterprising firm of Messrs. Willans & Robinson, Ltd., are introducing a new Turbo Pump, which is designed both for high and low lift purposes. The demand existing at the present time for pumps capable of delivering water to a height, principally for mining purposes, is large; whilst the number of pumps installed almost daily for dealing with low lifts, such as circulating pumps for Condensing Plants, justifies attention being paid to this subject.

The Willans-Victoria Pump, of which we are able to give an advanced illustrated description, has been designed on lines which will enable the pump to be manufactured accurately and cheaply in view of the fact that machine work enters principally into the construction; and it follows, therefore, that the individual parts of the pump can be manufactured to gauge and in standard sizes.

The high lift pumps are being built to deal with heads of some 2,000 ft., whilst the low lift pumps are arranged for pumping against heads of some 50 to 60 ft. or less.

One of the most fruitful sources of trouble in high lift pumps is the pressure gland at the delivery end. To avoid undue leakage these glands have to be screwed up very tight, and the pressure of the packing material on the shaft causes very considerable wear, and also loss of efficiency, amounting to as much as 7 per cent.

The Willans-Victoria Turbo Pump has no pressure Stuffing Box, as only low pressure exists in the end chamber behind the last diaphragm. This feature of the design removes one of the most fruitful sources of trouble and annoyance to a pump user.

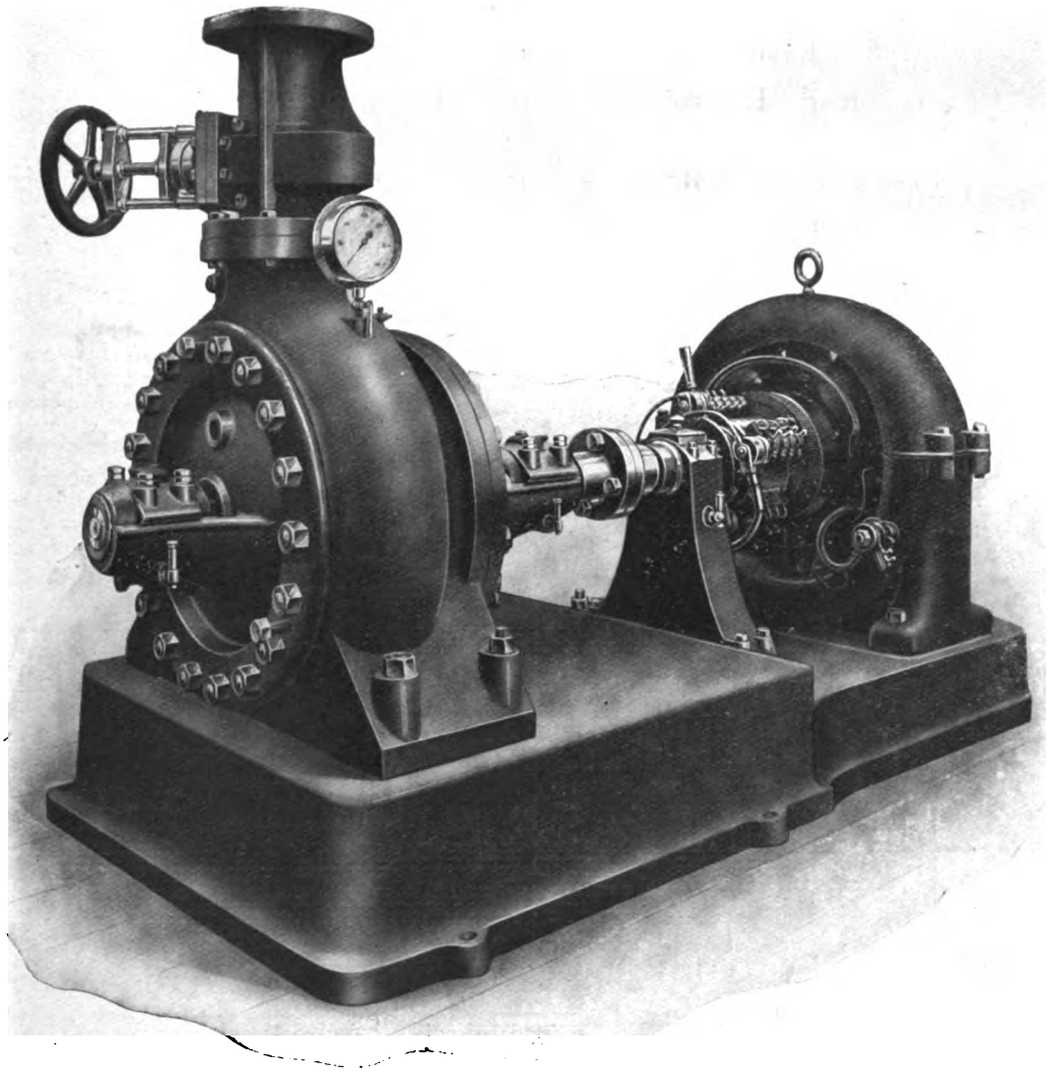

FIG. 1.

The stuffing box at the suction end is water sealed, and as it has only to hold tight against one-tenth of an atmosphere, there is no necessity to set the packing hard against the shaft.

There is no end thrust bearing in the Victoria Pump, as there is no end thrust. The end thrust is balanced by a special patented arrangement of extreme simplicity, and this cannot wear or get out of order, and automatically adjusts itself for changes of head and output while the

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pump is running, and for any wear that may take place in the impellers.

The absence of a thrust block in the Willans-Victoria Pump is a feature of considerable importance. It is claimed for other pumps that the end thrust has been balanced, and whilst this is often true when the pump is new, yet as soon as wear takes place the balance is destroyed. The fact remains and speaks for itself, that in nearly all other

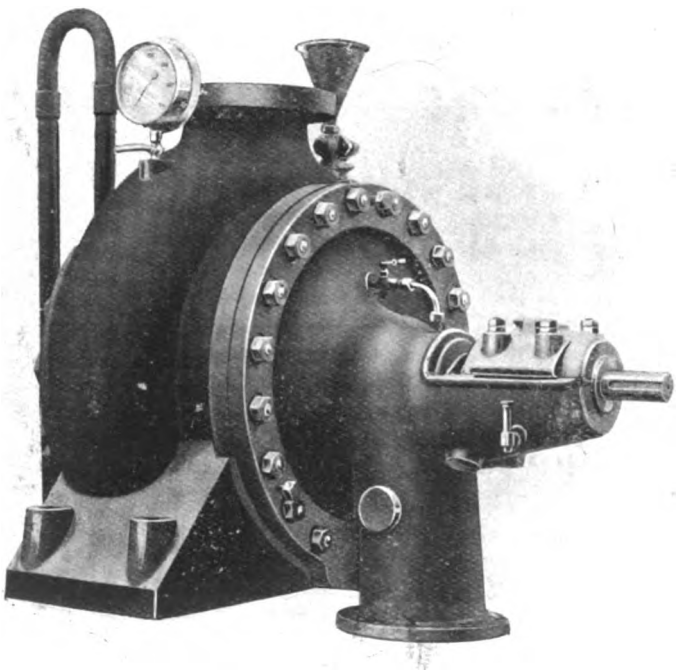

Fig. 2.

Centrifugal Pumps end thrust bearings are fitted.

The bearings are separated by a gap of an inch or two from the packing, so that it is impossible for any grit, mud, or water to enter. The bearings are cast in one piece with the end covers, and these latter fit cylindrically into the centre casing. It is therefore impossible for any part to get out of alignment if the pump is dismantled.

The bearings are arranged for ring lubrication. In the case of sinking pumps the bearings are arranged to be supplied with oil under pressure.

In the case of the Willans-Victoria design of pump, the central casing is of cylindrical bore, and the guide wheels and diaphragms fit cylindrically into the casing.

The dismantling and re-assembling of the sundry parts is, therefore, an extremely easy matter, as they only have to be pushed in one after the other from the open end. It is therefore impossible even for an unskilled erector to get the parts out of true alignment.

The impellers and guide wheels are all made of special bronze, and the inner surfaces of the impeller and guide wheel channels are carefully finished throughout, either by machine or by hand, so that the water during its whole passage through the pump from the first Impeller to the delivery casing, never comes in contact with any rough surface. The finish of these parts is an important point, as experience has shown that the wheels treated in this way have a much longer life when dealing with gritty or muddy water than those having unfinished channels. The Central Casing of the pump is in all cases lined with special bronze, so that no acid or gritty water comes into contact with the casing itself at any point.

The result of careful design and manufacture has become apparent in the high efficiencies which are being obtained in practice with these pumps, and which reflects no less creditably upon Messrs. Willans & Robinson, Ltd., than it does upon Mr. Orten Boving, to whose designs the pumps have been built.

"UNION" INSULATION TESTING SET.

Particulars have been sent to us describing the "Union" Insulation Testing Set, one of the specialities of the Union Electric Co., Ltd. The apparatus is calculated to appeal particularly to contractors, who require an efficient, but yet not too expensive, testing set, and, further, one that they are able to carry about with them without much trouble or fatigue. It is also suitable for the mining industry and, in fact, all places where electrical machinery is installed, as undoubtedly much trouble and expense may be saved by periodical and regular testing of the insulation of the various circuits. The set comprises a magneto generator wound for 500 volts, and, connected with it, a sensitive galvanometer of the moving coil type, which records the readings direct in megohms. The instrument is designed for testing the insulation resistance of electrical circuits. The test is made by connecting one terminal to earth, the other terminal to the circuit under test, the handle of the magneto is gradually speeded up until, at the correct speed, an automatic arrangement locks the pointer of the galvanometer at the position on the scale corresponding to the insulation resistance of the circuit. The instrument reads from 50–0 megohms direct. The scale at the higher values enables readings to be accurately taken.

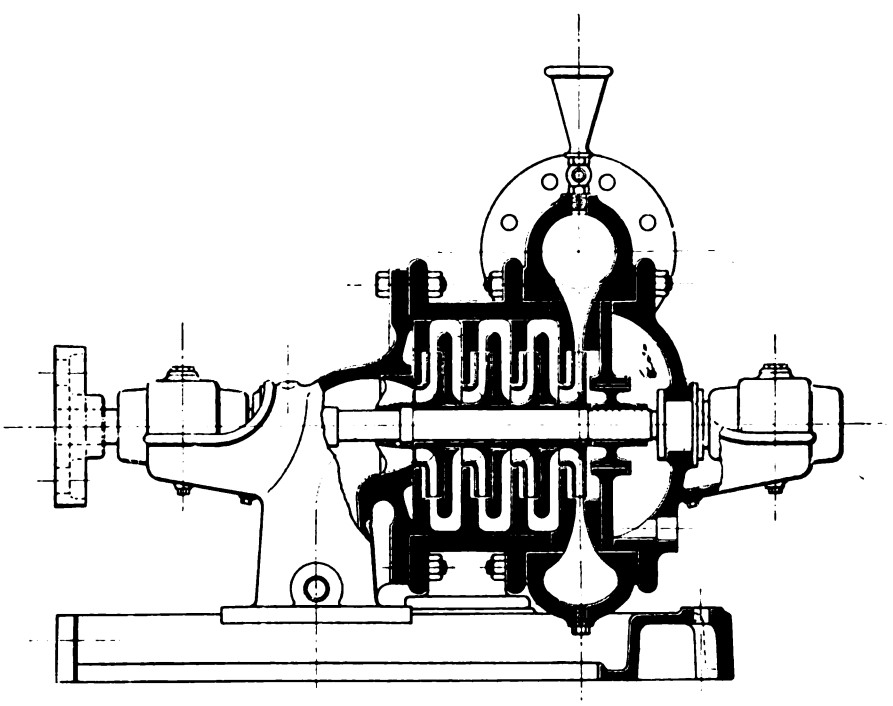

Fig. 3.

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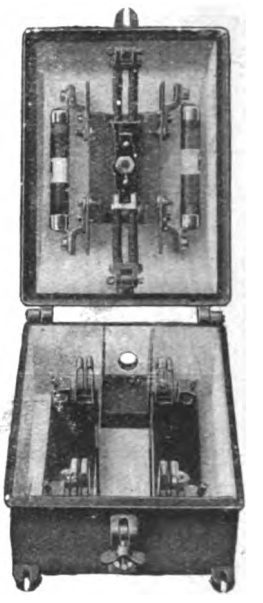
THE PROPRIETOR of the PATENT No., 29363 of 1904, for "Improvements in and relating to Electrical Measuring Instruments," is desirous of entering into arrangements by way of license, and otherwise, on reasonable terms for the purpose of exploiting the same, and ensuring its full development and practical working in this country.

All communications should be addressed in the first instance to HASELTINE, LAKE & CO., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

FITTINGS AND ACCESSORIES.

One or two new designs of fittings and accessories appear in the Simplex Conduit, Ltd., latest catalogue relating to their well-known system of steel conduits. A notable feature is a large junction box for main cables, which is suitable for use either above or below ground in connection with large lighting and power mains. These boxes are made in two sizes, provided with cast bosses on each side, which can be drilled and tapped for conduits up to 2 in. diameter; the flanges on the longer side of the box are suitable for receiving two conduits of this diameter, and those at the end, one. The watertight joint is effected between the cover and the box itself by means of a rubber insertion, the cover being provided with an overlap and held down by four screws passing into external lugs. The cover is further strengthened by means of ribs on the underside. Special interiors are manufactured for use in connection with these boxes, made up of ¾ in. slate; bus-bars of ample capacity are mounted on separate slabs, divided by a central fillet and provided with sweating sockets. Already a number of these boxes are in use in connection with a large power scheme, and have been found to provide a very convenient inspection and junction box.

A further feature is the introduction of spacing saddles for use on installations where moisture is present, and the conduits and fittings are run on the surface of the walls By means of the use of these a clearance of ½ in. between the surface of the wall and the underneath side of the tube or box is obtained, whilst an equally firm fixing is obtained, as where the ordinary form of saddle or clip is used. They are made of enamelled steel of a special shape, and the tubes are sprung into them; when in position, the conduits are raised on two shoulders provided. Two forms of saddles are made, one suitable for tubing, and the second type for standard, circular, or rectangular boxes.



Simplex "Fool Proof" Switch —"Push-On" and "Pull-Off."

In connection with switch gear, a new form of switch fuse is the latest addition to the Simplex system: this type belongs to the well-known "Push-on" and "Pull-off" variety, but of improved action and design. The action is certain, giving a rapid make and break, and incorporating a locking device which makes it impossible to open the case with the switch in the "On" position. The contact pieces and terminals are of ample size, mounted either on slate or fibre insulating material. The switch blades are fitted with sparking contacts. All types are suitable for use on circuits up to 600 volts, and, considering this, the whole design of the switch is very neat and compact, reducing the projection to an absolute minimum; the case is also watertight by means of a rubber insertion between the cover and the base of the box, placed in a rib specially cast for this purpose. The fuses used are of the Simplex well-known standard enclosed type, and the range includes sizes suitable for up to 400 amps.—double or triple pole.

APPOINTMENT AS AGENTS.

We are requested to announce that Messrs. Geary, Adams & Co., Ltd., Central Arcade, Wolverhampton, have been appointed as agents for Messrs. Davey, Paxman & Co., Ltd., Colchester.

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FOREMAN.—Experienced in charge of Bitumen Department; own mixings; refs.—Box D, c/o THE ELECTRICAL ENGINEER.

FITTER.—(Englishman), age 27; experienced in repair and construction of Dynamo and Motor parts, Power-board work, Resistances, Electric Light fittings, and Railway work. Can speak Spanish and French fluently.—Box E, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

POWER Station Assistant, or Electrician on private estate; experienced in Water Turbine Installation, Gas, Oil and Petrol Engines, and test-room in instrument-makers' factory.—Box F, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

SWITCHGEAR Draughtsman, age 23; thoroughly accustomed to designing Switches, Fuses, Circuit-heaters, etc.—Box G, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

ELECTRICAL Engineer.—Fully qualified Engineer, practical experience in all Electrical work; Marine experience as Chief Electrical Engineer. Board of Trade certificate.—Address, Box H, THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

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MEN OUT OF EMPLOYMENT in all branches of the Electrical Trade should write to Box No. 20, c/o THE ELECTRICAL ENGINEER, 149, Fleet Street, London, E.C.

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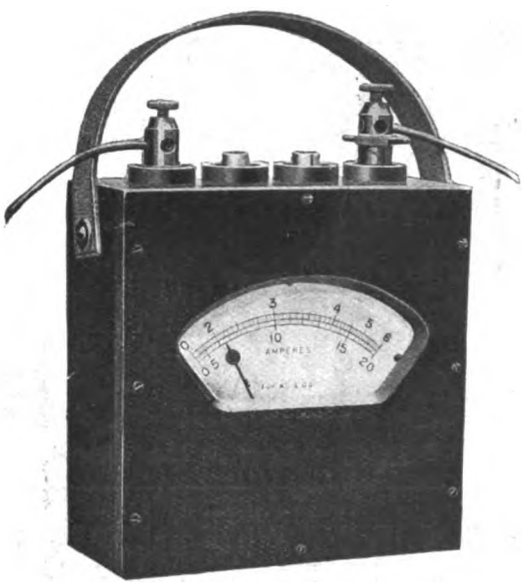

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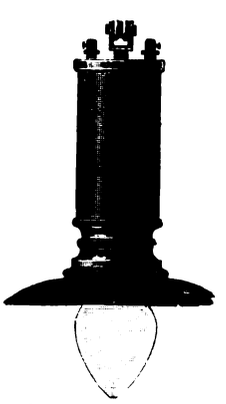

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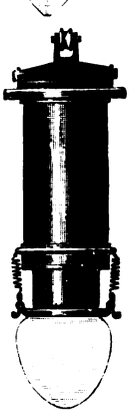

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We reproduce below the design of the latest "Osram" showcard, now being issued by the General Electric Co., L'd. The striking feature of the card is the announcement

"20 hours for one penny," which with the view of the happy family seated at the table, shows that the "Osram" lamp forcibly appeals to the modest household.

ELECTRIC SIGNALLING DEVICES.

To accelerate the electric train service on the District Railway, London, additional sections have been put down in connection with the signalling system. The recently installed "headway clocks," which are worked from relays of the electric signalling installation, shows the driver the interval of time since the previous train passed. These contrivances are to be seen by the driver at Blackfriars and at Sloane Square. Recording instruments have also been installed, showing the actual service head the whole day, and every time a given train service passes a certain point.

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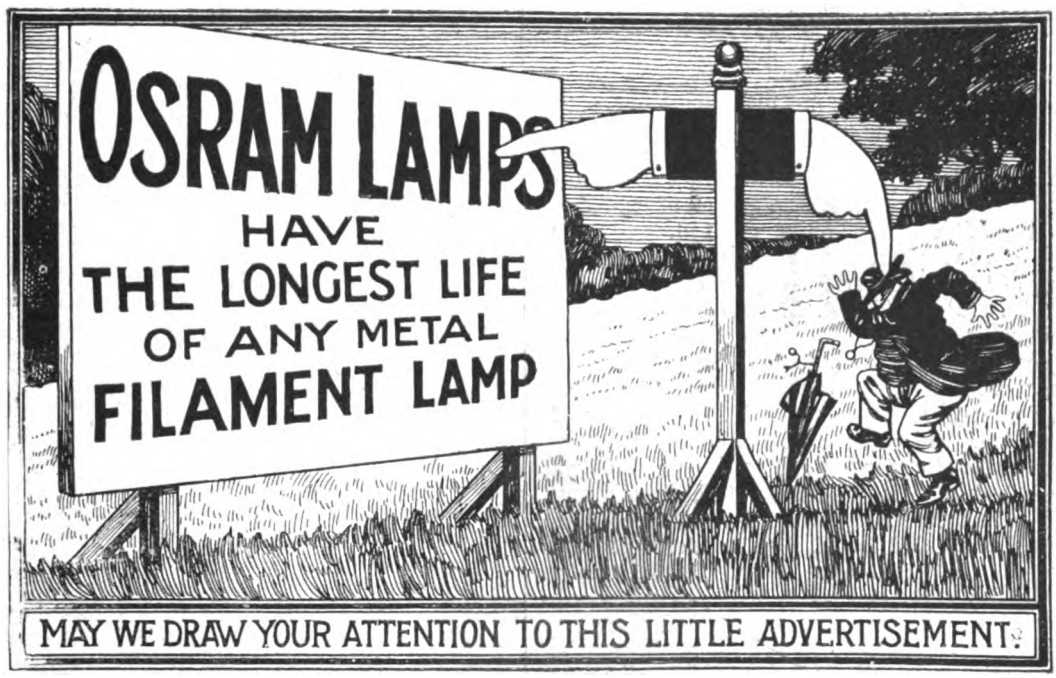

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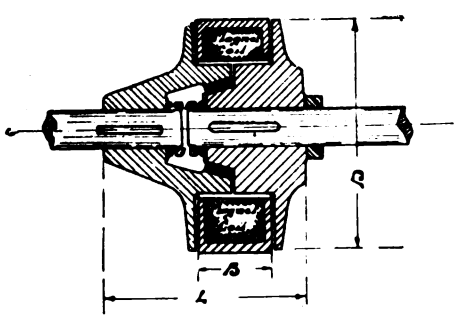
ELECTRO-MAGNETIC CLUTCHES.

The S.M. Electro-Magnetic Clutch, which is largely used on the Continent, has been put on the English market by Messrs. C. E. Lugard & Co., of Middlesbrough. This clutch consists of a stationary magnetic body containing a coil, and provided with feet for fixing to a suitable support. The armature is divided into two parts, the driver is fitted with a renewable cone of phosphor bronze or hard fibre (according to the nature of the drive), the driven part is fitted with an accurately ground cone of steel.

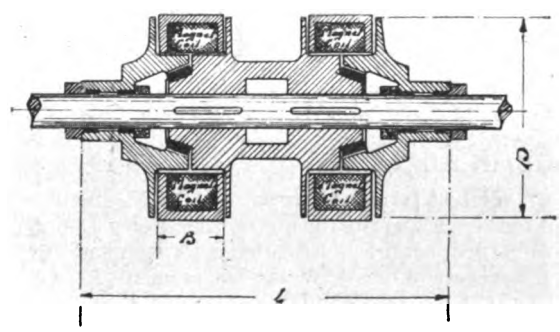
Continuous current is supplied to the energising coil, which draws the two parts of the armature together, driving being effected partly by friction of the cone and partly by magnetism. Between all other faces of the clutch an air cap is maintained, so that sticking from residual magnetism is impossible.



TYPE "A."

The great advantage of the clutch is that it has no slip rings or brushes, the cable being connected to terminals fixed on the side of the stationary magnetic body. The accompanying illustrations show sections of two types of the clutch.

Some large clutches have been successfully applied to rolling mills; 1,200 h.p. at 350 r.p.m., 600 h.p. at 215 r.p.m. have been running for some time on wire rod mills, enabling instant stoppage of the mill from any number of desired points, and an automatic safety device against overload.



TYPE "C."

For machine tools, several reversing clutches have been fitted to large planing machines, doing away with shifting belts, striking gear, etc.; they are better than reversing motors, because the same speed of cut and return can be maintained for any length of stroke. For shafting, loose pulleys, etc., a very large number have been made; one firm alone has 58 which have been running day and night since 1903, without stoppage or repairs of any kind. The clutch is made in 17 standard sizes, and three types.

A NEW MONTHLY REVIEW.

On November 1, *The Local Government Review* is to make its bow to the public. This new monthly is to treat of all subjects relating to local government from a broad, national point of view. While generally severely technical, articles will often deal with principles and policies. The promoters have certainly produced a most attractive prospectus, and have secured the co-operation of a splendid list of contributors. Electricity is not forgotten in its programme. We are promised a "half crown review for a shilling." It should find a place among the list of our indispensable periodicals.

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ELECTROLYTIC DISINFECTING FLUID.

An official report to the Metropolitan Borough Council of Poplar contains particulars relating to the manufacturing, bottling and issuing of electrolytic fluid for the years 1906–9, and the cost of carbolic disinfectants, including bottling and issuing (Public Health Department only), for the years 1903–5. The cost of electricity and materials in the manufacture of the 32,586 gallons of disinfecting fluid from February, 1906, to January 31, 1908 (a period of two years) included:—Electricity, 4,888 units at 1½d. per unit, £30 11s.; salt, at 24s., 26s. and 32s. per ton, £9 4s.; chloride of magnesium, at £3 17s. 6d. and £4 10s. per ton, £14 9s. 6d.; caustic soda, 7s. 2d. per 48 lbs., £7 2s. 8d.; and water, £1 13s.; making a total of £63 0s. 2d. Bottles, corks, labels, etc., cost from February, 1906, to December, 1906, £127 19s. 2d.; from January, 1907, to January 31, 1908, £22 17s. 8d.; and from February, 1906, to January 31, 1908, £150 16s. 10d. The cost of material in manufacturing 28,280 gallons of the electrolytic fluid for the year 1908 was as follows:—Electricity, 4,543 units at 1½d. per unit, £28 7s. 10d.; chloride of magnesium, (23 cwt. 3 qrs. 3 lbs.; 24 cwt. 0 qrs. 7 lbs.), £10 9s. 3d.; salt, 6 tons, £9 18s.; caustic soda, £5 17s. 4d.; and water, £1 10s.; total, £56 2s. 5d. Bottles, corks and labels involved an expenditure of £42 4s. 5d. The cost of materials and electricity (January to August inclusive, 1909) in manufacturing 17,794 gallons of the electrolytic fluid was as follows:—Electricity, 2,988 units at 1½d. per unit, £18 13s. 6d.; chloride of magnesium, £10 7s.; salt, £4 18s.; caustic soda, £3 2s. 6d.; water, 18s.; total, £37 19s. Bottles, corks and labels cost £25 10s. 3d.

Since the plant has been installed, a period now reaching four years, nearly 80,000 gallons have been manufactured at a cost for electricity and materials of under £160. The Public Health Department is not only furnished with the disinfectant and the various institutions of the Council (the public baths, etc.), but the institutions of the Managers of the Sick Asylums and of the Board of Guardians (within and without the borough) are supplied with an unlimited quantity free. For the fluid supplied to the Works Department a charge of 1d. per gallon is made, the Public Health Department is credited with this amount although no actual monetary transaction takes place. Wages (including holiday pay) for manufacturing and issuing from seven depôts involved an outlay of £416 1s. The total cost of electrolytic fluid, corks, labels and bottles, 1906–1909, was: Fluid, £157 1s. 7d.; corks, labels and bottles, £218 11s. 6d.; total, £375 13s. 1d.

The plant was erected at the end of 1906 and beginning of 1907, the cost being as follows:—1906–7: Installation—initial outlay, £325; fittings, etc., Electricity Department, £71 7s. 11d.; sundries, Electricity Department, £11 13s. 10d.; structure of depôt, Works Department, £1:0 6s. 1d.; sundries, £31 4s. 8d.; and carboys, £23 16s. 9d.; total, £583 9s. 3d. 1907: Repairs to dep ts, carboys, sundry additional apparatus, paint, etc., £23 9s. 1d. 1908: Cost of repairs, renewals, and improvements for the whole concern, £45. 1909: Zinc electrodes, £2 19s. 11d.; carboys, etc., £14 10s.; total; £17 9s. 11d. The aggregate cost, to end of August, 1909, of plant, main dep t, etc., came to £669 8s. 3d. Wooden store sheds have been built in connection with the main depot and wooden benches erected in depôts, but the expenditure is not included above.

Cost of carbolic disinfectants, etc., for the Public Health Department only for the years 1903, 1904, 1905 cost £379 2s. 6d., £448 16s. 3d., and £482 9s. 7d. respectively. The cost of disinfectants to the Guardians before the introduction of an unlimited supply of electrolytic disinfectant fluid, during the year 1905, was £199 14s. The average annual cost of disinfectants to the Managers of Sick Asylums, Devons-road and Blackwall, before the introduction of an unlimited supply of electrolytic disinfecting fluid was £20 per annum.

A further report upon the condition of swimming baths and water, and suggested use of the electrolytic disinfecting fluid, has been prepared by Dr. Fredk. Wm. Alexander (Medical Officer of Health). He states that the Baths and Washhouses Committee at their meeting on the 9th ult. considered a report upon the suggested advantages of the use of electrolytic fluid in the swimming baths' water with a view to rendering them more cleanly and a possible conjunction of economy in the cost of water. The committee resolved that the experiments with the fluid should be continued to clearly demonstrate the full benefits likely to accrue. Forty gallons of fluid were added to the first-class swimming bath on Saturday night, September 11, and 40 gallons again on Monday morning, September 13, 10 gallons on Tuesday night and 10 on the Wednesday—100 gallons in all. The large first-class swimming bath at Poplar has a capacity of 75,000 gallons. It is emptied and cleaned on Tuesday night and fresh water run in ready for the use of women and girls on Wednesday; after which use it is again discharged and cleaned and refilled either on Wednesday or Thursday night. Again on Saturday nights this procedure takes place. The Superintendent of the Baths stated that, following the addition of electrolytic fluid to the baths, the water was on the Thursday night apparently in as good a condition, after use for five days, as if it had been used by the bathers for one day only. However, Councillor Barge, the Chairman of the Baths and Washhouses Committee, who had closely followed the experiment daily, considered the bath should be emptied and re-filled with fresh water as usual. He was of opinion the object of the scheme was not so much to save water, but to give the bathers a pure bath and prevent the spread of disease by sterilising the water and interior surfaces of the bath and oxidising as far as possible the organic substances that must necessarily gain access from the large number of persons using the bath. The smaller, second-class, swimming bath at Poplar, which contains 39,000 gallons, is emptied and cleaned on Monday night ready for the women and girls on Tuesday; again the process is repeated on Tuesday night ready for the use of men on Wednesday; and again on Thursday night ready for the use of women and girls on Friday. In the busy summer season practically the bath is emptied and cleansed every night. Into this smaller bath 20 gallons of electrolytic fluid were added on the Monday night; 10 gallons on the Tuesday, after being used by the girls; 10 gallons on Wednesday, and 10 gallons on Thursday. On Friday morning the water was clear, the bath having been used by 510 bathers.

The opinion of masters and mistresses attending with the boys and girls from the schools was that the water, by the addition of the electrolytic fluid, was fresher, more invigorating and had lost its body odour. The secretary of a swimming club on Tuesday night, September 14, stated that the members felt fresher, not languid; they had lost that "dead feeling" in coming out of the bath. The Superintendent stated that the cleansing of the bath was much more easily accomplished.

The results of experiments with the electrolytic fluid suggest that the committee should treat the five baths of the borough, which have a combined capacity of 363,000 gallons, with about 360 gallons of the fluid. Into the four baths, each containing over 70,000 gallons of water, 40 gallons (4 carboys) of ordinary made electrolytic fluid should be added to the water on the night when the baths are filled and be put into the bath early during the filling process so as to be well mixed; 20 gallons (2 carboys) should be added the next night, and 20 gallons the third night, a total of 80 gallons (8 carboys) in all. The fluid which is added after the first night should be emptied into the water at as many points as possible so as to get it equally diffused. Into the smaller, second-class, swimming bath at Poplar, containing 39,000 gallons, on the night of filling 20 gallons (2 carboys) of electrolytic fluid should be added, 10 gallons (1 carboy) on the second night, another 10 gallons on the third night (40 gallons in all, or 4 carboys), applied in the same manner as to the large baths. When the baths are newly filled the electrolytic fluid should always be added during the charging, but the later additions should be governed by the number of bathers and the condition of the water. By following out the above arrangements the water in the swimming baths will be kept pure and free from germs, and can be used for a longer period if necessary, but this, of course, is a secondary consideration.

Although a larger quantity of fluid added to the bath water would not doubt have still better results, there are possibilities that objections would be raised to the odour. One fact is absolutely certain to all observers, that the water keeps clear for a longer period and is more refreshing to bathers with the electrolytic fluid in it than without it. It is obviously healthier to bathe in water three or four days

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old which is kept pure by the addition of electrolytic fluid, than to bathe in water which is polluted by the bathers after a few hours' use when the fluid is not added to the bath. There is no doubt it will be noticed by observers that class-rooms will not exhibit the body odours usually associated with such places to the same extent if all children attending pass through a swimming bath treated with the electrolytic fluid.

REVIEWS.

"Enciclopedia Pratica per le Industrie Galvanoplastiche Elettrochimiche e Fotomeccaniche." By P Conter. 556 pages and 279 figures. Milan: Ulrico Hoepli. Price 5 lire 50 c. (4s. 6d.).

This handy little encyclopædia (6 by 4 in.) on all phases of the art of electro-depositing of metal, and everything appertaining thereto, is a credit to author and publisher. It is exhaustive as far as the ground covered is concerned, concise yet adequately full in its individual articles, usefully illustrated wherever necessary, and thoroughly up-to-date. As an instance of this we may refer to the article on damascening of metals by electro-depositing. The book is essentially of a practical nature, intended for ready reference in the course of industrial exploitation. As was to be expected from so competent an authority as Signor Conter, the art side is excellently done, many beautiful designs of different forms of electro-plating and modelling by means of electro-depositing prepared by the author are given. Numerous valuable tables and workshop recipes are found in the book, and there is a helpful list of chemical synonyms. Supplementing the alphabetical arrangement adopted is a full index. The publisher has done his part of the work well, so that this encyclopædia is worthy to take its place in the celebrated collection of Hoepli manuals.

"Lo Zinco." By Professor Roberto Musu-Boy. Milan: Ulrico Hoepli. Price 3 lire 50 c. (3s.).

Professor Musu-Boy has given in a comparatively small compass a detailed account of zinc. The first part is introductory, being concerned with history, mineralogy and geology. The second part deals with metallurgy, and we find a description of the magnetic concentration of zinc, while ten pages are devoted to the production of zinc by electrolysis. This section might have been elaborated with advantage. We find a reference to Mr. W. Mac A. Johnson's experiments in America on the electro-metallurgy of zinc, but no mention of the work carried out by Mr. Cowper-Coles in England. The same unfortunate hiatus is found in the suggestive but somewhat scrappy chapter on zinc alloys. Part three gives a description of Italian and other zinc mines. Part four is concerned with the uses of zinc, and part five with the economical aspect of the metal. The manufacture of oxide of zinc by different methods is dealt with fully in an appendix. Several diagrams and graphic tables complete the book, but there is no index, an omission which is not compensated for by the table of contents.

"Wireless Telegraphy and Wireless Telephony: An Elementary Treatise." By A. E. Kennelly, A.M., Sc.D., Professor of Electrical Engineering in Harvard University. London: T. Fisher Unwin, Price 4s. net.

This is a second edition, at least so far as the wireless telegraphy is concerned. But it has been brought up-to-date and three interesting chapters on wireless telephony added. The Professor styles his book an elementary treatise—it is so, in fact—and quite understandable by the layman, nevertheless many of the points discussed open out new views even to electricians. It is a book well worth reading, the eighty-four illustrations are good and the spelling less American than one has reason to fear in this kind of publication.

The "Mechanical World" Pocket Diary and Year Book for 1910. Manchester: Emmott & Co., Ltd. Price 6d.

This old friend makes its twenty-third annual appearance with commendable "previousness," for although we are yet some way from January, this diary has to find its way to the far East and the Antipodes, where many look forward to it. There are over 250 pages of notes and tables, all valuable, and, while mainly addressed to the mechanical engineer, much will be found to interest the electrician. The selection of matter is good, and the format of the book handy for pocket or desk.

"Surveying and the Civil Engineer," is the title of a new technical weekly issued at 3d. from the *Pall Mall Gazette* offices.

This newcomer is in competent hands, the editor, Mr. B. Wyand, already well-known as the indefatigable secretary of the Institution of Municipal Engineers, having had considerable professional experience, both as regards practice and as a writer. "Surveying" takes a wide scope. Many of the articles in the first number are excellent, and the illustrations, type, and paper are good. We welcome it, however, more on account of its promise than its actual performance. But the first difficult step having been taken, "Surveying" should settle down to a useful career, especially if its techincal side is developed, for there is distinctly room for a periodical which will deal with the practical rather than the trade union, and mere ephemeral news aspects of the profession.

MINING INSPECTOR'S VIEWS.

In his presidential address at the meeting of the South Staffordshire and Warwickshire Institute of Mining Engineers, held at Birmingham University, on Monday, Mr. Hugh Johnstone (Inspector of Mines for South Staffordshire) expressed the opinion that mineowners and managers should weigh very fully and carefully the advantages and disadvantages of the use of an electrical apparatus, which might be under the control of persons who could hardly be regarded as experts, before introducing it into a fiery or dusty mine. He believed that many of those who read the reports of the official enquiry into the Hamstead disaster entertained a great suspicion as to the part played in it by the electrical apparatus. In any case it was clear that the utmost care, and the use of every precaution, was called for on the part of owners, officials and workmen alike, if they were to improve upon the present position in regard to explosions. But deaths from explosions formed a comparatively small part of the total death-rate. The most prolific cause of death and injury was falls of roof and side, and as the cases occurred one or two at a time public attention was not called to them as in the case of an explosion.

DIMINISHING FUEL CAPITAL.

The special introductory lecture in connection with the courses of lectures and practical work on "Fuel" for the Session 1909–10, at the Sir John Cass Institute, Jewry-street, Aldgate, London, E.C., was given by Mr. J. S. S. Brame, Lecturer on Chemistry, the Royal Naval College, Greenwich. The other lecturers include Dr. Chas. A. Keane (Principal), on "Fuel Analysis," and Mr. C. O. Bannister on "Gas Analysis." Sir Boverton Redwood, who presided, observed that fortunately there was now a general recognition of the part that in the matter of fuel we had in the past been disgraceful spendthrifts, squandering our capital in such a manner that we had often obtained only a small proportion of the benefit which it was capable of giving. We were now becoming alive to the fact that our fuel capital, solid, liquid and gaseous was within measurable distance of exhaustion, and that we must husband our resources if we were to avoid bankruptcy at an early date. Mr. Brame began his lecture on "Liquid fuel and its economic aspects" by pointing out that as a fuel for steam-raising oils of high calorific value, cheapness and high flash point were demanded, while for internal combustion engine oils of high volatility were generally requisite in order that they might readily form explosive mixtures with air in the cylinder. Briefly, the advantages of liquid fuel over coal might be summarised as—inferior evaporation to coal in the ratio of 1·6 to 1, ease of handling, facility it afforded for stowing on ships in situations where coal could not possibly be stored, less space required than for coal, one ton of oil requiring only some 38 cub. ft., while coal required some 43 cub. ft. per ton. There were also numerous other minor advantages. Discussing the questions of supply *v* forces, he said liquid fuel could not compete with coal, and was not a fuel for general use, but for employment in special cases. For Naval purposes most Powers were following the lead given by Great Britain in its adoption.

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QUESTIONS.

Question No. 2006.—In order to place a temporary light in one of the haulage houses of a coal pit, the mains supplying the motor were used. The motor is a 3-phase induction motor, working at 520 volts and 50 cycles, and it is about 500 yards from the distributing station. Here the mains to the motor were temporarily disconnected from the power supply, and two of them were connected to the lighting supply, which is at a pressure of 260 volts, but no light could be obtained in the haulage house. There was found to be a pressure of 150 volts between each of these two wires and earth, but no voltage between the pair. I should be glad if some reader would explain.—"A. L."

Question No. 2007.—Explain briefly the principles of construction of the pure repulsion motor, particularly that type where the starting, etc., is performed by movement of the brush arms. State the conditions under which speed regulation is obtained, the method of starting and stopping, and the method of operating. Does torque vary with speed, and can the motor hold the load when standing still, or is a brake required? Is there any way of stopping sparking at starting other than by the two winding method? Would a supplementary brush trailing a little behind the principal brush, with the short-circuited coil between the two, bridged by capacity, be of any use?—"C."

Question No. 1203.—Consider the effect of the air gap of an induction motor on its size, cost, and general characteristics. State and explain its limiting values, and compare with the gaps of direct current machines.

Answer to Question No. 1203 (*awarded* 10*s.*).—An induction motor is equivalent to a transformer with a rotating secondary winding. If the rotor is locked while power is still supplied to stator, the motor becomes an actual transformer, with the only difference from usual static transformer, that there is an air gap in the magnetic circuit. It can easily be shown that the calculations for induction motors can be correctly made if the motor is considered as a transformer (*i.e.*, with locked rotor), and having a resistance in series with its rotor conductors to cut the current down to the normal running current in rotor. The calculations are then made as for the transformer circuit.

This analogy seems to point at once to the uselessness of the air gap in induction motors, for it would be absurd to see a static transformer with an air gap.

The gap is *only* required to give clearance between stator and rotor, and is kept as narrow as is consistent with mechanical construction. (Comparison must not be made with alternator design, where gaps of 3 cms. and more are common; the object, then, is to get a field strength to swamp the armature amp.-turns and give good regulation.)

In a normal motor the amp.-turns required for the air gap would be about half the total amp.-turns (for gap and iron circuit), and so increase in air gap means more magneto motive force required, and, therefore, greater magnetising current.

The circle co-efficient σ and circle diagram are of great assistance in motor designs and problems. (It must be remembered that transformers have a similar circle diagram—in fact, the motor diagram is deduced from that of the transformer.) Good motors have a low circle co-efficient.

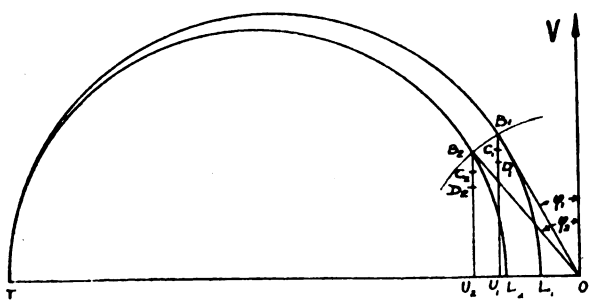
Bériot gives $\sigma = C \times \frac{R}{T}$ where

R = radial depth of air gap — cms.

T = polar pitch (at air gap) — cms.

C = constant, about 10 to 15.

From this formula, if the gap increases, for constant T, σ must increase, and bad designs will result.



The circle diagrams shown are for two similar motors, but one has double the air gap of the other, and, consequently, requires nearly double the magnetising current.

O T — ideal short-circuit current, assumed to be the same in both motors.

O L_1 — magnetising current: small gap motor.

O L_2 — magnetising current: large gap motor.

$$\sigma_1 = \frac{O\,L_1}{L_1\,T} \qquad \sigma_2 = \frac{O\,L_2}{L_2\,T}$$

O B_1 O B_2 — current input vectors.

B_1U_1 B_2U_2 — energy components of line current.

cos g_1 cos g_2 — power factors (small and large gap motors).

B_1C_1 B_2C_2 — respective stator losses.

C_1D_1 C_2D_2 — respective rotor losses.

C_1U_1 C_2U_2 — respective torques at rotor conductors.

D_1U_1 D_2U_2 — respective shaft outputs.

The losses in large gap motor will be greater than in small gap motor, due to increased magnetising current, etc.

The arc B_1B_2 is struck from O, and indicates that the same line current is supplied to both motors.

From the diagrams it is seen that, for this same current, the *large* gap motor has—

1. Lower power factor.
2. Power factor more remote from the possible maximum (*i.e.*, when O B is tangential).
3. Smaller energy component.
4. Less torque on rotor.
5. Less shaft output.

From the above considerations, we appreciate the importance of small air gaps.

The effect of wide gaps on size and cost will be to increase stator slots, since more amp.-turns and more winding is required, and probably mean larger stator altogether.

The copper cost will be increased, also winding costs; but against these must be set the decrease in cost due to the less difficult work in mounting the rotor. With larger air gaps, any inequalities of the gap are not so noticeable; whereas in small gaps they produce dangerous side pulls.

The lower limits of air gaps in induction motors rest wholly with mechanical construction, and the gaps are from 0·6 to 3·0 mm., according to size of motor.

In direct current motors of similar output, the gaps would vary from 3·0 to 7·0 mm.—"W."

Answer to Question No. 1203 (*awarded* 5*s.*).—The air gap of an induction motor is a most important factor in its design, and has a direct influence on its efficiency and commercial value. The factors dependent on the air gap length are first considered, and then comparisons are made between the characteristics of induction motor air gaps and those of other electrical machines.

The induction motor is only distinct from a static transformer, in that the secondary winding now rotates, a fact which necessitates the introduction of an air gap in the magnetic circuit. In no other respect is this air gap desirable, and to reduce the wattless or magnetising current of the machine, it must be made as small as possible. The air gap forms the main reluctance in the magnetic circuit of an induction motor, and to maintain a high power factor the magnetic leakage must be small, and hence the gap reluctance a minimum. The air gap being entirely eliminated in static transformers, it follows that the

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"magnetising" current of the latter is only ½ to 1% the full load current, instead of being ⅓ the full load current, as is frequently the case in induction motors.

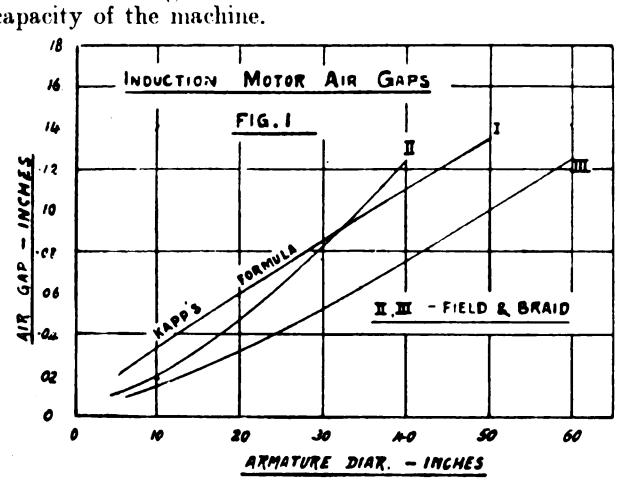
In general, the smaller the air gap of an induction motor, the easier it is to secure the required leakage factor, and so the desired power factor; but the more accurate the construction essential, the greater the risk of "whipping" caused by magnetic pull and the more frequent the bearing renewal necessary. It is usual to specify the gap as a function of the rotor diameter, and this is done in Fig. 1. Electrical and magnetic considerations, of course, frequently entail a departure from the provisional gap so determined. Specially well-built machines, which will be well tended when installed, may have yet smaller gaps than those given by Fig. 1. The nature of the service must be allowed for: in mining service, for instance, a considerable longer gap would be essential than in a machine shop motor or central station machine.

Influence of Gap Length on Leakage, p.f., Magnetising Current, etc.—The chief leakages in an induction motor are the slot, peripheral (tip to tip), zig-zag, and end connection leakages. Of these, the slot leakage varies directly with the gap length R, as also does the peripheral leakage (assuming the gap to be the only variable in both cases). The end connection leakage rises as the gap length increases, but less rapidly than the latter, owing to the fact that the axial core length also rises with R. The zig-zag leakage is usually expressed by a term independent of R. In a certain machine, doubling the gap length from the value actually adopted would have decreased the p.f. by 6% to 7% (*i.e.*, to 83·5%), while halving its length would have increased the p.f. by 3%. The influence of the increased leakage co-efficient consequent on the longer gap length is at once obvious from the equations—

(A) $\cos\phi = \frac{1-\sigma}{1+\sigma} = 1 - 2\sigma$ roughly, where σ = leakage co-efficient

and (B) magnetising current = full load current $\times \sqrt{\sigma}$.

If the value of σ be too high, the maximum p.f. is reduced, and is, moreover, attained at below the normal full load of the machine: conversely, if σ be too low, the maximum p.f. is increased, but is not reached till the machine is overloaded. A 20% increase in σ affects the p.f. by about 2% as a rule, while a further ill-effect of increased leakage co-efficient is the decreased overload capacity of the machine.



Suppose the p.f. of a motor to be low, owing to the use of a long air gap—for a given h.p. output the current taken must be increased; and, assuming a fixed permissible ampere turn loading per cm. of periphery, the number of conductors n per pole per phase is reduced, and hence the axial core length must be increased. Given the specification for an induction motor, the r.p.m. is usually fixed, or a value at once follows from the periodicity and desired number of poles. Assuming a peripheral velocity of rotor of 12 to 25 metres per second, the rotor diameter is determined. Thence, from Fig. 1 a provisional gap length follows, and from the equation

(C) . . . . . $C_o n = \frac{B R}{1{\cdot}5}$

the gap density B at once follows, C_o being known from equation (B) above. It has been shown that n is less the greater R, but the effect of R on C_o is greater: the nett result is that the greater R the less the gap density B, and hence the greater the core length to obtain the desired back E.M.F. per phase. The latter effect is obvious from the equation

(D) Back E.M.F. = $2{\cdot}2 \times \frac{5}{9} \times n \times b \times \boldsymbol{T} \times B \times p \times 10^{-8}$ volts

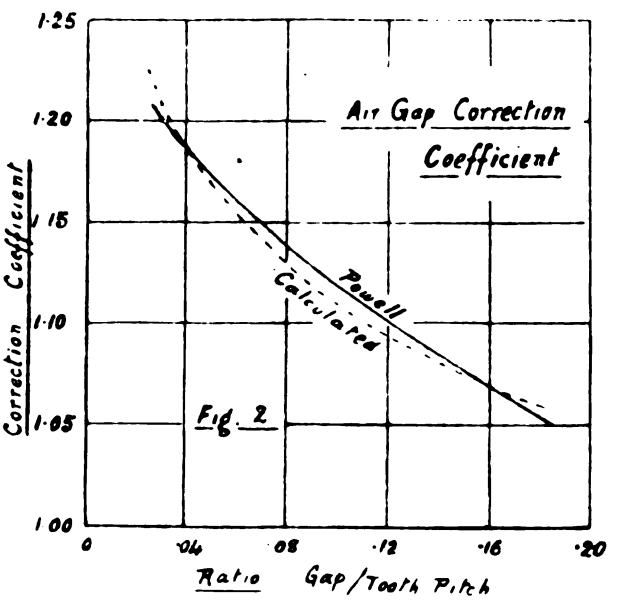
(n = condrs. per pole per phase : b = core length (nett) : $\boldsymbol{T}$ = pole pitch : B = gap density : p = number of poles).

Since both n and are B decreased by an increase in R, it is clear that b must rise correspondingly the E_b being constant.

Any increase in the gap length thus leads to a rapid increase in the output co-efficient, *i.e.*, to a less efficient use of materials. The increase in leakage with increase in gap length is the main inefficiency following on the latter, though the increased weight of iron and copper, and the less favourable ratio of pole pitch to core length probably necessitated, still further reduce the overall efficiency.

Gap Length and Air Gap Correction Co-efficient.—The disturbing influence of the teeth on the flux distribution along the pole faces is increased in induction motors on the one hand, by the fact that both rotor and stator are slotted, and is still further accentuated by the shortness of the gap length. T. F. Wall (*I.E.E.*, vol. xl.) has shown the means of determining the resultant flux distribution in an induction motor gap by compounding hypothetical fluxes, while Powell has recently shown the effect of gap length on the correction co-efficient. His results ont he latter point are shown in Fig. 2, the curve between air gap correction co-efficient and gap length being nearly hyperbolic, as shown by the dotted hyperbola most nearly fitting the experimental curve.

A further effect of the very short air gap, amounting at times to little more than a mechanical clearance, is that the insulation between core laminations does not appreciably decrease the gap density above it, owing to the bulging of the magnetic stream lines. The distinction between the nett and gross core lengths is, therefore, largely removed, so far as concerns the gap flux distribution.



Comparison between Induction Motor Air Gaps and those of other Electrical Machines.—On simple direct current machines the armature ampere turns should be $\leq$ 0·7 of the field ampere turns, and the length of air gap is varied till this condition is satisfied. On interpole machines, owing to the direct neutralisation of much of the armature, reaction and distortion effects a higher ratio, say, 1 : 1, is permissible, and a shorter gap and weaker field, therefore, possible. On the simple machines a gap length of 1 to 2 cms. is common, while on interpole machines this may fall to from 3 to 8 mms. The shorter gap enables economies in field copper, which partially compensates the cost of the interpoles, and this without introducing the difficulties consequent on the very small gaps of induction motors.

In turbo alternators a gap 6 to 8 cms. long is frequently necessary to ensure a field sufficiently "stiff" to give the

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desired voltage regulation, but normal, moderate speed alternators do not differ greatly from direct current machines in the matter of gap length, 1 to 3 cms. being usual, the exact value being determined with reference to the armature strength and the voltage regulation stipulated.

Gap Densities in Induction Motors.—The high magnetic frequency in alternating current machines (50 ∽ /sec. on a 50 cycle supply) necessitate lower flux densities in the iron than are permissible in direct current machines, where much lower armature frequencies are aimed for (10 — 15 ∽ /sec., say). The gap densities permissible are hence less for alternating current than for direct current machines, and the following values, suitable for induction motors running on 30 to 60 ∽ /sec. supply, may be compared with the usual densities allowed in direct current machines.

	C.G.S. lines per sq. in.	C.G.S.lines per sq. cm.
D.C. machines	30,000 to 50,000	4,700 to 7,700
Induction motors (mean B)	19,500	3,000
Maximum B 2-phase	36,500	5,610
,, B 3-phase	33,170	5,100

The maximum gap densities in the case of the induction motors have, then, the values shown, the ratio

$$\frac{\text{B gap maximum}}{\text{B gap mean}}$$

being about 1·87 for 2-phase motors and 1·70 for 3-phase motors.—" R."

TYNESIDE NOTES.

(From our Correspondent).

NEWCASTLE.

In view of the interest now being taken in the application of electricity to industrial purposes, it is useful to note particulars of an equipment recently installed and set to work for Messrs. Stephen Easten & Co., Ltd., of Newcastle-on-Tyne, who are probably one of the largest building contractors in the North of England. A fire in the timber working shops necessitated sweeping renovations, and in progress of these a gas engine, with considerable shafting losses, was displaced by electric motor drive, as individual in its nature as possible. The consulting engineer was Mr. F. T. Hanks, of Newcastle, who worked in conjunction with Mr. Pettie, the electrical engineer to Messrs. Stephen Easten. Direct current motors made by the General Electric Co., Ltd., are installed, and run off the 430-volt supply of the Newcastle and District Electric Lighting Co., Ltd. The motors drive wood-working machines by Sagar, Kirschner, Hardill, and other makers. A Hardill circular saw, capable of giving a 12-inch cut, and having a rise and fall motion, is driven by a 15 h.p. motor. A Sagar pendulum saw requires 5 b.h.p. motor drive. A similar power is required for a tenoning machine with travelling bed for framing up sashes and mouldings. A group drive is adopted in the case of a cutter-grinding machine, an automatic grinder for planer irons, and a saw sharpener, which are driven by shafting and belting from a 5 h.p. motor. A 20 h.p. motor, placed in a pit beneath the floor in order to leave the floor clear to turn pieces of wood, drives a Hardill four-cutter capable of dealing with stuff up to 12 in × 4 in., while a 20 in. × 9 in. hand and power feet surfacing and thicknessing machine requires 5 b.h.p. Above the shop containing the heavy machinery is a top floor carrying a circular saw, elephant, band saw, band saw setting and sharpening machine, etc., which are group driven. Tantalum lamps are used throughout for lighting, the leads in the shops being mounted on insulators, while in the adjacent stables and motor garage of the firm conduit wiring is employed. The general lay-out of the plant was under the direction of Mr. Trotter, of the firm of Messrs. Stephen Easten, who worked in conjunction with the gentlemen named above in the electrical arrangement. The result is an up-to-date wood-working equipment of a very fine character.

Miners' Anti-Electric Agitation.

The resolution placed before the Miners' Federation by the Durham Association against the use of electricity in fiery mines was withdrawn, but this was not regarded as being due to an error of fact, but an error of tactics, in presenting the resolution. The general opinion among mining men appears to be that, pending the investigation of a Parliamentary Committee, any private verdict would prejudice the situation. There is no doubt, however, that very strong feeling against the introduction of electricity into mining still prevails. I have received information, which I believe to be reliable, to the effect that within the last few weeks about 25 coal-cutters, electrically-driven, have been taken out of the North Biddock, Margaret and Lady Annie pits by the management of the Lambton Coal Co., owing to the agitation of the men against their retention, and it is reported that the question of taking them out of other collieries in the Durham area is being considered. During the past 18 months at least two men have been killed in this area owing to the baring of trailing cables attached to the coal-cutters, in consequence of friction caused by falling stone. Another quite recent fatal accident was caused by the man attempting to lighten a loose cable with a bare spanner. The man in question was a pump minder with no authority to interfere with the electrical plant. It is very difficult to prevent accidents due to non-authorised interference or carelessness in view of the ease with which men of insufficient knowledge may interfere. In all mines full instructions are posted up, accompanied by penalties ranging from 5s. to 10s. for breaking rules, regarding use of electricity, but it is most difficult to get men working coal-cutters to realise that danger is only to be prevented by adherence to the rules. Owing to piecework they are so anxious to get the coal that they are careless as to whether the trailing cables are damaged, as they will not free the cable of fallen stone, but drag it through. The result of such accidents is always to create a prejudice against the whole system in the minds of the men.

A Protective Device for Trailing Cables.

It is becoming realised that the men have to be protected against themselves in this respect, and a device is now being adopted which may become general, and which makes the apparatus practically "fool-proof." This device is the invention of Mr. H. J. Fisher, the electrical engineer to the Lambton Colliery, and is being made by Messrs. W. T. Glover & Co., Ltd. It consists of a trailing cable with an extra covering of a metallic nature which is used exclusively for earthing the framework of the coal-cutter. The earth wire of the trailing cable is connected up to an automatic switchboard located at the gate end box, so that directly the earth wire in any portion of the trailing cable becomes damaged or broken it causes the automatic switch to trip, the power to the trailing cable and the coal-cutter being shut off. The tripping device has to interrupt 10, 15 or 20 h.p. (the usual powers for coal-cutters) at pressures usually from 500 to 650 volts, the Board of Trade limit being 700.

Electrical Colliery Developments.

Despite the present scare in the north-east English colliery area, which may be regarded as temporary, electric power supply to collieries by the County of Durham Electrical Power Distribution Co., Ltd., is proceeding apace, and this is a most encouraging symptom. The electric winder at Harton, which I mentioned in a previous letter, is probably one of the largest in existence, and in addition to this, at Harton the New Bent House pit and the second Harton shaft are to be electrically driven. The Norwood pit of the Dunston and Garesfield Co. is to be electrically equipped throughout, while the Ushaw Moor pit, belonging to Messrs. Pease & Partners, is to be fitted with electrical plant, and there is a probability of extension at Blaydon Main. In the Sherborne group of pits a very fine installation is just being completed, including a 700 h.p. pump and a considerable amount of power absorbed in coal-cutting and other purposes, and which is distinguished by having a pole line system with aluminium conductors.

MIDLAND NOTES.

(From our Correspondent.)

BIRMINGHAM.

The application of electricity as a motive force in iron production and in engineering work continues to spread rapidly in the Midlands. Messrs. Walter Somers & Co., Ltd., of the Hayward Forge, Halesowen, have just had put in three additional large motors for general tool and lathe driving. These were supplied by the British Thomson-Houston Co., Ltd., of Rugby, and form the second order for large machines executed by them for this firm. The important installation of electrical plant at the works of Alfred Hickman, Ltd., Bilston, has recently been supplemented by a generating plant in connection with the blast furnaces, providing motive power for the refrigerating apparatus. Six motors, each of 395 h.p., have been put in by the General Electric Co., Ltd., of Witton, while the switch-gear has been provided by the British Thomson-Houston Co., Ltd., who also supplied the principal switchboard for the rolling-mills. The new switchboard provides for a total power-capacity of 2,250 kw., and comprises three panels, each controlling 750 kw. 500-volt generators, six 400 h.p. 500-volt motor-control panels, with four blank panels, screens and supports, and the necessary bus-bar extensions.

Electric Power at Iron Works.

A visit has been paid by the Birmingham Society of Mechanical Engineers to the works of the District Iron and Steel Co., at Smethwick, in which a considerable use is made of electrical

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power. The current is obtained from the public mains, and during the nine months in which part of the plant has been in use, the supply has proved perfectly satisfactory. Another interesting point is that the plant was designed by the Company's Engineer (Mr. Elijah Willcox), and to a large extent constructed in the works. The first application of electrical power was to the 16-inch merchant mill, where the motor has superseded a beam engine of an old type. The mill is now driven by a three-phase, 400-volt, 25-period motor, supplied by the British Westinghouse Electric & Manufacturing Co., Ltd. The 5,000-volt current from the public main passes through a Westinghouse transformer provided by the Corporation. The power is transmitted to the rolls by rope pulleys, the pulley-wheel and the fly-wheel being each 16 ft. in diameter, and the latter weighing about 35 tons. The effective capacity of the motor is 275 h.p., at a speed of 360 r.p.m., and the drive is four to one, giving a speed of 90 revolutions on the train. The rolls thus served constitute an ordinary merchant-mill for all sections, up to 16 ins. Auxiliary to it is an electric saw, driven by a Westinghouse three-phase alternating-current, 400-volt Westinghouse motor.

Expectations Fully Realised.

The experiment satisfied the directors as to the superiority, in economy and other respects, of the new form of power, and it was decided to adopt it also for the 9-inch mill, which is used for rolling tubes, motor sections, bicycle tubes, etc. The electrical plant has been in operation here for some weeks past, and has fully answered the expectations formed of it. The mill is driven by a three-phase, 25-period induction Westinghouse motor, taking the full current at 5,000 volts from the main, running at 365 r.p.m., and developing 395 h.p., the mill being rope-driven. The 7-inch mill is at present driven by a beam engine and horizontal engine coupled, but the early substitution of electrical power here also is contemplated.

University Electrical Courses.

The Electrical Engineering Department of the Birmingham University, under Professor Gisbert Kapp, has opened the new session with 53 students. Of these, 35 are in the third year, and are devoted to mining, civil, mechanical and electrical engineering. Eighteen students of the fourth year are devoting the whole of their time to electrical engineering. The number of students in the mining department who take up electrical study shows a decidedly increasing tendency, while mining managers and mining engineers already in practice are taking advantage of the facilities afforded by the University for perfecting their knowledge of a subject, the importance of which to the mining industry is every day being more and more recognised.

Birmingham Electric Club.

The Birmingham Electric Club, which has been in existence six years, has now 85 members, and it is expected that the rate of increase—from 15 to 20 members each year—will be, at least, fully maintained for some years to come, as the club is in a very flourishing and vigorous condition. The new session was inaugurated by a smoking concert at the Colonnade Hotel. Mr. Geo. T. Wood, A.I.E.E., presided, and among the 50 members present were Messrs. Vincent E. Walters and G. A. Pope (Vice-Presidents), E. A. Morgan (hon. treasurer), and W. G. L. Riddle (Hon. Sec.). The meeting arranged for a visit to the Daimler Motor Works, Coventry, to take place on November 29. The first paper of the session will be read on November 13, by Mr. Carl de Hoedt, of Birmingham, whose subject will be "A Discourse on Problems of Power Generation and the Transmission and Distribution of Electrical Energy." The programme for the session is not yet complete, but it will include a paper on "Aerial Motors." Other useful papers are being arranged for. The annual meeting is fixed for December 11, when Mr. Geo. T. Wood, the present President, will be asked to retain office for another year.

From Wolverhampton to India.

Advantage was taken of Saturday's meeting to bid farewell to Mr. P. M. Baker, B.Sc., who is an old member and who has lately been teacher of electrical engineering at Wolverhampton Technical School. He left England on Wednesday last to take up a position in technical education at Bombay College. A presentation has been made to him by the Wolverhampton Electrical School. Formerly he held a similar position in connection with the Birmingham Municipal Technical School, and he received his training in Birmingham. He also won his degree B.Sc. after a long course of study in connection with the Midland Institute. Mr. Baker will carry with him the good wishes of all his old colleagues.

AMERICAN NOTES.

(From our Correspondent).

NEW YORK.

The electrical industry was never in a more flourishing condition than it has been during the past week, and all branches of trade are participating in the increased demand. The big advertising campaigns organized simultaneously in the technical periodicals and popular newspapers and magazines have had their natural and inevitable sequel in a largely increased activity among manufacturers and retailers, which in its turn has materially swelled the output of Central Stations. Electrical securities are in good demand at firm prices, and the outlook is cheerful all round. Wholesalers dealing in domestic electrical appliances report that trade in these lines is exceptionally brisk, and numerous extensive dealings in heavy plant are notified. Among other developments the increased demand for turbines is especially noteworthy, particularly in connection with mill drives. In New England alone, the Allis-Chalmers Co. has sold thirty-eight steam turbines of the full annular-flow, horizontal reaction type, aggregating in total capacity 51,000 horse power. The power house of the new Nashawena Mills in New Bedford, will contain two 3,000 k.w. and one 500 k.w. steam turbines of their make. The Allis-Chalmers Co. has also contracted with the Whitman Mills, at New Bedford, for power-house equipment, including a 2,000 k.w. steam turbine, and with the Byron-Weston Co., of Dalton, Mass., for one 750 k.w. steam turbine.

Some Big Contracts.

Among other large contracts notified during the week may be mentioned that of the Lord Electric Co. of this city, for the roadways, railings, lamp brackets and wiring of the new Manhattan Bridge across the East River. The work includes the construction of a roadway of creosoted wooden blocks and of two sidewalks to be made of concrete and artificial stone along which there are railings with ornamental posts. There will be six of these railings on the lower deck of the bridge and four on the upper deck. The bridge will carry eight tracks, four for trolleys and four for third-rails. The company will also do the entire wiring for the lighting and traction work on the bridge, including the wiring and bonding of the four tracks on the lower deck. The lighting equipment includes ornamental brackets for both arc and incandescent lights, and the fixtures for the latter. There are 54 of these arc brackets and 198 incandescent. The company will also construct two switchboards, one on each end of the bridge. It is proposed that the energy for lighting be divided between the Manhattan and Brooklyn Edison companies. The work is to be completed by December 15th, as it is proposed to have the bridge ready for opening in January. Another important contract is that which has just been entered into by the Niagara Falls Hydraulic Power and Manufacturing Co., to supply current for the operation for 76 years of the new municipal water-pumping station at Niagara Falls. The city will sell the power company the property in the lower milling district on which the municipal station now stands for $20,000. Over 800 h.p. will be acquired, the price to be $10 per h.p. The engineer of the water board will see what arrangement can be made with the Niagara Falls Power Co. for a breakdown power service. The city is engaged in building a new water system, the supply of which is to be taken from the upper river, whereas in the past the municipal plant has been supplied from the hydraulic canal.

New Arc Carbon Plant.

The Wilckes-Martin Co., the great lamp-black firm, is organizing a new company with a capital of a million dollars to build a large manufactory for lighting carbons. It is the intention of the new company to make all kinds of high-grade lampblack carbons, including flaming-arc, searchlight, moving-picture and enclosed-arc carbons, and in addition to this to manufacture the ordinary petroleum coke carbons, which are still used to a considerable extent in street lighting in this country.

Charging Electric Cars.

A new device of supreme value to owners of electric cars has just been perfected by Professor John Montgomery, who occupies the chair of Electrical Engineering at Santa Clara College, California. By means of this invention storage batteries of practically every description can be charged with the ordinary low-voltage currents used in the household. In the case of a motor car the apparatus may be attached to an electric-lighting wire anywhere at night, and in the morning the car will be ready for use. The charging current may be turned on whenever the car is not in use, insuring plenty of power for every emergency.

Hydro-Electric Contract.

The J. G. White Co. of this city has secured from the Canadian Light and Power Co. of Montreal, the engineering contract for the construction of the new hydro-electric plant on the St. Lawrence. The contract includes the construction of a canal intake and headgates about 3,200 ft. below the present intake; the enlargement of the Beauharnois Canal from the intake to the station site—32,000 ft.—to the capacity of an initial installation of 21,600 shaft-h.p.; the construction of a forebay with concrete headwall and the power station itself; the tailrace excavation; the construction of the 27-mile transmission line to Montreal, and the substation and distribution system in that city. The power station will contain four main units and two exciter units, the equipment of which will include three 7,200-h.p. turbine units, two 440 h.p. exciter turbine units, three 4,000 k.w generators, two 250 k.w. generators, three 4,000 k.w. transformers, switchboard, etc. The present initial development will cost about $4,000,000.

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Electric Mining Hoist.

An electric mining hoist of unusual power and dimensions has been installed by the Connellsville Manufacturing and Mine Supply Co., in the mine of the Washington Coal Co. at Dawson, Pa. The hoist, which is located 800 ft. below the surface, will haul thirty-five cars each weighing, loaded, 3,800 lbs., up a maximum grade of 8½ per cent. 8,000 ft. long, at a speed of 600 ft. per min. The hoisting drum, which is of heavy steel, is 6 ft. in diameter and 5 ft. wide between flanges, and is fitted with a hand brake on one end and a hand operated friction clutch on the other. All the gears are cast-steel with machine-cut teeth, the main spur gear being 10 in. face and the motor gears 13 in. face. The frame is made in sections and the drum, large gears, and friction clutch parts are made in two pieces for convenience in installing in position. The hoist is driven through a flexible coupling of a 500 h.p., direct-current, non-reversing, compound-wound Westinghouse motor controlled by a standard semi-automatic Westinghouse magnetically-controlled unit switch controller, provided with an accelerating relay which prevents the starting switches from closing too rapidly and prevents too large starting currents. Thus the second switch cannot close until the current allowed to flow by the closing of the circuit has fallen to a predetermined value. As soon as this value is reached the second switch closes, thereby short-circuiting a resistance section and the current rises, but the third switch cannot close until the current has again fallen to the predetermined value. This not only prevents injury to the motor from careless handling during acceleration, but ensures rapid starting. The controller is provided with a safety relay which opens the resistance switches in cases of excessive overload, but a notable feature is that if the relay operate while the motor is running the latter does not stop but is automatically brought up to full speed again.

Current Items.

The American Monorail Co. is planning the construction of a monorail line through Pelham Park to City Island, New York. A speed of upwards of two miles a minute may be developed. Should the scheme prove successful proposals may be made for an upper deck for monorail expresses over the New York Elevated.

The Albany Southern Railroad Co., which has been incoroporated at Albany, N. Y., is a reorganization of the Albany and Hudson Railroad, the third-rail electric line between Albany and Hudson, which recently was sold under mortgage foreclosure.

Alberto Sanchez, an electrical engineer in the Belern prison in Mexico City, claims to have invented an apparatus whereby vision as well as voice can be transmitted over an ordinary telephone wire. It is said that the prison officials have tested this and it has proven very successful. The apparatus resembles a short opera glass connected to a battery.

The Willamette Valley Co. has deeded to the North-western Corporation all its property in Oregon, including electric-lighting plants in Albany, Corvallis, Eugene, Springfield, Dalles, Monmouth and Independence, including also water systems at Albany, Springfield and Independence, and a gas plant at Eugene.

The Genesee Light and Power Co., with principal offices at Batavia, has been incorporated with a capital of $250,000 to operate in the various villages and towns in Genesee County. The company is a reorganization of the Genesee County Light, Power and Gas Company.

Mr. Clarence Mackay, President of the Postal Telegraph Co., denies the report that that Corporation has absorbed the Western Union Telegraph Co.

The New York Telephone Co. has increased its capital stock from $50,000,000 to $100,000,000. The company pays a state tax of $25,000 on the increase. The company has filed a certificate showing that it has merged the Central New York Telephone and Telegraph Co.

COMPANIES' MEETINGS AND REPORTS

MESSRS. WILLANS AND ROBINSON, LTD.

At the ordinary general meeting of Messrs. Willans and Robinson, Ltd., of Rugby, held at the Cannon-steet Hotel, London, Mr. James C. Peache presided.

The Chairman, in moving the adoption of the report, described the result of the past half-year's trading as disappointing. After allowing for the loss on the half-year's working, the balance standing to the credit of the profit and loss account was insufficient to provide for the payment of the full preference dividend, and there was no surplus to go to the payment of interest on, or the redemption of, the funding certificates. The directors realised that that was a result which the shareholders must view with concern and anxiety; but he could allay that anxiety, and satisfy them that when the period of failing trade was past they would again attain the condition of progress that had lately marked the course of the company's affairs. The disappointing result of the past half-year was entirely due to the continued depression in trade. The principal business of the company was the production of machinery for the generation of electricity. This was a line of business that had been adversely affected to a greater extent than perhaps any other in this country. The introduction of the metallic filament lamp and the great economy in current realised by its use was having a very serious effect on the revenue of electric lighting stations. In all parts of the country the output of current was falling off, and electricity concerns, instead of having to order new plant, were finding that their existing plant was in excess of their requirements. In the end, no doubt, the cheapening of electric light would lead to a great extension of its use, and to renewed demand for plant. For the present, however, new construction was at a standstill, and the business of building electric generating plant, for this country at all events, was in a state of stagnation. The number of orders to be obtained in this country for electric generating plant were few, for owing to excessive competition prices had been driven to a level that left only a narrow margin of profit. The value of orders obtained in recent half-years had been insufficient to keep the works fully employed. It was true that in the first half of 1909 the value of orders obtained was considerably larger than in the previous half-year, but the bulk of their old orders had been worked off, and for two months in that half-year it was necessary to put the works on short time. Since June, he regretted to say, the improvement experienced in the early part of the year had not been maintained, and there was no doubt that for the present and for the immediate future they had to face a continued scarcity of work. They had devoted great efforts to obtaining orders for steam turbines abroad, and in this direction they had met with considerable success, and had obtained good orders for Canada, Australia, South Africa, and Japan. They had endeavoured, with some success, to extend their connection with industrial concerns in this country, and had supplied a number of turbine plants for driving the machinery of cotton mills, collieries, harbour works, etc., but in these directions the demand had been restricted by the depressed state of trade. Cotton mills, for instance, were now running on short time, and no new mills were being built. Other branches of manufacture in which the company was engaged had not yet reached the final stage, but it was hoped that in the near future some of them would be of material help in earning a profit for the shareholders. Notwithstanding the poor result of the past half-year's working, the position of the company's affairs to-day was sound. In cash and marketable securities they had a substantial provision against the needs of the immediate future. With regard to the Queen's Ferry works, there was some hope that a sale might result from negotiations now in progress. In conclusion he said the directors trusted that the present set-back was but temporary, and that when the state of trade returned to a more normal condition the works would be well prepared to take full advantage of it.

Mr. Shirley Price seconded the adoption of the report. The motion was carried with one dissentient.

RIVER PLATE TELEPHONES.

The report of the Sociedad Cooperativa Telefónica for the year ending June 30, states that the profits amounted to $230,7641.47 m.n, as compared with $202,057.49 for the previous year. The expenses were $591,835.04, as against $539,928.79, and revenue $824,565.75, as against $748,547.64. The subscribers numbered 6,164, as against 5,790. Out of the profits, $149,671.90 goes to the shareholders' fund, and will be distributed in the form of shares. The land lines to La Plata have been finished, and will be opened to service in a few months. The cost value of the properties of the company stands at $445,070.41.

ROSARIO ELECTRIC COMPANY.

The report of the Rosario Electric Co., Ltd., for the year ended June 30 last, states that the balance at credit of profit and loss account, after making a provision for depreciation of buildings, plant, etc., is £35,014, to which must be added the amount brought forward from the last account, £6,549, making a total of £41,563. The directors now recommend a dividend of 5s. each on 14,513 Ordinary shares (making 8% for the year), and at the rate of 8% (less amount already paid) on the Second Preference shares, converted into Ordinary shares, adding to the reserve £15,000, leaving to be carried £9,282. The directors have ordered an additional steam dynamo of 1,000 kw. to cope with the steadily increasing demand for both lighting and power. A more favourable price for coal has beneficially affected the results of the year's working, and the new condensing plant has reduced the amount of coal required per unit of energy sold. The Chairman sailed for Rosario in July to visit the property, and is now on his way home.

DRAKE AND GORHAM, LIMITED.

The eighth annual report of the directors of Messrs. Drake & Gorham, Ltd., for the year ended June 30 last, states that after payment of all charges, including bonuses due to staff, there remains a net profit of £2,282 1s. 8d., which, with the sum

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of £1,327 11s. 9d. brought forward from the previous year, makes a total of £3,609 13s. 5d., which it is proposed to appropriate as follows:—By payment of dividend at the rate of 2½ per cent. per annum, £3,125; by carrying forward, £484 13s. 5d. The work carried out by the London Office during the past year compares very favourably with the previous twelve months, and the Agency business in Osram and Tantalum Lamps continues to expand; the orders, however, for installation work in the Northern district have unfortunately, considerably decreased, which is attributed to the prevailing depression within the last eighteen months, and the reduction in dividend is mainly due to this cause. A satisfactory feature of the past year is the large amount of work executed for old clients in connection with the modernising and extension of existing installations. The retiring Director, Mr. John C. Forster, is eligible for re-election. The Auditors, Messrs. Jackson, Pixley, Browning, Husey & Co., retire, and are eligible for re-election.

CONTRACTS OPEN.

HOME.

BRAY.—Town Council.—For a 50 b.h.p. Diesel engine, and high and low tension disconnection boxes. October 19.

FRODINGHAM.—Urban Council.—Tenders for lighting the streets in the Urban District of Brumby and Frodingham by electricity. Direct current at 220 volts is already available, and the number of lights will be 55 of 50 c.p. each. October 16.

KEIGHLEY.—Corporation Electricity Department.—Tenders for two boiler feed pumps, high-tension switchboard and transformers, one 300 kw. motor-generator and mains. October 16.

OVERSEAS.

BATAVIA.—Colonial Government.—Extension of Atjeh tramway. Est., £100,000. (Part., Ministère des Colonies, The Hague).

BOLOGNA.—Material for extension of electric tramways (Soc. An. des Tramways de Bologne).

BRUSA.—Municipality.—Construction and exploitation of electric tramways. November 30.

CAPE COLONY.—Tender Board, Cape Town.—Tenders for the supply of eight electric motors. October 19.

LEGHORN.—Tramway construction.—Material and rolling stock (Soc. An. des Tramways de Livourne).

MELBOURNE.—Deputy Postmaster-General.—Two sets of accumulators. By 3 p.m., November 23.

SPAIN.—The Ministerio de Fomento.—Tenders for a 60 years' concession for the construction and working of an electric tramway from Sans to Coll-Blanch (Barcelona). Tenders must be enclosed in sealed envelopes, bearing on the outside the name of the tenderer, and addressed to the Dirección General de Obras, Públicas, Madrid, where they will be opened at noon on November 20. To qualify any tender a deposit will be required of 1,295 pesetas (about £47), which should be enclosed in a separate envelope. An application respecting this concession has already been submitted by the Compañía General de Tranvías, who have certain preferential rights in the competition.—For a 15 years' concession for the working of the urban telephone system at Oviedo, the present lease expiring on October 31, 1909. Tenders will be opened by the Dirección General de Correos y Telégrafos, Madrid, at 11 a.m. on November 8, but they must reach that address not later than noon on November 2. The concessionaire is to have the right to modify or extend the present telephone system within a radius of 15 kilos. The "Gacetas," containing further particulars, may be seen by British firms interested on application to the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C. *Local representation is necessary in each case.*

SYDNEY.—Postmaster-General.—Switchboard apparatus for subscribers' premises. Particulars of all Australian contracts, 72, Victoria-street, Westminster, S.W. January 10, 1910.

VALENCIA.—Harbour Board.—Six one-ton electric cranes for timber unloading. November 2.

SOME CONTRACTS.

CANADA.—It is reported that the Northumberland-Durham Power Co., lessee of the whole of Healey Falls power from the Dominion Government, and the Culverwell syndicate, owning certain Trent river powers, north of Trenton and at Campbellford, have completed a contract with a leading Montreal financial corporation for the underwriting of two and a half million dollars bonds for the development of these powers. Power will be transmitted to Belleville and the cement mills, Deseronto, Napanee and Kingston, also west to Port Hope and Cobourg, and also north to Havelock, Norwood and Blairton mining districts. These powers will be developed on the dams being built by the Dominion Government for the Trent Canal.

The contract for the aluminium cable for the Toronto (Ontario) city power distribution plant has been awarded to the Montreal Cable Co. at about $20,000.

OTHER CONTRACTS.

The D. P. Battery Co., Ltd., of Bakewell, have received from the Corporation of Dudley an order to supply, erect, and maintain for a period of ten years, a Storage Battery of 256 cells of their LS 37 type. This battery is capable of supplying over 1,000 amperes for an hour.

TENDERS ACCEPTED.

BELFAST.—The tender of Messrs. Imeson, Finch & Co., of Stockton-on-Tees, for the supply of two miles of trolley wire for the Corporation Electrical Department, was accepted.

MERTHYR.—The Merthyr Public Works Committee accepted the tender of the Merthyr Electric Traction Co., at £535 10s. per annum, for lighting Merthyr Vale and Aberfan, as compared with the present cost, £570 8s. per annum, for gas.

VICTORIA (Australia).—The Prahran and Malvern Tramways Trust has accepted the tender of Messrs. Duncan & Fraser, of Adelaide, for the supply of 13 car bodies (under contract 6), to be delivered not later than March 31 next, the price to be £536 13s. per car.

BUSINESS NOTES.

LIGHTING AND GENERAL—Home.

ALVASTON.—The Urban Council received a letter from the Town Clerk of Derby, thanking the Council for their acceptance of the offer to instal electric light in the Alvaston district. As there was the possibility of objection when the matter came before the Board of Trade, it was desirable that the Corporation should know why the Alvaston Council approved of the extension of the electric light to their district. The Clerk placed the proposals in detail before the Council, who unanimously decided to adhere to their original decision.

ASTON.—The Electricity Committee reported to the Town Council that during July and August last there had been an increase of 222,080 units in the current sold.

BALLYCLARE (Ireland).—An Electrical Engineer attended before the Urban Council with reference to the proposed lighting scheme. He explained that the probable cost of an efficient scheme for lighting the street and an estimated supply to private consumers, including the costs of a Provisional Order, would amount to about £4,000.

BRAY.—The Urban Council received a letter from the Local Government Board sanctioning a loan of £1,000 for the purposes of electric light works, the repayment to be spread over twenty years.

CARDIFF.—At the meeting of the Electric Committee, Councillor Chappell called attention to a complaint to the Trades Council, to the effect that many people were thrown out of employment in the electric light department, and said that these kind of complaints were doing harm. He proposed that an opportunity be given to the Trades Council to meet the committee. Mr. Arthur Ellis expressed his willingness to explain in detail why, in the interests of economy, the Eldon-road Power Station had to be shut down. He put up a notice three months ago saying that this would be done, and suggesting that the men should look out for work elsewhere. If the Corporation did not reduce the men they would, he said, be compelled to reduce the hours of all. The matter then dropped. The general manager of the tramways informed the committee that the effect of the increased car fares was that the takings this year amounted to £1,000 more than they were at this time last year.

COLCHESTER.—A Committee of the Council passed a resolution recommending that a small sub-station, similar to that at Hythe, should be erected at Lexden, and that the Tramways Committee be asked to consent to the use of the overhead tramway wires for conducting current to the sub-station.

DAWLISH.—The Urban Council received from Mr. Purves, on behalf of the Provisional Board of Directors formed with the object of carrying out if possible the electric light undertaking for Dawlish, plans showing where they proposed to lay the mains, and also a sketch of the poles proposed to be used for overhead mains, asking the Council's approval thereto. The Surveyor reported that although he recommended underground mains, he did not see much objection to the Council allowing overhead mains in the rural parts. The style of pole submitted would be objectionable in the streets. A committee recommended the Council to approve underground mains from Queen-street to Luscombe-terrace, and from Old Town-street and the Bartons, and that ornamental posts be required in some parts of the district for overhead mains. The question of arc lighting was referred for a statement as to the cost in comparison with the existing system of lighting. It was suggested by Mr. Purves that the electric light station should be on the ground between Matham and the Wesleyan Sunday-school. The matter was referred to a Committee of the whole Council.

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DERBY.—Several questions were asked at the Town Council meeting relative to the lids on the electric light manholes, and whether it was not desirable to have different covers in view of a disastrous explosion which occurred in Peter's-street recently. Alderman Butterworth, replying on behalf of the Electric Light Committee, said that as to the deplorable explosion they could not take upon themselves as a committee any responsibility for the accumulation of gas in their chambers. The chambers were ventilated to a certain extent, and if they were to put a bridge on top of the manholes it would form opportunities for the rain and moisture to get into the manholes, and that would be detrimental to their works. He must respectfully decline to offer any opinion as to where the responsibility lay for the explosion.

DERBY.—The Town Council will consider the question of applying to the Board of Trade for a Provisional Order under the Electric Lighting Acts, 1882 and 1888, to authorise the supply of electrical energy by the Corporation, for public and private purposes, within the Urban District of Alvaston and Boulton, and the parishes of Littleover, Breadsall, Chaddesden, Normanton and Sinfin Moor, in the Rural District of Shardlow, and Markeaton and Darley Abbey in the Rural District of Belper.

DUDLEY.—At the Town Council meeting, Mr. W. H. Hughes (chairman of the Streets, Tramway, and Lighting Committee) referring to electricity undertaking, announced that during the year there had been a reduction in the number of units sold, in round figures, of 45,000. The decrease was entirely confined to the tramway and motor supply. The output in connection with the tramways showed a decrease of 45,843 units, whilst the shrinkage in the output for motor purposes was 28,700 units, making a total of over 73,000 units. As the total decrease, however, was only 44,000 units, it was apparent that there had been a considerable increase in the consumption of electricity for private lighting purposes. The total works costs in connection with the generation of the electricity had been 1·560d. per unit and the average price per unit sold 1·573d., which represented a microscopically small profit. He quoted figures showing that Dudley compared favourably with Birmingham, Wolverhampton, Walsall, and West Bromwich in regard to the average selling price per unit, Wolverhampton being the only place where it was slightly lower; but unfavourably with all these towns in respect of the load factor. At present the undertaking was not costing the town anything, and electricity was being supplied at prices which should encourage its use for all purposes for which it was required.

FAREHAM.—The Engineers at the new Electricity works reported to the Urban Council that, mainly owing to the non-delivery of some of the electrical parts connected with the larger sets, the work had been greatly delayed, and the position was still unsatisfactory. They did not see any hope of getting the plant into running order for some considerable time yet. However, it was hoped to make the transfer before Christmas.

FINCHLEY.—A deadlock has ensued between the District Council and the Local Government Board respecting an application by the local authority for permission to borrow £2,200 for electric arc lamps in Great North-road and Regent's Park-road. The Local Government Board are withholding their sanction to the loan unitl the Council supply them with an estimate of the cost of lighting the same thoroughfares by gas. The Council informed the Board that as regards the question of the illuminant to be used for the streets the Council consider they are the best judges. They submit that the point which the Board is called upon to decide is whether a loan should be granted for the necessary sum to enable arc lighting to be installed, and not as to whether gas or electricity should be used. The Board regard this letter as unsatisfactory, and adhere to their recommendation that the Council should carefully consider the relative cost of public lighting by gas and by electricity. The Council, in reply, say they have nothing to add to their previous letter, and a deadlock has followed. The Council have decided to expend out of the current rate £240 for electrically lighting Regent's Park-road.

GLOUCESTER.—At the City Council meeting, Mr. Collett announced that the last two months showed a very considerable increase of business in connection with the electricity undertaking. In July they sold 7,000 more units than a year ago, bringing the month's output up to 98,000 units; and in August they sold 106,500 units as against 92,000 units in August of last year. In July their revenue was £860 as against £793 a year ago, whilst their expenditure was reduced from £489 to £476. In August their revenue was £901 as against £787, and their expenditure had gone down from £513 to £463 as compared wish August last year. Mr. Collett referred to the revised scale of charges for current for power purposes which the Engineer had submitted. The Engineer represented that in order to work still more advantageously they ought to increase the power load, and the scale which they had adopted compared very favourably with those of any similar undertaking, and ought to induce people who were now producing their own power to obtain current from the City Station. For 1,000 units per annum they were reducing their charge from 1·9 to 1·5d. per unit, and for half a million units from 1,125d. to 0·75d. per unit.

HESSLE.—A letter was read from Mr. W. Coulson, Clerk to the Hessle Urban District Council, to the Hull Electricity Committee, stating that the Urban Council regretted the offer made by the Hull Corporation for a supply of electricity could not be accepted. They would, however, be willing to meet a deputation. The Chairman (Mr. Hanger) pointed out that the price was very generous. It was agreed to meet the Hessle Council representatives.

HULL.—At the suggestion of the Drapers' Association, the Chamber of Commerce communicated with the Town Clerk for transmission to the Electric Lighting Committee suggesting that light users of electricity should be put on equal terms with power users, who at present were receiving considerable advantages. They received, it was stated, special discount by paying in a certain time, and it was felt that the light users ought to have similar privileges. The Secretary's interim report stated that the Chamber had given its support to the Corporation against the North Eastern Railway Bill, and in the Electric Lighting Acts (Amendment) Bill amendments had been secured in support of electrical contractors as against municipal trading. Important amendments had been secured with respect to the Trade Boards Bill.

KENDAL.—Mr. H. R. Hooper, M.Inst.C.E., held a Local Government Board inquiry respecting the application by the Council for sanction to a loan of £10,000 for purposes of the electricity undertaking, and £2,000 for a refuse destructor. In view of the conditions laid down by the Inspector for the repayment of superseded expenditure rendered necessary by the removal scheme, it was announced for the Council that they would not further press upon the attention of the Board the proposal for the erection of a destructor and station at the canal head. They further resolved that the application be amended so as to correct the loss of voltage at the station immediately and to enable the Corporation to increase the output when necessary. The scheme was opposed by Mr. L. G. Thompson on behalf of a number of ratepayers.

LONDON.—An artesian well has been completed at Basildon House. The well provides a water supply of 2,000 gallons per hour from a depth of 450 ft. from the surface. For lining the upper portion 8 in. steel tubes were used. The plant includes an electrically-driven pump, the gearing being mounted on ball-bearings, and running in a specially constructed oil chamber. The pump is coupled direct to an electric motor, an automatic arrangement being attached to start the pump when the water in the storage tank drops below a certain level. The work has been carried out by Messrs. Alfred Williams and Co., of Bow.

MIDDLESBROUGH.—To the Electric Lighting Committee the Chairman (Councillor C. Dorman) intimated that they had concluded the first year's working under the arrangement with the Power Company, and the result of the working had been most satisfactory. The gross profit on the capital was 8·6 per cent., and, while the current had been supplied at the lowest rate hitherto recorded, the profits were the highest for any of the years the undertaking had existed. The capital account was £109,454, and the amount redeemed was £20,900. The Engineer (Mr. Taylor) reported that the estimated revenue for the past month was £1,454, against £1,379 during the corresponding period of last year, and the estimated profit, £782, compared with £713. The units sold totalled 151,000 against 142,000, and the consumers numbered 1,023, an increase of 123 on last year.

NEWCASTLE (Ireland).—The Urban Council had under consideration the question of lighting the town by electricity, and correspondence from a number of electrical engineers on the subject was submitted. A Lewisham firm, in reply to the Council's queries, wrote fully on their proposals as to their proposed installation of electricity for lighting and power purposes in the town, and desired the Council's consent to their application for a Provisional Order. Mr. Newell was opposed to granting a monopoly to a company. He was opposed to the Committee's recommendation that the correspondence with the Lewisham firm be submitted to the Council's solicitor for his legal opinion, as he considered such a course premature. The Committee's recommendation was adopted, and it was decided to write the electrical engineers practising in Belfast and Dublin asking their fees for the preparation of a report and estimate on the subject.

OLDHAM.—The question of disposing of the Rhodes Bank electricity buildings is under consideration by the Council. The Electricity Committee having received a number of applications for the supply of electric energy to premises situate outside the borough under the powers conferred by the new Act, the Town Clerk has been instructed to apply for the consent of the Lancashire Electric Power Co., the respective District Councils, and the Board of Trade.

OULTON BROAD.—The General Purposes Committee reported to the District Council that applications had been received for particulars in connection with the working of the Electric

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Lighting Provisional Order, and submitted a letter from the Oulton Broad Electricity Co., Ltd., asking if the Committee would meet two or three directors of their company to suggest some means of carrying out the working of the Order. A letter was also read from the Electrical Engineer of the borough of Lowestoft. It was decided to appoint a sub-committee to consider the terms and conditions upon which the Order could best be carried out, and with power to meet representatives of firms if required. The Clerk stated that six or seven applications had been received.

PLYMOUTH.—At the Borough Council meeting, Mr. Anthony, presenting the minutes of the Electricity Committee, drew attention to the annual report, which was exceedingly good. The condition of the undertaking was such that everybody in the town ought to feel very well satisfied.

ROYTON.—The Urban Council had before them an application from the Oldham Electricity Committee to supply electricity within the Royton district. Consideration was deferred pending further particulars.

WALSALL.—Submitting a report from the Electricity Committee, Mr. Hayward informed the Town Council that the introduction of mechanical stokers had been found to effect great economies, and the results already fully justified the outlay.

WESTHOUGHTON.—The Electric Lighting Sub-committee of the Urban Council considered the question of the price of electric current for the lighting of the Town Hall, clock, library, Technical school. Mr. Taite, on behalf of the Lancashire Electric Power Co., made the following offer:—All current supplied to be charged for at 4d. per unit less 10 per cent. discount, subject to the average maximum charge per quarter not exceeding as follows: Town Hall £8 10s., clock £1 10s., library £3 15s., Technical School £2 10s., total £16 5s., or a maximum in the aggregate not exceeding £65 in any one year; the offer to stand for a period of three years. The matter was referred back.

WHITBY.—At the Urban Council's meeting, Councillor Cook submitted the report of the Lighting Sub-Committee, with respect to the Council's electricity undertaking. He explained that the number of consumers had been increased by 15, bringing the total to 382. The profit was £700, far in advance of any other year; this being exclusive of stock and assets. The income had increased by £483, and the expenditure by £19, and during the next year it is hoped still further to increase the turnover, and decrease the expenses by converting all the two-light carbon public lamps to single Osram lamps. The station had been maintained in full efficiency, the plant and building being thoroughly overhauled. The Engineer (Mr. L. H. King) advised the purchase of flat irons, kettles, and food warmers, to lend out for trial. The total receipts of the department were £4,077 5s. 9d., of which £2,391 19s. 11d. was from private lighting, and £1,599 0s. 6d. from public lighting. The total expenditure was £3,376 19s. 9½d., leaving a profit as stated, of £700 5s. 11½d.

WORTHING.—Alderman White announced at the Council meeting that it was estimated that in March there would be a deficiency of £830, and unless an increased demand should come by reason of the cheap cost of current, they might have to transfer a substantial sum for the relief of the electricity undertaking. The total sum paid from the rates to the undertaking was £4,478, and that was paid in the first five years of the undertaking. Since 1905 it had received no assistance whatever from the rates, and but for the economies in public lighting, reduction in the price per unit, and the introduction of the new filament lamps—they would still be paying their way. Alderman Walter (Chairman of the Electricity Committee) said that they had now about 100 more customers than twelve months ago, and this should be re-assuring to those who thought the undertaking was a detriment to the borough. Although the undertaking had suffered at the outset by the introduction of the metallic filament lamp, he could not think of anything more calculated to make the light popular. Councillor Ellis urged that the present was a golden opportunity for the electricity department to adopt thoroughly up-to-date advertising methods for pushing the concern.

YORK.—In accepting the tender of Messrs. Dick, Kerr & Co., £2,031 4s. 1d., for extension of the electricity mains along the routes of the light railway, as announced in our last issue, the York City Council decided to ask the contractors to employ local labour as far as practicable. Mr. A. Brown moved an amendment that the recommendation to appoint the electrical engineer as general manager of the tramways be referred back. Several members strongly supported the recommendation, which was carried.

LIGHTING AND GENERAL—Overseas.

CHIPPEWA.—The Electrical Products Co., of Niagara Falls, New York, propose erecting a plant, which will be the largest of its kind in the province. The electrical energy will be supplied by the Ontario Power Co.

BUENOS AYRES.—The output of the German Electric Light Co. for the first seven months of the current year amounted to 18,029,194 k.ws. for lighting, 6,913,236 k.ws. for power, and 28,348,940 k.ws. for traction, the figures for the corresponding period of the previous year being 14,659,832 k.ws., 5,779,334 k.ws., and 26,422,741 k.ws. respectively.

INDIA.—The South Indian Railway contemplate fitting 28 bogie coaches on the Travancore Branch (Tinnevelly-Quilon) for electric lighting on Messrs. J. Stone & Co.'s system. On the broad gauge section taken over from the late Madras Railway, the South Indian Railway had 254 vehicles fitted for gas lighting and one for electric lighting, while on the metre gauge section 157 vehicles were fitted (up to December 31, 1908) for electric lighting.

TORONTO.—For the purpose of renewing the interest of the municipalities in the Hydro-Electric power scheme, a meeting took place in Toronto. The engineers and mechanical superintendents decided to organize. Mr. R. A. Ross, Montreal, consulting engineer of the commission, was chosen Chairman, and Mr. E. Clarence Settell, Secretary of the commission, Secretary. Municipalities who have not at present civic lighting and power service were represented at their request by Mr. P. B. Yates of the commission's engineering staff.

TRACTION—Home.

BRADFORD.—A scheme has been provisionally passed for the promotion of a Bill in Parliament for the installation of a system of trackless tramcars.

EAST HAM.—The Board of Trade have sanctioned the borrowing by the Council of £2,000 for extensions to the tramway sheds and incidental works, the repayments to be spread over a period of 30 years. The Council defeated a proposal to invite tenders, and decided to instruct the Engineer to proceed with the work.

LEEDS.—It is proposed to promote a Bill in Parliament to authorise the adoption of a service of trackless tramcars.

ROTHERHAM.—The Electric Light and Tramways Committee decided to recommend that the Corporation agree to renew the present agreement for through traffic with the Sheffield Corporation for a period of five years with a slight alteration in the conditions. They also recommend that the Borough Engineer be authorised to construct the permanent way of the Wellgate tramway to the point agreed upon with the Board of Trade in Broom-road, and that the tramway track in Westgate be doubled wherever possible.

LIVERPOOL.—The electric train service is to be extendep to Aughton, Ormskirk, and Burscough, while eventually the whole of the triangle represented by Liverpool, Southport, and Burscough is to be brought within the electric traction scheme. Developments of the Exchange and Southport termini, as well as of the generating plant, will be a natural corollary.

TRACTION—Overseas.

ADELAIDE.—The half-yearly report of the Adelaide Electric Trust shows that the substitution of electric for horse traction is being appreciated. The total horse traffic receipts for the period were £37,783, and electric £33,863, or a total of £71,646, which is in excess of the previous term by £16,375, or nearly 23 per cent. increase. As against this traffic expenditure, including wages, amounted to £31,728, compared with £27,250 for the previous term, representing an increase of £4,478. The half-year was begun with a credit balance of £15,638, and this now amounts to £13,037. For the electric traction construction account £227,243 was received in Government advances, and other items raised it to £223,308. The electric service traffic expenses came to £10,904; general, £1,270; the maintenance of the permanent way, rolling stock, buildings, and electrical equipment of lines, £3,109; power expenses, £4,416; and interest on revenue account £2,763, making the total £22,461. The construction of the electric tramways necessarily accounted for some large sums of money. Under this account appear the following items:—Permanent way (including bridges), £86,706; electrical equipment of lines, £26,870; buildings and fixtures, £51,794; power station and sub-station plant, £7,719; cars, £27,646; miscellaneous equipment, £5,560; general expenses, £3,993; unproductive expenditure, £4,428; stores, £9,872; capitalised interest, £1,355; cash deposits, £1,065; and other lines which helped to make up a total of £228,601.

BUENOS AYRES.—Messrs. Guerrico and Williams have applied to the Buenos Ayres Legislature for a concession for electric tram ways in Bahia Blanca. The Pacific and Southern Railways are at the present time installing a system of electric tramways in Bahia Blanca.

JOHANNESBURG.—The proposed extensions to the tramways, include the following works: Extend Fordsburg tramway to station, £6,410; Bezuidenhout Valley line to south side, £6,500; extend Parktown West line to Rosebank terminus, £13,836; duplicate Parktown line from Ridge to Zoo, £3,800;

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extend Auckland Park line to Helville, £6,800; and extend Newtown line to Brixton, £19,295.

LAS PALMAS.—A scheme for the introduction of electric trams has been decided on.

MONTEVIDEO.—The Montevideo Electric Tramways returns for the first seven months of this year show that the passengers carried numbered 30,524,526, against 20,837,416 for the corresponding period of the previous year.

PERSONAL.

Mr. A. Whalley, M.I.E.E., is leaving the British Insulated and Helsby Cables, Ltd., to commence a consulting practice, from November 1, at 27, Chancery-lane, London, E.C. (c/o Knox, Hassal, Dodd & Co.), and at 19, Croxteth-grove, Liverpool. During 23 years with the Telegraph Manufaturing Co., Helsby, and with the British Insulated and Helsby Cables, Ltd., he has been chief Engineer at Helsby, and Manager and Engineer at Liverpool, respectively, and been responsible for the design and manufacture of every description of insulated wire and cable for lighting, power, traction, telephony, etc., also of all apparatus for complete Trunk and Local Telephone Exchanges, Telephone Instruments, etc., and, in addition, of Telegraph equipments for railway and postal administrations.

A farewell dinner was given at the Midland Hotel, Manchester, in honour of Mr. K. K. von Krogh, who has resigned his position with the British Westinghouse Company, to engage in consulting engineering work in Norway, his native country. Mr. Newcomb Carlton, Managing Director of the British Westinghouse Company acted as toast-master. The General Manager of the works, the General Sales Manager, and some twenty-five other prominent members of the staff were present. The esteem in which Mr. Krogh was held by his business associates was demonstrated in a fitting way by their presentation to him of several valuable mementoes, and his wide circle of English friends will wish him every success and follow with interest his future career. Mr. Krogh was with the British Westinghouse Company about five years. Mr. Krogh has joined in partnership Mr. Jacob Prebensen Nissen, of Nodre Slotsgade, 15, Christiania. The firm will in future be known as Nissen and von Krogh, and in addition to extensive power transmission work, will engage largely in industrial and municipality undertakings.

Mr. Eustace E. Baker, Mechanical and Electrical Engineer, Manchester, has become an Associate Member (Federated) of the Manchester Geological and Mining Society (federated with the Institution of Mining Engineers).

Mr. W. T. MacCall, of Halifax, has been appointed Principal of the Electrical Engineering Department at Sunderland Technical College.

Mr. C. P. Sharks, Chief Engineer to the County of London Electrical Supply Co., has been asked to report on the Newport Corporation's electrical undertaking, whether it is being worked to the best advantage, what, if any, improvements or alterations are desirable, and whether it is desirable to increase the corporation's plant as suggested by the Borough Electrical Engineer's report on the question of tariff, method and system of generation, continued use of Llanarth-street power station, etc. He is to be paid 250 guineas, plus travelling and out of pocket expenses, for his report.

EDUCATIONAL.

DUNDEE.

The new Dundee Technical College is being equipped with a motor-generator set, supplied by the British Electric Plant Co., Ltd., of Alloa.

SHEFFIELD UNIVERSITY.

The Electrical Engineering Department in connection with the University of Sheffield, offers carefully graduated courses for students. The department is equipped with three electro-chemical laboratories and a central station. The plant in the practical steel laboratory includes an electrically-driven pneumatic hammer, weighing about half-a-ton, capable of dealing with sizes up to four inches square and which can strike 100 blows per minute. In the engineering department the equipment has been augmented by a new lathe of large size for research work upon the life of cutting tools. The main shaft is driven by a 45 h.p. electric motor, and the feed shaft by a 5 h.p. motor. The small transformer with motor generator and switchboard especially for this tool was made in the workshops. For experiments of high speed drills there is an 8 h.p. motor available.

CATALOGUES AND LISTS.

The Union Electric Co., Ltd., are sending out a new brochure describing and illustrating the variety of uses to which "Union" motors have been put.

We have received from Messrs. A. P. Lundberg & Sons, London, a copy of their latest list dealing with the "Tripin Combination" (Combined Switch and three-pin wall connection), single and two-way types, and the "Presto" Tumbler Switch.

The advantages of the "Eclipse" Metallic filament lamp are explained in a list just issued by Mr. G. Branlik, London.

The new season's catalogue describing the specialities of the Simplex Conduits Ltd., has been issued.

An illustrated pamphlet describing Halpin's Patent Therma Storage System has been issued by the sole licensee for England and Colonies, Mr. P. J. Mitchell, Caxton House, Westminster, London, S.W. This system of heat storage and utilisation is intended to do thermally, in the production of steam, what a fly-wheel does mechanically in steadying the action of a prime mover. Surplus heat is stored during light loads, which can be drawn upon to meet the heavy or weak demands, so that the actual load on the boilers themselves is equalised to the greatest possible extent over the whole 24 hours.

From Messrs. Bruce, Peebles & Co., Ltd., Edinburgh, comes a pamphlet dealing with their large size open type continuous current dynamos and motors. These machines are manufactured by them in all the usual types, and they are suitable either for direct coupling to an engine or other machine, or for belt or rope driving. They are fitted with commutating poles, which in conjunction with the laminated pole tips, which the firm always fit, render the machines sparkless at all loads within their capacities.

INSTITUTION OF MINING ELECTRICAL ENGINEERS.

As briefly announced in our last issue, a well attended general meeting of the Institution of Mining Electrical Engineers was held at Sheffield.

The President (Mr. Wm. Maurice) in opening the proceedings said the Council thought that in view of the exceptional degree of success which had attended the formation of the Society, and by reason of the constant accession of members, the time had arrived for putting the affairs of the Institution on a legally constituted basis. To effect this very desirable end it had been necessary to draw up a "memorandum" specifying the objects for which the Institution was formed, and Articles of Association under which it purposed working. They had now arrived at what seemed to be a sound and satisfactory working scheme. He (the President) would not, then, take up their time by giving a complete account of the Articles of Association, but for the general information of the members he would inform them in regard to the main points.

First, as regarded the objects of formation. The two principal clauses were expressed thus:—

(*a*) To consider means for minimising the risks attending the application of electricity to the industry of mining, and to promote the adoption of approved methods and devices tending to increase safety.

(*b*) To promote the general advancement of electrical science in its applications to the industry of mining; to facilitate the exchange of information and ideas on this subject amongst the members of the Institution and otherwise; and, generally, to extend the experience, increase the efficiency, and elevate the status, of those engaged in such applications.

It might also interest them to know that power would be taken to form a Benevolent Society for the assistance of necessitous members. The qualifications for membership of the Institution had been designed to admit everyone who was interested in its objects, while at the same time providing for the establishment of a special class for mining electricians. Specifically, membership of the Institution would consist of Honorary Members, Honorary Corresponding Members, Diploma Members, Associates, and Students. Their respective qualifications were defined in the manner following:—

QUALIFICATION OF MEMBERS.

Honorary Members shall be persons who have distinguished themselves by their literary or scientific attainments, who are intimately connected with electrical science in its applications to the industry of mining, or who have made important communications to the Institution, and, whom the Institution especially desires to honour.

Honorary Corresponding Members shall be persons resident beyond the United Kingdom who are prominently associated with the objects of the Institution and who will from time to time communicate such matters of interest to the Institution as may arise in their respective countries of residence.

Diploma Members shall be members who are or have been actively engaged in the care or management of electrical mining installations, and who have passed the Institution's examination in that subject.

Members.—Every candidate for admission into the class of Members, or for transfer into that class, shall be more than twenty-five years of age, and shall have been regularly educated as a mining, electrical, or mechanical engineer, according to the usual routine of pupilage, and have had subsequent employment for at least two years in some responsible position as an engineer or electrician; or if he has not undergone the usual routine of pupilage, he must have been employed, or have

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practised as a mining electrical engineer or electrician in a responsible position for at least five years; or who is so associated with the application of electricity to the industry of mining that the Council consider his or her admission as member would conduce to the interests of the Institution.

Associates shall be persons, more than 23 years of age, who have been Students or who are not qualified under Article 7 to become Members.

Students shall be persons of any age who, at the time of election, are serving pupilage to a mining or electrical engineer or electrician, or who are studying mining or electrical science at one of the universities, public colleges, technical institutions or Government schools, or who otherwise satisfy the Council that there are special circumstances which, in the opinion of the Council, entitle them to admission. No person shall remain in the class of Students after September 30 next following the expiration of three years from the time of his election, unless at the expiration of such three years he shall not have attained the age of 23 years, in which case he shall be entitled to remain in the class of Students until September 30 next following the day on which he attains that age.

It had already been explained to members, in the circulars which had been issued (the President continued), that the General Council of the Institution (which was composed of representatives from Branches) would conduct the management of affairs; the Branches themselves being the bodies upon which all the practical work, reading of papers, holding of monthly meetings, etc., would devolve. The working arrangements for these Branches were being pushed forward ,and the regular meetings would commence, the Council hoped, in November.

FORMATION OF LONDON BRANCH.

A London branch was in the course of formation for the convenience of consulting mining electrical engineers, and of that large body of men associated with such work who were constantly engaged abroad but with London as their centre of operations. The Secretary of this new Branch was Mr. Reginald Kra'l, A.M.I.C.E., M.I.M.M., of Balfour House, Finsbury-pavement, E.C.

The President went on to deal with the question of selecting a suitable centre for the inaugural general meeting. He thought that London would prove the most suitable, partly because the average cost per member would probably work out lower than it would in attending a provincial meeting, and partly because London had many advantages for such a purpose to which the mining towns could not lay claim. On the other hand, a visit to a mining centre afforded an opportunity for visits to collieries, providing, of course, that the necessary invitations were forthcoming. Manchester, Newcastle, Sheffield and Birmingham had been mentioned. He also spoke of the generous support the Institution had received and continued to receive from the whole of the mining and electrical Press. Their assistance was highly appreciated, and would, he hoped, redound to their material advantage. No mining or electrical man could afford to be without as many technical publications as he had time to read.

INQUIRY INTO ELECTRICAL ACCIDENTS.

Perhaps the most important matter which he (the President) had to bring before them was one which had reference to the numerous accidents which had happened during the past few years in the use of electricity in mines. Alarm had been expressed in certain quarters which tended to suspend electrical development. The Council, therefore, considered it their duty to take such steps as would, they hoped, tend to restore public confidence. They had, therefore, determined to appoint a small Committee to inquire into the causes and means of preventing accidents arising out of the use of electricity in coal mines. This Committee would draw up a general statement, which would be submitted to the Branches at, it was hoped, the December meeting. That statement would form a basis for discussion. Detailed evidence would afterwards be taken of every member who was willing to help in the inquiry, and on the evidence so obtained a report would be drawn up representing the collective views of the Institution. It should be clearly understood that this inquiry was not an inquiry into the necessity or otherwise of revising the rules relating to the use of electricity in mines. It was an inquiry into the causes of accidents, and since 75 per cent. of the Institution's now considerable membership were actual colliery electricians, it was thought that the evidence obtained would be of great practical value. He hoped that colliery owners and managers would do all they could to facilitate the work of the Committee and thus contribute towards the solution of the problems involved.

FIRE AT ELECTRICAL WORKSHOP.

In the early hours of morning a fire occurred at the premises of Messrs. Barnsley & Co., electrical engineers, Queen's-road, Brighton. The Fire Brigade turned out smartly, and located the outbreak in the basement used as a workshop. With the aid of the chemical extinguisher the flames were overcome. The workshop, however, was burnt out.

PUBLICATIONS.

Post Office Electrical Engineers' Journal. In the quarterly number just issued, Mr. J. E. Taylor, A.M.I.E.E., continues his article on "The Early History of Wireless Telegraphy." "Determination of the distance and direction of a Radio-Telegraphic sending by means of Barreter measurements" is dealt with by Mr. B. J. Stevenson; Mr. J. W. Turner, A.I.E.E., writes on "Transferring an Exchange to a new building"; Mr. E. G. Kennard contributes a notable article on "Modern illumination"; and Mr. H. A. Miles completes his description of "The Machinery of the Post Office."

"Journal of the Institution of Electrical Engineers, late Society of Telegraph-Engineers and Electricians," published under the supervision of the Editing Committee, and edited by Mr. P. F. Rowell, Secretary. London: E. & F. N. Spon, Ltd. Price, 5s.

The volume gives a detailed account of the proceedings of the meetings, with the papers on "The Electrical System of the London County Council Tramways," by Mr. J. H. Rider; "The Theory and Application of Motor Converters," by Mr. H. S. Hallo; "Extending the Limits of Power Transmission," by Mr. A. M. Taylor; "Electric Traction Vagabond Currents," by Mr. J. G. Cunliffe, M.Sc.Tech., and Mr. R. G. Cunliffe, M.Sc.Tech.; "The Electrification of Steam-driven Non-reversing Rolling Mills," by Mr. W. F. Mylan; "Interpole Designs," by Mr. W. B. Hird, M.A.; "The German Standards and Regulations for Electrical Machinery," by Mr. N. C. Bridge; "The Metal Tungsten as 'Valve' Electrode," by Mr. L. H. Walter; and "Magnetic Testing of Iron with Alternating Current," by Mr. A. Campbell. B.A. Particulars of the discussions are also embodied in the work, which is further enhanced by a series of diagrams and illustrations.

"The Institution of Electrical Engineers: Articles of Association and list of Officers and Members."

This is a useful compendium of information relating to the Institution, the particulars being corrected to August 31 last. The lists of members, associate members, associates, etc., are given in alphabetical order, and their addresses also appear.

PATENTS.

Electric Motor Control.

6567.—1909. H. E. WHITE, Schenectady, U.S.A. This system of electric motor control comprises a plurality of electrically controlled switches which automatically close in succession when no overload exists, and a device responsive to a predetermined overload which causes the switches to open in reverse succession while the overload exists.

Overhead Conductors for Electric Railways.

20647.—1908. J. ORMSTON & W. E. CHARLTON, Sunderland. The object is to provide means to obviate the necessity for removing the trolley from the trolley when it is desired to reverse the direction of the travel of the train or car. For this purpose an off set section is provided in the conductor system at places where it may be desired to reverse the direction of the car, whereby the trolley pole is carried out at right angles to one side of the car so that when the direction of the car is reversed the trolley is caused to assume a trailing position. The trolley is transferred from one conductor to the other by a crossing and points before or after reversal.

Transforming Electrical Energy into Heat Energy.

19333.—1908. C. O. BASTIAN, Brondesbury Park. This device for transforming electrical energy into heat energy has an inclosure for containing the resistance made of quartz, whereby very high temperatures, as, for example, 1,000° C., can be obtained. The enclosure covering the resistance is very light in weight. When at the working temperature the resistance and the enclosure are in surface contact with each other.

Electric Furnaces.

26356.—1908. C. BINGHAM, London. In order that the suspended electrode of an electric furnace may be replaced by a new obe when worn out without interrupting the working of the furnace to any appreciable extent, a joist is fixed above the furnace, and upon this two carriages travel from which the furnace electrodes are suspended. As one electrode is consumed its support is pushed along the joist and a new one brought to take its place.

Magneto Ignition Apparatus.

25547.—1908. R. BOSCH, Stuttgart. This is an improvement in a device for operating magneto ignition apparatus of the kind in which the moving part of the generator oscillates on an axle and springs co-operate with a deflecting piece. In order that the springs may be strained as little as possible, the deflecting piece is placed excentrically to the axle of the moving part so that while the strain put upon the spring is small, yet the length of stroke of the operating lever is not lessened.

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Automatic Electric Timing Switch.

27323.—1908. F. W. W. Baker & G. Pearce, Muswell Hill, N. This automatically closing switch is particularly suitable for the purpose of short exposure radiography, whereby current can be supplied to the induction coil for any predetermined length of time. Two switches are arranged, one for making the circuit and the other for automatically breaking the current. A dashpot arrangement of the usual construction is arranged momentarily to close an auxiliary contact which acts on an electric contact attached to the second switch, which it releases and thereby breaks the main circuit. The interval during which the circuit remains closed depends on the working of the dashpot, which has been previously regulated.

Clamping Devices for Electrical Fittings.

21912.—1908. Siemens Bros. & Co. & J. S. Huddleston, London. This improved device consists of a metal clamping ring provided with V-shaped grooves for the conductors, clamped to a metal base plate. The ring surrounds an interior porcelain piece, which contains the electrical fittings and is fixed to the base plate. When the ends of the cables are inserted into the grooves of the clamping ring, the ring and the base plate are screwed firmly together to form a complete mechanical and electrical connection between the sheathings of each of the ends of the cables which enter the fitting. Since the clamping ring can be constructed of flat metal the grooves have a longer area of contact on the metal covering of the cable, thus making a better electrical and mechanical connection, than hitherto possible by previous methods.

Apparatus for Electrical Separation.

16583.—1908. Huff Electrostatic Separator Co., Boston, U.S.A. This process of electrical separation consists in causing mixed, comminuted solid materials to progress in contact with an electrode, giving the particles a charge by connection from a spraying electrode and opposite in sign to the charge and possessed by the surface of the contact electrode, then subjecting the materials to the influence of a static field, characterised by pure static stress. In this way the particles are separated according to their differences in electrical conductivity and separately collected.

Service Registers in Telephone Systems.

10203.—1909. Siemens & Halske, A. G., Berlin. In a telephone service in which the register electromagnet is brought into a local circuit by the act of plugging the enquiry jack and the service is registered over the third lead of the plug cord, over which lead the ring off signal is also brought into circuit, the core of the register electromagnet has two oppositely wound windings, so proportioned that both during conversation and when the receiver is hung up the number of ampere turns of the one are equal to those of the other. By this means the current which flows through the ring off signal or its relay is prevented from affecting the register electromagnet.

Electrical Signalling on Railways.

18996.—1908. G. H. Brown, Belfast. This comprises an electrical block system for railways, in which signalling apparatus is provided in the signal cabins and also on the engines. The electrical connections are arranged on the track in the signal cabin and on the engine in such a manner that an incoming train automatically indicates its presence to the signalman of the cabin controlling that particular section of the line by the completion of an electric circuit, and, when leaving that section, automatically blocks the section and automatically indicates its approach to the signalman controlling the section of the line ahead if that section is clear. At the same time the train automatically clears the section of the line in rear of the section just left by the completion of an electrical circuit. If the line ahead is blocked the danger signal is indicated on the train by the breaking of an electric circuit. Means are provided for establishing visible or audible communications between the train official and the signalman of the section of the line in which the train is, and for indicating the geographical position of the train to the train officials.

Contact Devices on Travelling Bridge Cranes.

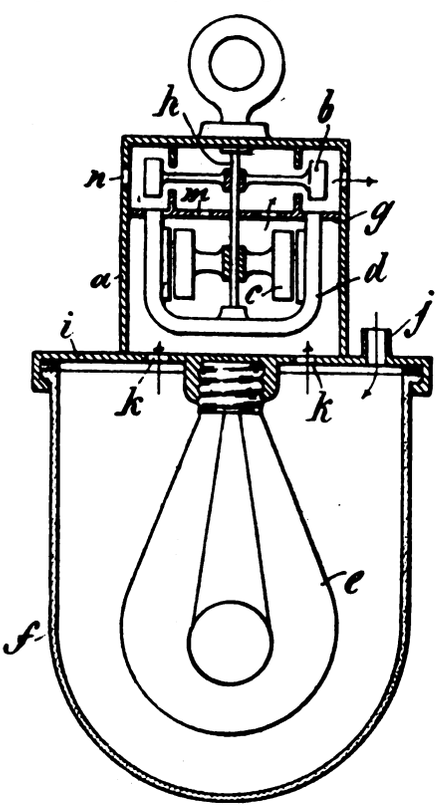
28076.—1908. Maschinen und Dampfkesselfabrik "Guilleame Werke," Neustadt-on-Haardt. This is an improvement in contact devices attached to travelling bridge cranes for conveying current from an overhead conductor to electric locomotives passing under cranes without interfering with the working of the crane. The live wire for the locomotive crosses the crane above the crab track, and the contact rods slide on the cable so as to form, in conjunction with other rods, a contact path for the collector of the locomotive.

Aerial Electric Cable.

28485.—1908. C. J. Beaver & E. A. Claremont, Hale. The object is to make an aerial cable in which moisture shall be excluded from the interstices of the stranded conductor and in which the coverings shall not be deteriorated by atmospheric conditions or chemical fumes. The spaces between the strands of the conductor are filled with a solid compound and the conductors are protected by a covering of asbestos tapes treated with bituminous or other preservative compound.

Electric Safety Lamps.

10312.—1909. G. Wolters Weitmar. In connection with many industries it is not possible to employ electric lighting owing to the danger of fire from short circuiting the conductors. This is more especially the case in connection with mines, where the danger of igniting fire damp is very great. Electric lamps have been constructed with storage batteries, and having no exterior conductors. These are, however, heavy and inconvenient to manipulate, and have, of course, to be continually recharged. It has been proposed to employ a lamp in which the electric energy is generated by mechanical means, and in which the current generator is mounted in a casing, directly attached to the lamp, the generator being driven by compressed air. In this improved lamp, shown in vertical section in the diagram, the electricity is generated by a generator driven by the motor *b* mounted in the housing *a*, the motor being adapted to be driven by fluid pressure, such as water or air. The motor chamber is divided off from the rest of the housing by a partition wall *g*, through which the shaft *b* of the motor passes. An armature *c* is mounted on the extending end of the motor shaft, which rotates with the shaft within the magnet frame *d*. The electric lamp *e* is attached to the casing *a*, and is enclosed in a protecting glass or globe *f*. This protecting glass is fitted airtightly to



the plate *i* carrying the casing *a*. In order to extinguish the lamp the moment the glass is broken, the fluid pressure for driving the motor is fed to the motor through the glass or globe. With this object in view a pipe connection *j* is fitted to the plate *i*, through which the driving fluid is fed to the glass *f*. The plate *i* is provided with holes *k* leading to the casing *a* and through which the driving fluid passes to the motor. The driving fluid may exhaust through the exhaust outlets *n*. Thus it will be seen that the moment the protecting glass *f* is broken, the fluid pressure will cease and the motor will stop and the lamp go out. In the case of fluid driving pressure the pressure space of the motor is in communication with the interior of the protecting glass, and even if the latter is only cracked, the liquid in the same will prevent any fire damp from penetrating to the electric lamp. Then, again, if the protecting glass becomes cracked, the reduced speed of rotation or vibration of the current generator will cause the lamp to go out. The device could be constructed with several lamps connected to one current generator, in which case each lamp could be provided with a protecting glass and the interiors of the glasses could be connected up with each other, thus forming a common pressure space.

Magnetic Blow-outs for Electric Switches.

25954.—1908. T. von Zweigbergk, Preston. This invention relates to magnetic blow-outs by which the arc formed on

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breaking a contact is expanded and finally blown out. The object is to construct a magnetic blow-out in such a manner that while the current density in the coils of the blow-out is small when the contact is made, on the breaking of a contact a current of very high density flows in the coils when required to blow out the arc. In rupturing high tension direct currents of 3,000 to 4,000 volts, the density of the currents required in the coils of the blow-out will cause the fusing point to be approached, and current densities of 20,000 to 28,000 amperes per sq. in. are necessary in order to bring the size and cost of the blow-out sufficiently low for commercial practice. If auxiliary contacts are used in order to charge the blow-out coil just before the main contact is broken, there is always the possibility of these contacts getting out of order, and if these should fail the blow-out is instantly fused. The use of auxiliary contacts,

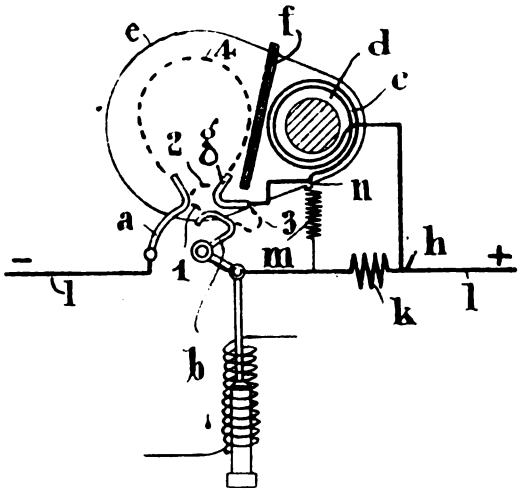

FIG. 1

moreover, adds greatly to the complication of the moving parts. The present device consists in so arranging contacts that the current density of the blow-out coil depends on the position of the arc to be blown out. Fig. 1 is a diagram of one form of the invention, and Fig. 2 is a modified form. In Fig. 1 the contacts *a*, *b*, are arranged in proximity to a blow-out coil *c*, having a core *d* and flanges *e* extending from the core to cover the sweep of the arc, insulation shields *f* being provided to shield the coil from the arc. In this arrangement normally the current flows through the low resistance coil *k* to the movable contact *b*, the blow-out coil *c*, and high resistance coil *m*, being in series so that little current passes through the blow-out coil. On breaking the contact the greater part of the current still passes through the low resistance coil *k*, and across the break, 1, between the fixed and movable contacts *a*, *b*, but there is also a bye-pass path, through the blow-out coil, and either through the high resistance *m* or across the auxiliary spark gap, 3, from the fixed contact *g* to the movable contact *b* and thence to the

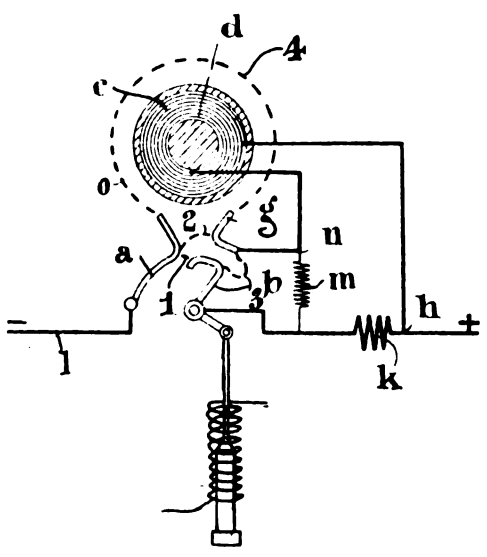

FIG. 2

fixed contact *a*. The blow-out coil now forces the arc upwards away from the movable contact so that the main arc passes between the two fixed contacts in the position 2. The arc 3 from th e movable contact *b*, to the fixed contact *g*, is now blown out and the blow-out coil is fully energised, the whole current passing through this coil and across the gap between the two fixed contacts *a*, *g*. This arc is then rapidly expanded to the position 4 and blown out by the full energy of the blow-out coil. It will be seen that in this system the blow-out can never be charged beyond its carrying capacity, except when the arc is in such a position as to be rapidly expanded for rupture. As the arc at this point is moving rapidly the time during which the blow-out coil is charged is a minimum, and it has been found by experiment that after breaking several hundred times in succession a current of 100 amperes at 4,000 volts, the blow-out was not unduly hot, although the coil was charged at the time of the rupture with a current density of over 20,000 amperes per sq. in. The low resistance placed normally in parallel with the coil may be made very low and will resemble that of a shunt used for an ammeter, in fact the blow-out works without any resistance whatever in this position, due to the fact that the arc itself has a tendency to lift up and thereby travel to the position between the two fixed contacts. It is not, however, advisable to dispense with a resistance as the contacts become burnt owing to the blow-out being absent on the first breaking of the contact. In the form shown in Fig. 2 adapted to the metallic shield form of blow-out, a similar arrangement of resistance and contacts is employed. The main arc in this case is divided into two when it strikes the metallic shield *o* of the blow-out coil, the two parts being then swept upwards to the position 4, so that the blow-out effect is doubled by dividing the arcs into two in series.

Electric Light Fittings.

19150.—1908. A. T. WOODHALL & A. EMERY, London. The improvement is in electrical fittings, particularly where a plug having the wires connected to it has to be replaced and rigidly but detachably fixed in the sconce out of which the wires lead. Hitherto an ordinary screw threaded joint has been employed, and this requires a long twisting movement of the plug in a confined space so that the wire connection is damaged. A bayonet joint connection is sometimes

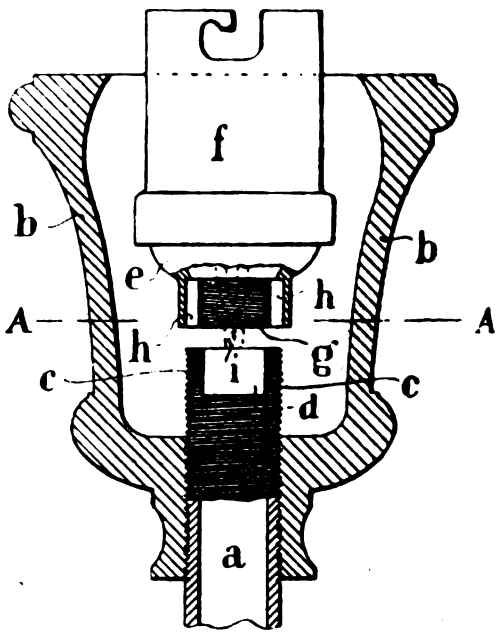

FIG. 1

employed, but is not sufficiently rigid to hold the attached lamp steady. Fig. 1 is a sectional elevation showing the two parts of the improved fitting separated ; Fig. 2 is a section on the line A—A of the parts assembled. The hole end of the pipe *a* leading the wires into the sconce *b* is formed with a sectional male screw thread having two or more threaded portions *c* with intervening plain recessed parts *d*. The plug *e* which carries the contacts *f* to which the lamp is to be attached is provided with a corresponding sectional female threaded part *g* and intervening plain parts *h*. In use when the wires *i* which pass up the pipe *a* in the base of the sconce have been attached to the plug *e*, it is only necessary to place the plug *e* over the projecting end of the pipe *a* in the

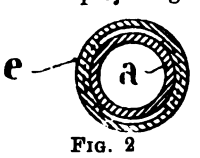

FIG. 2

base of the sconce and give it a quarter turn in order to secure the plug firmly in position. It will be obvious that the number of threaded portions and intervening gaps may be varied and if required the width of one threaded portion may be made greater than the other to make the fastening more firm. With this arrangement the attachment will be so firm that the long candle-like lamps employed with the candelabra type of fitting will be held firmly in an upright position, and no strain will be put upon the wires on the terminals.

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COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last prices. £
British Insulated and Helsby Cables, Ord. 1-100,000	5	7½-7⅝
—— 6 p.c. Cum. Pref., 1-100,000	5	6¼-6½
—— 4½ p.c. Mortgage Debentures	100	*103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100	89-94
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 1-200,000 and 275,001-475,000	3	3/16-7/16
—— 4 p.c. Mortgage Debenture Stock	100	39-42
Callender's Cable, Debentures	100	105-107
—— Ordinary	5	10¾-11⅛
—— 5 p.c. Pref.	5	5⅜-5⅞
Consolidated Electrical Co., Ordinary, 1-110,000	1	⅜-½
Dick, Kerr, and Co., Ordinary, 1,260,000	1	1-1¼ xd
—— 6 p.c. Cum. Pref., 1-305,000	1	1-1¼ xd
—— 4½ p.c. Debenture Stock.	100	100-103
Edison and Swan United, " A " Shares, 1-99,261	3	3/16-5/16
—— " A " Shares, 01-017,139	5	1-1¼
—— 4 p.c. Deb. Stock, Red.	100	68-73
—— 5 p.c. 2nd Debentures	100	82-85 xd
Electric Construction, Nos. 1 to 112,100	2	7/16-11/16
—— 7 p.c. Cumulative Pref.	2	1 3/16-1 7/16
—— 4 p.c. Perp. 1st Mort. Deb.	100	65-69
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100	68 -74½ xd
General Electric Company (1900) 5 p.c. Cum. Pref.	10	8¼-8⅝
—— 4 p.c. 1st Mort. Deb. Stock	100	83-87 xd
W. T. Henley's Telegraph Works, Ordinary	5	12½-13½
—— 4½ p.c. Preference	5	5¼-5⅝
—— 4½ p.c. Debentures	100	106-108
National Electric Construction Co., 1-170,000	1	⅜-½
Telegraph Construction and Maintenance	12	34½-36
—— 4 p.c. Bonds	100	101-103

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Bournemouth and Poole, Ordinary	10	9¾-10¼
Brompton and Kensington, Ordinary	5	6¾-7⅛
—— 7 p.c. Preference	5	6¾-7⅛
Canadian General Electric Co., Common Shares	$100	120-125 xd
—— 7 p.c. Cum. Pref. Stock	$100	119-121
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5	4-4¼
—— 4½ p.c. Cum.. Pref., 1-80,000	5	4⅜-4⅞
—— 4 p.c. Debenture Stock, Red.	100	98-101
—— " City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5	3⅜-4⅛
City of London, Ordinary	10	10⅜ 10⅞
—— 6 p.c. Cumulative Pref.	10	11⅜-12⅜
—— 5 p.c. Debenture Stock	100	121-124
—— 4½ p.c. 2nd Deb. Stk. Red.	100	100-103
County of Durham Electrical Power Distribution Co., Ordinary, 1-50,000	5	1½-2
—— 5 p.c. Preference, 1-50,000	5	2⅞-3⅜ xd
County of London Elec. Supply, Ordinary	10	7⅜-8⅛
—— 6 p.c. Cum. Pref.	10	10⅜-11¼
—— 4½ p.c. Debentures Prov. Certs. Al pd., Rd.	100	104-107
—— 4½ p.c. 2nd Debentures, Red	100	100-103
Edmundson's Electricity Corporation, Ord., 1-80,000	5	⅛-5/16
—— 6 p.c. Cum. Pref.	5	⅜-½
—— 4½ p.c. First Mort. Deb.	100	57-60
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100	91-94
Kalgoorlie Electric Power and Lighting, 6 p.c. Non. Cum. Pref., 1-150,000	1	¼-27/32
Kensington and Knightsbridge Elec. Lt., Ord , 1-21,000.	5	7-7½
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100	96½-99½ xd
London Electric Ordinary	3	1⅞-2⅛
—— 6 p.c. Pref.	5	5-5⅛
—— 4 p.c. 1st Mortgage Debenture Stock, Red.	100	93-97
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	76-80
Metropolitan Ordinary, 100,001-300,000	5	4¼ 4⅜
—— 4½ p.c. First Mortgage Debenture Stock	100	105-108
—— 4½ p.c. Cum. Pref.	5	4⅜-5
—— 3½ p.c. Mortgage Debenture, Red.	100	83½-86½
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,050 ($500) M 1-4,400 ($1,000)	—	82 84%
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb. Red	—	98-100
Newcastle-upon-Tyne Electric Supply, Ord., 1-50,000 and 57,010 to 137,500	5	4¼-4⅜
—— do. 50,001 to 57,009	5	4¼-4⅜
—— do., 5 p.c. Pref., 1-137,500 Non. Cum.	5	4⅜-5⅛
Notting Hill Electric Lighting	10	12½-13½
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	6-6½
—— 4 p.c. Debenture Stock	100	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1	1⅝-1⅞
—— 6 p.c. Non-Cum. Pref., 1-100,000	1	1⅝-1⅞
—— 5 p.c. Debenture Stock, Red.	100	103-106
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5	5⅞-5¹³⁄₁₆ xd
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5	5⅞-6⅛ xd
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	—	105½-107½%
Smithfield Markets Electric Supply, Ord., 1-12,000	5	⅜-½
South London, Ordinary	4	2⅝-3
South Metropolitan Electric Light and Power Ord.	1	5/16-9/16
—— 7 p.c. Cum. Pref.	1	1 1/16-1 3/16
—— 4½ p.c. 1st Mort. Deb.	100	100-103 xd
St. James's and Pall Mall, Ordinary, 101-20,080 and 40,081 to 60,100	5	8½-9
—— 7 p.c. Pref. Non. Cum.	5	7-7½
—— 3½ p.c. Deb.	100	84-88
Urban Electric Supply Co., Ordinary	5	⅝-¾ xd
—— 5 p.c. Cumulative Preference, 50,001-100,000	5	1⅛-1⅜ xd
—— 4½ p.c. First Mort. Debenture Stock, Red.	100	78½-78¾ xd
Westminster, Ordinary	5	8½-9
—— 4½ p.c. Cum. Pref., 110,101-191,379	5	5-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 5 p.c. Cum. 1st Pref., 1-640,000	5	4⅛-4⅜
—— Debenture Stock, Red	100	92½-93½
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1	⅛-¼
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1	9/16-11/16
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	87-90
British Columbia Electric Railway Co., Ord. Def.	100	144-149
—— Ord. Pref.	100	120-125
—— 5 p.c. Cum. Perpetual Pref. Stock	100	109-112
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	102-104
—— 4½ p.c. Vancouver Power Deb.	100	102-105
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10	⅛-1
—— 6 p.c. Cm. Pf., 30,001-60,000	10	2-2¼
—— 5 p.c. Perpetual Debenture Stock	100	82-85 xd
—— 4½ p.c. 2nd Deb. Stock	100	62-66
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100	98-100
Calcutta Tramways, Ord., No. 1 137,610	5	4¼-5⅛
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5	4¼-5
—— 4½ p.c. 1st Deb. Stock, Red.	100	98-102
Cape Electric Tramways, Nos. 1-491,222	1	3/16-7/16
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5	4⅜-5⅛
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100	98-102
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5⅛-6
—— 4 p.c. Deb. Stock, Red. (1985)	100	98-101
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12⅛-13⅛
London United Trys (1901) 5 p.c. Cum. Pref.	10	2⅛-2⅜
—— 4 p.c. 1st Mt. Db. Stock, Red.	100	67-70
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	1/32-5/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1	11/16-13/16
—— 4½ p.c. Deb. Stock, Red.	100	94⅛-96½
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100	100½-103½
Provincial Tramways Co., Ordinary, 1-24,912	10	4-4⅛
—— 6 p.c. Cum. Pref., 1-10,000	10	9½-10½
San Paulo Tramway, Light, and Power Co.	$100	149-152 xd
—— 5 p.c. 1st Mort Deb., Red. (1929) 1-12,000	$500	101-103%
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅜-½
—— 4 p.c. Deb. Stock, Red. (1940)	100	69-73
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5	¼-⅜
—— 6 p.c. Cum. Pref., 1-46,261	5	1⅜-2⅛
—— 4½ p.c. 1st Deb. Stock, Red.	100	81-85

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100	61-63
—— 4 p.c. Pref.	100	85-87
—— " " deferred	100	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	101-103
City and South London, Consolidated Ordinary	100	30-31½
—— 4 p.c. Debenture Stock	100	100-102
—— 5 p.c. Pref. Stock '91	100	108-110
—— " " " '96	100	104-107
—— " " " '01	100	100-103
—— " " " '03	100	96-100
Underground Electric Railways of London, 5 p.c. Pri r L - Bds.	—	102¼-103½

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price £
Amazon Telegraph Co., 1-25,000	10	3-3¼
—— 5 p.c. Debs., Red., within 1-1,609 Red	100	94-97
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000	96-98
Anglo-American Telegraph Co., Ordinary	100	61¼-63¼
—— 6 p.c. Preferred Ordinary	100	104-105
—— Deferred Ordinary	100	20¼-21¼
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100	88-90 xd
Direct Spanish Telegraph Co., Ordinary	5	3-3⅛ xd
—— 10 p.c. Cum. Preference	5	8-8½ xd
—— 4½ p.c. Debs., 1-600	50	100½-102½
Direct United States Cable Co.	20	13¼-13⅝
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 p.c. Mort. Debs., within 1-8,000 (1913,	25	100-102
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	25	100-102
Eastern Extension, Australasia and China, 1-300,000	10	11¼-12⅛
—— 4 p.c. Mort. Deb. Stock, Perp.	100	102-104
Eastern Telegraph Co., Ordinary Stock	100	129-132
—— 3½ p.c. Preference Stock	100	85-87
—— 4 p.c. Mortgage Debenture Stock	100	104-106
Great Northern Telegraph Co. (of Copenhagen)	10	26-27
Marconi's Wireless Telegraph Co., Nos. 1-394,190	1	⅛-¼
National Telephone, Preferred	100	106-108
—— Deferred Stock	100	121-123
—— 6 p.c. Cum. First Pref.	10	10¼-11
—— 6 p.c. Cum. Second Pref.	10	10¼-10⅞
—— 5 p.c. Non. Cum. Third Pref.	5	5 7/16-5 11/16
—— 3½ p.c. Deb. Stock, Red.	100	98-100
—— 4 p.c. Deb. Stock, Red.	100	100-102
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100	100-102
West Coast of America, 1-30,000 and 53,001-53,008	2½	1⅝-1¾
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	100-102
West India and Panama Telegraph Co., Ordinary	10	11/1613/16
—— 6 p.c. Cum. 1st Preference	10	8¼-9¼
—— 6 p.c. Cum. 2nd Preference	10	8⅛-9⅛
—— 5 p.c. Debs., Red., 1-800	100	101½-103½
Western Telegraph Co., 1-207,930	10	13¼-14
—— 4 p.c. Debenture Stock, Red.	100	103-105

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1909.	1908.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Oct. 6	1,417	1,495	— 78	— 599	27¼	27¼	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940,	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Aug. 7	2,770	2,650	+ 120	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Oct. 3	1,175	1,132	+ 43	— 398	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Oct. 2	7,076	6,681	+ 395	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,273	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 3	2,310	2,479	— 170	— 338	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,008	1·47	11·71	2,912	7·22
Bradford Corporation	Oct. 2	5,036	5,052	— 16	+ 3,567	98	98	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	Oct. 10	975	947	+ 28	+ 1,355	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Oct. 8	5,747	5,360	+ 387	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Oct. 9	1,319	1,207	+ 112	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Oct. 10	310	306	+ 4	— 202	10	10	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Oct. 9	5,517	8,603	— 3,086	— 34,519	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	Aug. 7	3,695	3,515	+ 180	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Oct. 10	3,240	3,111	+ 129	+ 1,415	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Oct. 7	527	496	+ 31	—	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Sept. 24	1,801	1,457	+ 344	+ 2,527	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Oct. 8	147	141	+ 6	+ 78	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Oct. 8	5,535	5,460	+ 74	+ 1,491	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Oct. 9	1,011	960	+ 51	+ 3,632	14	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Oct. 2	17,902	19,247	— 1,345	— 4,077	185½	179	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Aug. 7	4,430	4,480	— 50	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Oct. 9	1,640	1,622	+ 18	+ 1,395	28½	28½	„ 31	84,704	16,200,020	1,960,320	1·29	10·37	2,421	5·10
Hull Corporation	Oct. 9	2,639	2,877	— 237	+ 1,905	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Oct. 2	475	480	— 5	—	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Oct. 6	137	150	— 13	— 239	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Oct. 6	1,280	1,548	— 268	— 723	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Sept. 25	10,982	10,660	+ 322	— 1,837	104	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Oct. 3	1,263	1,374	— 111	+ 55	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Sept. 25	39,156	36,905	+ 2,251	+ 35,946	124½	122½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	„ 17	216	258	— 42	— 743	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Oct. 9	195	202	— 7	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Oct. 9	10,010	9,784	+ 226	+ 5,677	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Oct. 10	16,455	17,436	— 981	— 4,363	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 9	148	130	+ 18	— 4	2½	2½	Mar. 31	7,362	2,060,712	204,7·0	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Oct. 2	3,852	3,958	— 106	— 1,570	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 2	677	703	— 26	— 337	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Oct. 7	664	639	+ 25	— 115	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,596	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Oct. 3	5,741	5,824	— 83	— 1,005	68½	66½	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Sept. 29	1,079	1,111	— 32	— 391	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug. 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Sept. 22	169	156	+ 13	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 17	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Oct. 9	884	899	— 15	+ 675	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Sept. 30	2,304	2,289	+ 15	+ 3,896	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Sept. 22	879	804	+ 75	— 784	22½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train miles. *h* Half-year's figures.

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NOTES.

NATIONAL ELECTRIFICATION.

As we show in our leader columns, the Swiss are probably on the eve of electrifying their entire national system of railways. They are certainly happy in three things: in having a national system of railways; in having a splendid, widely distributed source of water-power; and not least in possessing a numerous body of well-trained, exceptionally apt electricians. It is, indeed, well that the first attempt on so large and comprehensive a scale should be made in a so richly dowered state. Even the doubt as to the full economical utilisation of the water power, owing to remote position of some of the falls, seems to be within measurable distance of solution. For the Oerliken Co. of Zurich have succeeded in placing on the market some electric accumulator locomotives, now doing duty for shunting and marshalling purposes, on the line between Oerliken and Seebach. The engines, which weigh 12·8 metric tons, carry a 30 h.p. motor, working at 800 r.p.m., with a geared transmission to the axle. The energy is derived from a battery of 144 cells, connected in groups of 12, and divided into two lots, one placed in the front and the other at the rear of the engine. The plates are placed rather close together, with insulating plates between. The capacity is 240 a.h., and on the level the engine can run at 10 miles per hour, and have a tractive power of some 3,300 lbs. It is probable that these engines could be improved so as to meet the necessity of running trains over the few miles here and there of the lines which it might not be convenient to electrify.

APPRENTICESHIP.

Apropos of our note on the National Institution of Apprenticeship, Mr. J. S. Ballin, the Hon. Secretary and founder, writes: "I think it is unfortunate that so few apprentices have been bound to the electrical and engineering trades. This is not due to the unwillingness of lads to be apprenticed, but to the fact that so few good masters are willing to take apprentices on terms that are acceptable by the great majority of lads applying to the Institute for apprenticeship." Mr. Ballin requests us to give publicity to this statement, and also to say that he invites firms who have vacancies for apprentices to communicate with him on the subject. We have much pleasure in doing this, because we feel that good as are the results from the work of technical classes, this form of education does not satisfactorily replace apprenticeship in the training of artisans.

APPRECIATION OF BRITISH ELECTRICIANS.

In this connection, however, it is only fair to reproduce certain remarks of Sir William H. Preece, uttered when he distributed the prizes at the Wolverhampton Science and Technical School. He said that he knew intimately the head of an electrical industry in Germany who had requested him to supply the German firm with young English electrical engineers. He had done so, and the young Englishmen were great successes. Feeling curious as to this demand, he asked, "Why, with your good system of education in Germany, do you come to England for your electrical engineers?" The reply was, "We are too much educated in Germany. If you want a calculation made or a formula discussed, we can do that in Germany; but if we want work done we like the young Englishman. He doesn't bother us. The German will not do anything without instructions from headquarters, but the young Englishman will always do his work well without bothering the heads of the departments." This is reassuring in a way. On the other hand, if the industry is to flourish, it is necessary to have the thinker and contriver. Few will dispute the fact that, in spite of our possessing a few brilliant inventors, we are rather followers than leaders in the field of electrical development, which is not as it should be.

WAVES AND TIDES.

We are accustomed to think of Italy as a country where hydro-electric enterprise is highly developed. This is true enough as regards Lombardy, the Alpine provinces, but scarcely of the coastal districts, if we except Liguria. Apart from mountainous regions, rivers are few and far between, and practically dry for many months of the year; and as Italy is very nearly coalless, there have been many who have turned to the sea as a possible source of power. Professor Ricardo Salvadori is the latest to turn his attention to this matter, and he has been giving the benefit of his researches to the Italian Electrotechnic Association. His efforts were devoted to the utilisation of wave force. As might have been expected, his report is the very reverse of sanguine. He found that the mean energy of the waves per metre of coast line was little above 1 h.p. per annum, and that to recover this 1 h.p. the capital expenditure would have to be about 5,000 lire, or £200. He estimates that on the Italian coast there are 200 days in the year with power reaching 1 metre high and over. But it is notorious that Mediterranean storms are fierce, sudden, or comparatively of little duration, and most irregular. To recover force of waves seems a hopeless task. It is otherwise with tides. In the Mediterranean the tidal movement is negliable; not so in other seas. On certain coasts it would be quite possible to utilise tidal force for hydro-electrical works at no great expense. By an arrangement of flounces, it would be easy enough to fill a reservoir of desired proportions, and by regulating the descending force, drive turbines or water-wheels. Even the ascending tide might do its quota of work. Of course, accumulators would be necessary with any such system.

ELECTROLYTIC BLEACHING.

A strike among lime quarrymen, leading to irregularity in the supply of bleaching powder, and a rumour that a combination among chemical manufacturers would lead to enhanced prices, has caused many cotton manufacturers to turn their attention to the production of bleaching liquor by electrolysis. The process has been before bleachers for several years now, but has received very little welcome in England, though used to a considerable extent on the Continent. The bleaching liquor is merely an electrolytic solution of common salt. It is an established fact that a given quantity of chlorine produced electrolytically from salt is more powerful than an equal quantity produced chemically from lime. But the question is not so much one of superior strength as one of price. In Switzerland, where water power is used, electrolytic bleach is cheaper than bleach made from bleaching powders, but, then, bleaching powders are dearer on the Continent than they are here. In England, it would seem, that if power is purchased from a central station, the electrolytic process is more expensive than those of bleaching powder, but if power is generated on the premises, all is in favour of electrolysis: it is quicker, gives good colour, and is cheaper. Attempts have been made to introduce electrolytic bleaching in laundries, but so far without any great success. The plant required is simple enough, and there is no trouble with the process, but in laundries there is a

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tendency to use the bleach too strong, and then, again, the question of cost comes in. Has anyone attempted to use sea water, say, on board ship or in some coast town, for the preparation of an electrolytic bleach? It is worth trying.

ELECTRICITY AND TRAMWAY COMMITTEES.

Usually municipal tramway accounts are condemned as little less than fraudulent, on the ground that the Tramways Committees obtain their power far too cheaply from the tax-supported electricity generating station. In Manchester, however, the accusation is the other way about, somebody having blamed the Electricity Committee for charging too high a price for the electric current, thereby crippling the tramways and inflating the budget of the Electricity Department; and it is hinted that that Tramway Department ought to generate its own power. To this Mr. George Howardt, Chairman of the Electricity Committee, replies that within the last few months the Tramways Committee have considered whether they could have obtained better results if the City Council had installed separate generating and distributing plant instead of the present combined plant, and after careful detailed comparisons with other towns they came to the unqualified conclusions (1) that the combined supply had been justified, and (2) that, making proper allowance for differences in physical conditions and financial policies (*e.g.*, density of population and treatment of depreciation), traction current was being produced and sold as cheaply in Manchester as in any other municipality.

SPARKING OF PORTABLE LAMPS.

A curious accident is reported from Bradford. It appears that a mechanic was in the inspection pit in the Central Motor Garage, and was using a portable electric lamp. Through some cause or another the lamp fused, sparks were emitted, and ignited the petrol and oil soaking the sand at the bottom of the pit. Happily the man escaped without much harm, but there was an explosion, five cars and the building being badly damaged. This is a point worth studying, for we usually recommend electric portable and other lamps on account of their safety. It should not be feasible for these to attain such a temperature as to make fusing possible.

MARCONI'S "WIRELESS" AND THE POST OFFICE.

We are glad to find our view as to the all-round satisfactoriness of the agreement between the Post Office, Marconi's International Marine Communication Co., Ltd., and Marconi's Wireless Telegraph Co., Ltd., confirmed. The Secretary of the latter Company has sent out a circular to shareholders in the course of which he remarks that none of the stations belonging to Marconi's Wireless Telegraph Co. are included in the agreement with the Post Office. Moreover, the agreement does not affect the Transatlantic stations at Poldhu and Clifden, nor does it in any way relate to the trans-oceanic business of Marconi's Wireless Telegraph Co., Ltd. The directors are of the opinion that this agreement, whereby a very small portion of the business of the International Co. has been transferred to the Post Office, is distinctly satisfactory to both Companies. The manufacturing business of Marconi's Wireless Telegraph Co. will be affected beneficially, and the closer relations which are now established with His Majesty's Post Office will assist both the Companies in many ways, not only in this country, but also in the Colonies.

A DRASTIC STEP.

A beneficient revolution is threatening the railways of Chicago—probably the greatest railway centre in the world, all things considered. A municipal ordinance has been published, and in all probability will be carried into effect, making compulsory, by January, 1912, the substitution of electricity for steam as a motive power within an eight-mile radius of the City Hall. In this particular matter the Chicago railways, with two notable exceptions, would appear to have maintained a curiously conservative policy. Notwithstanding the object-lesson afforded by the City of New York, they have consistently declared against the practicability of electrification, and where valid arguments on this point have failed them, have fallen back upon the contention that even if New York has shown their calculations to be erroneous in this respect, the question of cost still makes the change impossible. As a matter of fact, technical authorities of high standing have shown that the conditions which indubitably made electrification extremely costly in New York City are practically non-existent in Chicago, yet New York grappled with the problem and emerged triumphant ultimately to find its reward in the fact the number of passengers carried was increasing at the rate of 55,000,000 per annum. Details of the somewhat drastic step contemplated by the City Fathers of Chicago are given elsewhere in to-day's issue by our New York Correspondent, but it may be pointed out here that the proposal is by no means the outcome of any sudden access of reformers' zeal. Chicago, like London, has suffered for many years under the smoke nuisance, and the railway corporations, alternately cajoled and threatened, have "sat tight" and made no attempt to minimize the evil. If the electrification ordinance is carried the companies will have none but themselves to thank for it.

MINES COMMISSION REPORT.

The interim report of the Royal Commission on Mines just issued is interesting in many ways. Although dealing mainly with accidents underground from falls, and the way to prevent them, electricity does come in for some consideration. It is evident that the Committee had no prejudices against electricity, but they observe that in certain mines, and they appear to incriminate North British mines especially, the electricity arrangements leave much to be desired. They pertinently point out that the blame is not so much to be laid on electricity as on the management, men deficient in electrical knowledge often being in control. This should not be. No doubt the new Departmental Committee will have something to say about the revision of the regulations and greater stringency in the matter of competent supervision. We, however, are inclined to place more hopes on the influence of the young but vigorous Institution of Electrical Mining Engineers.

AMERICAN ELECTRIC RAILWAY SCHEME.

Subscriptions have been invited in this country for 400,000 shares of £1 each in the Washington Traction Co. The company was formed under American laws to construct and operate an electric railway for freight and passenger service in the State of Washington, the length of railway, which passes through Columbia, Walla Walla, and Franklin Counties, being about 88 miles. The company is empowered to acquire and operate steamers, lighters, barges, etc., on the Columbia and Snake Rivers, and also to acquire docks, piers, and wharves, and to generate and supply electric power for all purposes, its charter being for a term of 50 years. Electricity will be generated by water power derived from the Toucanon River, and it is expected that there will be a large surplus of power available for sale, after providing for the working of the railway. Some 11,500 acres of land have been acquired, about 40 per cent. of which is under cultivation, and sales of this land, together with the proceeds of the present issue, are expected to be sufficient to cover the cost of the development of the water power construction and the complete equipment of the railway. The capital of the company is 5,000,000 dols., in shares of 5 dols. each.

The Advisory Board in England include:—Mr. H. G. McMicken, Railway Traffic Manager, 14, St. Mary Axe, London, E.C., Mr. A. C. Colebrook Codd (Messrs. Hutchinson & Co., bankers), 29a, Charing Cross-road, W.C., and Mr. Gilbert Rosenbusch, Ex-Chief Assistant Engineer, Underground Railways, London, of Queen Anne's-chambers, London, S.W. The registrars and transfer agents are Messrs. Hammerton & Co., Ltd., 6, St. Swithin's-lane, London, E.C.

TECHNICAL PROBLEMS.

Owing to an unfortunate error the Questions published in our last issue were wrongly numbered. They should bear the numbers 1206 and 1207 respectively. This, of course, will make no difference in the adjudging of the competition.

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ELECTRIFICATION OF THE FERNDALE COLLIERIES*

By W. H. PATCHELL, M.Inst.C.E.

When the author was called in to advise the directors of Messrs. D. Davis & Sons, Ltd., upon the electrification of their Ferndale Collieries he was asked to look at the matter on broad lines and to report as to the best scheme in view of the present and ultimate requirements.

It was decided that it would not be advisable to put up a generating station at any rate in the earlier stages of the work, while the demand for electricity would only be moderate.

As the South Wales Power Co. was supplying in the district, arrangements were made to take energy from them. This settled the question of system and periodicity.

A complete scheme was got out in sections so that, while when completed the whole would be homogeneous, the development could be carried out by such stages as were desirable.

The general plan of the collieries is shown in Fig. 1, from which it will be seen the principal pits lie in a line about three miles long in the Rhondda Fach Valley, No. 3 pit at Bodryngallt is in the big Rhondda Valley and isolated from the other pits by a mountain. The sinking of No. 9 pit was at that time only just put in hand, now it is finished. It will further be noticed that the pits are in pairs, 8 and 9, 6 and 7, 1 and 5, 2 and 4, following their order in the valley from south to north.

The heaviest work at that time was at Nos. 6 and 7 pits, and as the supply of steam was sometimes inadequate, attention was first directed to that point, and electric power was taken from the Supply Co. for eight main haulages, pumps, and sundry surface motors.

No. 8 pit called for attention next, there three main haulages, three pumps, and the surface motors and screening plant were electrified.

The directors then thought it wise to make themselves independent of an outside supply, and as by the time the power station could be equipped the load would be increasing rapidly, and closely approximate the paying stage, the power station was therefore put in hand.

After considering several sites, one was settled upon nearly opposite Nos. 8 and 9 pits at Tylorstown. This is not at the electrical centre of gravity of the system, but it possessed better advantages, taking it all round, than any other available site.

Meantime the fan at No. 9 pit was started, and preparations were made to change the steam-driven fan at No. 6 pit to electrical driving, while an equipment of main haulages, pumps, and surface motors for Nos. 1 and 5 pits was put in hand.

The power station was first operated in March, 1908, when a load of 2,164 h.p. installed was being handled by the Power Co. At Easter No. 6 fan was ready, and the load on the station then began to assume important dimensions.

The equipment of main haulages, pumps, and surface motors for Nos. 2 and 4 pits, the installation of "Sirocco" fans at the upper and middle fan pits, and the addition of sundry other motors at the pits already electrified, completes the sketch of the progress of the works, with the exception of a very important item, the large electric winder at No. 9 pit.

Table I. summarises the various classes of plant electrified—stand-by motors being omitted.

TABLE I.

Number.	Type.	Total H.P.
22	Haulages	3,250
4	Fans	1,060
40	Various surface plant	810
11	Pumps..	590
4 Motor generator sets	Surface lighting ..	261
8 Transformers ..	Pit bottom lighting ..	64
1	Winder	2,000
Total 90		8,035

* Abstract of paper presented before the South Wales Institute of Engineers, October, 1909.

Having thus described the plant in general outline, details of the various sections will be more readily followed.

POWER STATION.

The building is about 165 ft. long by 100 ft. wide, and is of steel frame construction, the brickwork merely acting as a filling between the steel stanchions, which take the weight of the roof, the upper floors, and the traveller. This type of construction was adopted on account of the ever-present possibility of subsidence on the surface of a colliery. The engine foundations are for the same reason constructed independently of each other and of the building foundations. The engine-room walls are lined with glazed bricks, the floor is finished with red tiles, and the underside of the roof is match-boarded. The roof trusses are of the usual steel construction and the roofs are covered with slating, except where glazed. All the roof glazing is of wired glass. The floors are constructed of steel joists and concrete, calculated to carry safe loads of from 1 to 5 cwt. according to their position in the building, A siding in connection with the Taff Vale Railway passes through the temporary end of the building on to the engine-room floor, and another passes over the coal hopper and along the west side of the building.

The overhead travelling crane is of Messrs. Herbert Morris & Bastert's manufacture, constructed for lifting up to 25 tons safe load, the span being 62 ft. 5 in.

The speeds when the crane is fully loaded are as follows :—

Hoisting .. 12 ft. per min. with a 35 h.p. motor.
Traversing .. 80 ft. per min. with a 6 h.p. motor.
Travelling .. 130 ft. per min. with a 12 h.p. motor.

The coal trucks are tipped by hydraulic rams, worked by the boiler-feed pumps, over a hopper in the yard under the boot of which the end of a Gibbons Bros. endless 16 in. belt conveyor runs. The conveyor rises at an angle of about 15° to the top of the steel coal bunkers in the boiler house, and thence runs along the bunkers into which the coal is delivered by a throw-off carriage at any desired point. The conveyor is driven by a 6 h.p. motor at a speed of 250 ft. per min., and will deliver 20 tons of coal per hour. The coal falls by gravity out of the bunkers into the hoppers of mechanical stokers by the Underfeed Stoker Co., Ltd. Dumping grates allow the clinkers to be discharged into deep ash pits under the boilers, from the bottom of which they are discharged into trucks and run out to the tip.

There are four 4-drum water-tube boilers, made by the Stirling Boiler Co., set in pairs. Each boiler has 6,209 sq. ft. of heating surface, a steam superheater of the McPhail type, with 800 sq. ft. of heating surface, two underfeed stokers, and will evaporate 30,000 lbs. of water per hour at a steam pressure of 180 lbs. per sq. in. The feed pumps and water heaters for the sake of cleanliness are divided off from the boiler-room. The pumps are of Clarke Chapman & Co.'s Compound Vertical Woodeson type, and the water heaters of the Cochrane type by the Erith Engineering Co. Duplicate feed mains are provided with separate check valves on the boilers. The draught for the underfeed stokers is provided by two fans, 78 in. in diameter, driven by 15 h.p. motors, one of which is placed on the boiler-house floor, the other in the basement.

The steam pipes have British Standard welded flanges. A common header is fixed at the back of the boilers into which the boiler and engine branches are connected. There is no steam ring. On the engine room side of the wall each engine branch has a steam separator.

A CO_2 recorder supplied by Messrs. Sanders Rehders, type B, is fixed in the engine room, and connected by small pipes to the back of each of the boilers. This instrument records automatically the percentage of CO_2 present in the flue gases. The flue gases, at each operation of the instrument, are made to pass through a solution of caustic potash, which absorbs any CO_2 present. As many as 40 separate analyses can be recorded in one hour. The charts which rotate on a drum are suitable for 24 hours. Owing to the fact that forced draught is used for the underfeed stokers the suction draught at the back of the boilers is almost nil, and consequently the movement of the gases passing to the recorder was very sluggish. To overcome this an "inducer" was fixed in the return pipe line and connected to the suction side of the boiler fans, which has quite got over the difficulty.

The generating plant consists of three cross compound horizontal type engines manufactured by Messrs. Sulzer

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Bros., each of which is capable of giving 2,250 b.h.p. at normal load and of carrying a 30% over-load.

Each engine is provided with two jet condensers in the basement, the air pumps of which are worked from the crank pins. Following a practice which he had previously adopted, the author modified Messrs. Sulzer's design by inserting a water-heater between the low-pressure cylinder and the jet condenser. This practically forms a small surface condenser. Another modification on Messrs. Sulzer's design which is due to the author was mentioned by him on page 528, vol. 25, of the Proceedings. This modification has proved most beneficial, and has the effect of turning Messrs. Sulzer's open engine into practically an enclosed engine with automatic lubrication. The path of the crank pin is enclosed in a planished steel casing which is connected by a similar casing to the front end of the engine frames. Doors are fitted to the side of the frames to enclose the slides. A cylindrical oil vessel is mounted on a pillar between the two cylinders, and the oil is kept in constant circulation from this oil vessel to which it is returned by small pumps driven off the engine.

As the river water was not satisfactory, either as regards quantity or quality, injection water is provided from cooling towers standing upon concrete tanks. The cooling water is taken from the tanks by a light steel pipe, 4 ft. in diameter, which is buried in the concrete block which forms the floor of the engine room basement. After passing through the condensers the water is delivered into a steel pipe 5 ft. in diameter, which forms the hot well and from which it is lifted by centrifugal pumps to the cooling towers. These are circular steel towers. They are 33 ft. in diameter at the base and 83 ft. high to the top of the chimney. This height is necessary as they depend solely on natural draught.

The alternators are of the Lahmeyer Electrical Co.'s revolving field, three phase type, keyed directly on to the crank shafts of the engines, and are of sufficient weight to give even turning without a separate fly-wheel.

Each machine has a normal continuous capacity of 1,600 kw. at a power factor of 0·85 and a pressure of 2,200 volts to 2,500 volts. They are further capable of carrying a 30% over-load, and indeed when this load was applied the engine and machine operated as smoothly as when worked under normal conditions. The generators are separately excited at 200 volts. The necessary supply is given alternatively from a 75 kw. Belliss-Lahmeyer steam-driven exciter running at a speed of 525 r.p.m., or a motor-generator booster set of 120 kw. capacity, consisting of a 180 b.h.p., 2,200 volt, 3-phase motor, coupled direct to a shunt wound 120 kw. generator. On an extension of the shaft of this set is mounted a small booster which is capable of raising the voltage from 200 to 280 volts to charge the station battery. The battery is of the Tudor Co.'s make, and has a capacity of 380 ampere hours when discharging at a 38 ampere rate. Hand regulating 21 contact switches are used for the charge and discharge. The battery can also be charged by the Belliss-Lahmeyer set without the booster. The continuous current supply is also used for the station lighting, for some of the auxiliary motors in the station, and in connection with the tripping coils of the automatic switches on the main switchboard.

The main switchboard is located at the south end of the building on galleries. The switchboard operator controls the various circuits from the first gallery upon which a set of generator panels in the form of desks are located. Each machine desk comprises an ammeter, voltmeter, kw. meter, and ammeter for the field circuit as well as the handle for operating the main switch. The field resistance is located in the basement and worked by a chain from the wheel on the front of the desk. The synchronising gear is of the lamp type and fitted on the underside of the upper gallery so that it is directly in front of the operator when he is at the desks.

On the floor underneath the operating gallery is located the whole of the 2,200 volt high-tension switchgear. Each machine has a three-phase oil switch which is worked by a rod connected to the lever on the desk above, the switches being fitted with over-load and reverse current relay. The current after passing through the switch goes to ring bus-bars located above the iron framework carrying the switches. These bus-bars are provided with links so that they can be broken up in sections for testing or other purposes. The generators feed into the front half of the ring. At the two ends of the ring the bus-bars are broken and main meters are inserted. All current going from the generators round the ring to the feeders therefore has to pass through one or other of these meters. The connections for the supply are taken off from the back side of the ring, which is also broken up by links into sections. Each feeder

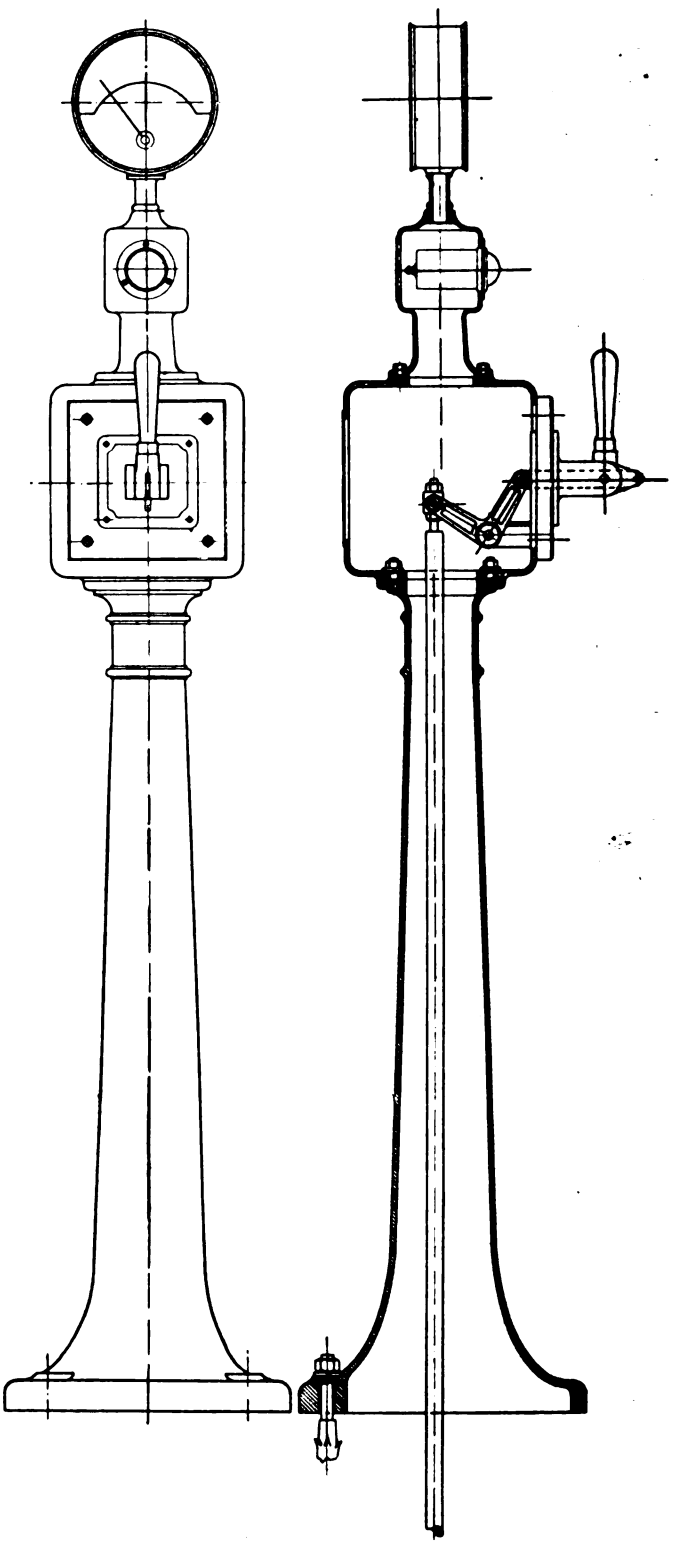

Fig. 1. Power Station: Feeder Switch Pillar.

is provided with an oil switch which is connected by rods to the levers on the feeder pillars which are situated on the gallery immediately over them. The feeder-switch pillars are shown in Fig. 1. It will be noted that the operator in the ordinary course of his work only has low-tension gear to handle. The whole of the high-tension work is locked up. The various automatic switches and connections forming the high-tension gear are arranged on an iron framework and enclosed with perforated iron sheeting. What has been described as the front and back half of the ring bus-bars form two parallel lines with a passage-way in between giving safe and easy access for inspection.

The advantage of this type of construction over the brick partition type is that less room is taken up and the whole of the gear can be inspected without removing any doors or

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shields. The supply for the pits in the vicinity of the power station is taken at 2,200 volts. The supply to the pits further away is transmitted at 6,600 volts. For this purpose transformers are located in the switch-board basement, *i.e.*, in the space below the high-tension floor. There are three transformers, two of 500 k.v.a. capacity, and one of 1,000 k.v.a. capacity, of the Lahmeyer Electrical Co.'s oil cooled type.

The 2,200 volt supply is taken direct to these transformers from the automatic switch controlled by a feeder pillar. The high-tension current at 6,600 volts is taken from the transformers by insulated cables to the top gallery where arrangements are made for putting any transformer on to any line, and the lightning arresters with liquid resistances and choking coils are located. From this point bare wires are taken through the wall of the building to the overhead transmission line.

All the a.c. local supply is at 2,200 volts, and controlled from the switchboard gallery by the station feeder pillar, the connections from which go direct to a distribution board situated against the east wall of the high-tension switch floor. A separate cable is run from the feeder-pillar switch to one of the three centrifugal circulating pumps, so that the distribution board can be shut down for cleaning without interrupting the working of the station. The distribution board consists of a light iron framework, bus-bars, and one set of high-tension oil fuses for each circuit, all enclosed by perforated metal screens. There are five circuits, one for each centrifugal pump, one for the motor generator set, and one for the a.c. forced draught fan motor.

The continuous current switchgear is located at the east end of the operating platform, and consists of three marble panels mounted on an iron framework. The left-hand panel contains the switchgear for the Belliss exciter set; the right-hand panel is for the motor-generator exciter set; and the middle panel is equipped with the switchgear for the battery, the booster, and the various feeder circuits for the station c.c. auxiliaries. The battery regulating switch is not mounted on this board, but at the other end of the gallery, thereby obviating the crossing of the gallery by the numerous battery leads. All fuses are mounted at the back of the board where a wide passage is provided to facilitate inspection.

The general idea of the distribution system is as follows: Each pit has a duplicate supply from the power station to a distributing centre or sub-station convenient to the pit top. From these centres the surface-plant cables and the duplicate-shaft cables radiate. The supply to motors and for lighting in the pits radiates from the underground distributing centres. To facilitate inspection and testing every cable is provided at each end with an oil-break switch. Four 2,200 volt feeders are run from the power station to Nos. 6 and 7 and 8 and 9 pits sub-stations respectively. For the supply higher up the valley this voltage is stepped up at the power station to 6,600 volts by means of the 1,000 k.v.a. and two 500 k.v.a. transformers.

The 2,200 volt supply is taken by insulated cables from the feeder switches to a lightning-arrester house built near the bed of the stream, on the way to which the Taff Vale Railway is crossed by means of six iron pipes laid in concrete. Thence the supply to Nos. 8 and 9 pits and the winder house is continued by duplicate cables, but the supply to Nos. 6 and 7 pits is carried further by a bare overhead line.

The 6,600 volt supply leaves the power station from the second floor at the east side and is run on two separate pole lines to Nos. 1 and 5 pits sub-station. At this sub-station a tapping is taken off for the 6,600 to 2,200 volt step-down transformers and for the 6,600 to 440 volt step-down transformers for the local supply. Thence two three-core 6,600 volt feeder cables are taken across the Taff Vale Railway in a similar manner to the 2,200 volt supply at the power station, over the river and through Ferndale town until they are connected to the so-called "House in the Field" which forms a terminal for the bare overhead line. From this point two pole lines are run to the middle fan sub-station where the 6,600 volt feeder is finally connected on to the switchboard.

At the middle fan house the current is stepped down for a 2,200 volt and 440 volt supply. A 2,200 volt single pole line is thence run to Nos. 2 and 4 pits and continues to the upper fan. A 440 volt insulated cable is run to Nos. 2 and 4 pits, and another to the wagon shop, for supply to the small surface motors. The poles are all arranged to eventually take two three-wire circuits, and the distance from the ground to the lowest wire is not less than 20 ft. The insulators are of the double petticoat delta type. Brown insulators were chosen in preference to white as they are not so conspicuous a target for stone throwing. The insulators are fixed on brackets on the sides of the poles.

Wherever the line makes an angle shackle insulators have been used. This type has also been adopted as terminal insulators for anchorages at the power station and at all the sub-stations. All the poles are provided with a metal hood and lightning conductor which are connected by an earth wire to the various brackets, so that all the ironwork on the poles is in metallic continuity. Substantial lightning arresters of the horn type are provided at all the sub-stations and at all the terminals of the various overhead lines. In connection with these lightning arresters, choking coils and large water resistances are provided, and disconnectors are inserted in front of the horns so that they can be inspected or adjusted without discontinuing the supply.

It will be noted that the distribution system on the surface is partly insulated cable and partly bare overhead lines on poles. The latter at first sight seems to be the cheaper construction, and in the case of long runs over clear spaces it undoubtedly is so. In the case of short runs the cost of suitable terminals and lightning arresters, as also the cost of cradles and protecting the lines, may raise the expense of the pole line till it closely approximates, even if it does not exceed, the cost of insulated cables.

Bitumen or lead-covered paper-insulated cables protected by lock-coil wire armouring are attached at suitable distances by long wooden clamps to the buntons. There are no joints in the shafts. Where it has been necessary to join a cable it has been taken into a ledge room where the joint can be made and inspected with ease and a certainty unobtainable in the shaft.

In the pits the shaft cables terminate at oil switches in switch rooms near the bottom of the shaft. These oil switches are arranged in iron-clad switchboards alongside the various feeder-cable switches. The feeder cables to the various haulages and pumps are of the bitumen or paper-insulated lead-covered type protected by two layers of steel-tape armouring. In some cases they are laid in shelves or ledges formed in the bricked sides of the roads, while in other cases they are suspended by thongs from the timbering.

The question of converting some of the existing haulages to electric driving was considered, but in view of their age and the fact that they could not well be spared during the time necessary to convert them, it was decided to put down complete new haulages. The result of this decision has been satisfactory, as no time or coal was lost during the fixing of the new sets, and the power exerted by the new sets has been considerably more than the old gears could have transmitted without breakdowns. The author has no hesitation in saying that both the beds and gearing for electric haulages must be more heavily constructed than the corresponding parts of steam or air driven haulages of equivalent nominal power. The sub-contract for the gears was placed with the Uskside Engineering Co., whose experience as builders of haulage sets is second to none, and the author well remembers their reluctance to increase the strength of parts which he called for when settling the drawings. When the time came to settle subsequent orders the makers readily admitted that the strengths decided upon for the earlier sets were not in excess of absolute requirements. As an example of the possibilities the members may be interested in hearing that in the case of a journey having run wild on an incline the resultant heap at the bottom is not laboriously cleared up by a breakdown gang in the usual way, but the haulage rope is attached to the top tram and the heap drawn out by an application of two or two and a-half times normal torque, into something like order which very considerably shortens the time during which the road is blocked! For the sake of convenience and to keep down the number of spare parts three sizes of haulages were decided upon, 200, 100, and 50 h.p. respectively. With the exception of those in No. 6 pit the motors work at 2,200 volts. As in No. 6 pit the haulage rooms are in the return air, 440 volts is used and obtained from step-down trans-

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formers installed in a room convenient to the pit bottom and ventilated with fresh air. In the case of the 50 h.p. haulages, double reduction gear is used, while single reduction was adopted for the larger sizes. This necessitates a large slow-speed motor, and as, if it was placed behind the drums, it prevented the engine man seeing his ropes, it was placed at the side of the gear and connected thereto through a flexible coupling to accommodate any slight inequality or settlement in the foundations.

This coupling also fills an important office in preventing the vibrations of the gearing being transmitted to the motors. For this purpose it is constructed in the form of a claw coupling, with the difference that the claws are faced with heavy indiarubber blocks. Each half coupling is in two parts so that it can be removed or replaced without displacing the shafting, but up to the present this feature has not been called into service, nor have any of the rubber blocks been renewed. The first-motion shaft also carries a brake which has proved of considerable convenience in handling the motor. The gearing in some cases is of cast iron, in others of cast steel. The drums are of cast iron with steel cheeks and brake paths, and are substantially bushed with bronze. The brake blocks are of cast iron renewable in segments.

The management took a liberal and wise view when deciding not to cramp the haulages, but made good wide arches for engine houses, and to save expense smaller pocket arches were made for the motors. In some cases the haulages are erected on the road level, in other cases they are erected over the roads. In the former cases concrete foundations are provided. In the latter concrete foundations can only be put under the motors, and the haulage gears are carried on heavy steel joists spanning the roads. These joists are built into the walls in such a way that alterations of level can easily be corrected. The engine man controls the haulages by means of four hand levers and two foot pedals. The left-hand lever actuates the clutch coupling of the left-hand drum and near it is the foot pedal for the left drum brake. The lever in the centre actuates the reversing switch and the controller proper. The right-hand lever actuates the clutch coupling of the right-hand drum, and between it and the pedal for the drum brake will be noticed the lever for actuating the emergency brake on the first-motion shaft. The weight of the foot pedals and levers is balanced by counterweights suspended from them by wires. The starting, reversing, and speed control is all done by the movement of the centre lever.

Controllers very much of the tram-car type or liquid-resistance switches were in common use and put forward by the various contractors when tendering for this work. The author was of the opinion that neither type was likely to give satisfactory results without considerable nursing and maintenance which in practical everyday use they were not likely to get, he therefore rejected them all, and in connection with Messrs. Lahmeyer evolved the type adopted, which they called " Patchell's System."

The controller consists of a drum of insulating material fitted with blocks forming contact segments. The fingers which make contact to complete the circuit through these segments are connected to the resistances. The lid of the cast-iron containing box is hinged and the drum is attached to the underside of the lid by two bearings and rotated by means of a segmental rack and pinion. The connections to the contacts are brought through bushings in the lid. This arrangement admits of easy opening and inspection of the contacts. A ratchet wheel between the pinion and the drum limits the motion from stop to stop. The drum and contact fingers are totally immersed in oil. The reversing switch is also oil immersed, and as previously mentioned, both it and the controller are connected to one lever, the motor being started up by pushing the controller lever forward and brought to rest by bringing the lever back into the centre position. Reversing is effected by pulling the lever sideways. These motions perpendicular to each other are interlocked mechanically so that reversing cannot take place when the rotor is short-circuited. The resistances in connection with the controller are metallic and oil immersed in iron cases, and to insure thorough cooling rotary pumps worked by the haulages circulate the oil from the resistance boxes through suitable radiators.

In the first haulages put down the pumps forced the oil in two directions according to the direction of the rotation of the motor. This was found to be a disadvantage, as in some cases the radiators were some distance away from the haulages, and the result was that the oil practically moved from the radaitor to the haulage and back on the return journey without being thoroughly circulated. In order to obviate this a set of non-return valves was afterwards provided, so that the oil is now forced in one direction no matter in which direction the pump is driven. The amount of heat to be dissipated when starting up a three-phase motor does not always receive proper consideration, the result being evident in burnt out motors and damaged resistances. In the case of liquid resistances it is no uncommon thing to find the liquid low in the container due to evaporation. When starting a slip-ring motor up to full speed about half the energy put into the motor is converted into work and given out on the shaft, the other half is turned into heat which must be dissipated, and it is important to dissipate as much of this heat as possible outside the motor.

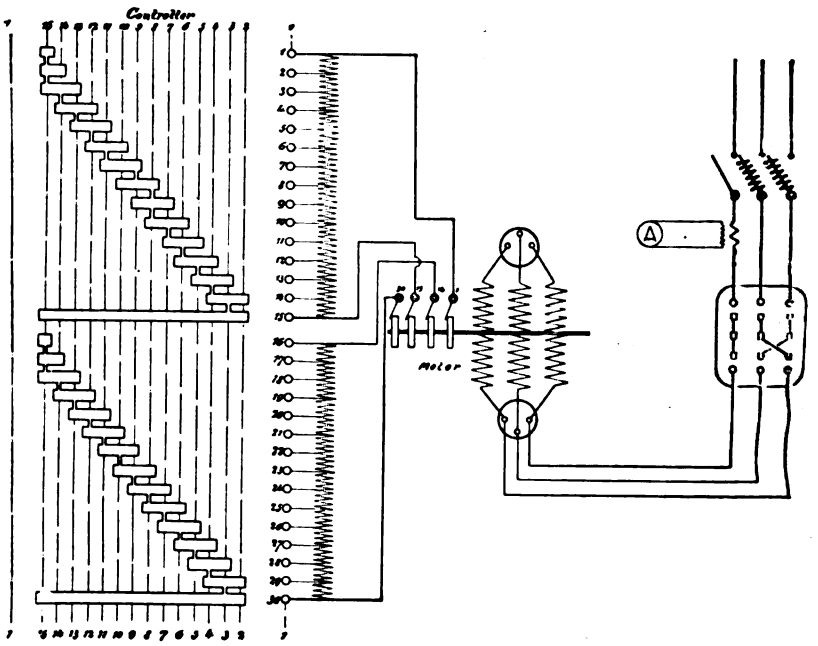

Fig. 3. Haulage: Controller, Diagram Connections.

In the case of a 200 h.p. haulage motor starting up and accelerating to full speed on full load in 20 sec., the heat to be dissipated amounts to some 2,000 b. th. units; the cumulative effect of this amount of heat unless readily dissipated may be serious. Observations were taken on one of the 200 h.p. sets, where the amount of work done at a reduced speed was practically negligible, or in other words the controller and resistance were used only for starting up. The temperature of the motor after the day's work was 77° Fah., while the temperature of the oil in the resistance tanks was 112° Fah. The supply to each haulage set can be cut off at the engine house by a three-phase oil switch, fitted with automatic release, which is fixed quite clear from the switches used for working the haulages.

The type of motor which was used in a part of the mines where General Rule 8 applied is fitted with " plate protection." This form of protection, as mentioned by the author in the discussion on Mr. Robert Nelson's paper, Transactions, Inst.M.E., 1909, vol. 37, page 488, was developed during the course of some experiments in Germany which were started in 1903.

The experiments covered tests on totally enclosed motors, motors ventilated with gauze over the openings, labyrinth ventilation, tube ventilation, the plate-protected type, and oil immersed motors. Very drastic tests were applied, and the plate-protected motors were the only type that withstood these tests satisfactorily. The way in which different authorities calculate the power called for by a haulage set varies within wide limits. For instance, whilst some take

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$\frac{1}{10}$ of the weight of the load and $\frac{1}{20}$ of the weigth of the rope in allowing for friction, others take $\frac{1}{20}$ of the load and rope.

When several haulages are required it is more economical to use standard sizes, and as the tendency is generally in the direction of increasing rather than of decreasing the load on haulage after it is put to work it is safe to put down the next size larger rather than the size calculated to exact requirements.

The varying conditions in a pit render close calculation impossible, but for all that the author thought it worth while to get some readings from which existing formulæ could be checked. Twelve loaded trams were taken just as they came out of the pit for the purpose of the experiments. Weight of total load, 48,400 lbs.; weight of wagons empty, 12,300 lbs.; useful load, 36,100 lbs. Each tram had four wheels, 16 in. in diameter on the tread. Diameter of the axles, 2 in. The axle boxes were of the common type, open at the bottom, a fairly loose fit, and lubricated with grease. Gauge of track, 2 ft. 10½ in.; width of rail-head, 2 in. The line was practically straight with a gradient against the load of 5°, that is 3·15 in. per yard. The haulage with which the experiment was made was a 100 h.p. single-reduction set with a drum 5 ft. diameter. The pull P indicated on the dynamometer fixed between the rope and the first truck with the load on the gradient and moving at a speed of 5½ miles per hour, that is 8·2 ft. per sec., was 5,500 lbs.

P is made up of :-

p = weight component due to gravity, or W sin 5°,

p_1 = tractive resistance.

Inserting the values we get

$p = 48{,}400 \times \cdot 08716 = 4{,}219$ lbs.

At the low speed air resistance may be neglected and the tractive resistance, p_1, *i.e.*, the friction of the journals in the bearings and the friction of the wheels on the rails, is easily determined.

$$p_1 = 5{,}500 - 4{,}219 = 1{,}281 \text{ lbs.}$$

We can now find the tractive co-efficient X which is always dependent on the component of the weight acting vertically on the rails.

$$\text{We have } 1{,}281 = 48{,}400 \cos 5° \text{ X}$$

$$\text{Hence X} = \frac{1{,}281}{48{,}400 \cos 5°} = \cdot 0265$$

As the trial track was rather better than usually obtains underground, this result ought to be increased slightly, or say, rounded off to ·03. We can then establish the following formula—

$$P = W \times \cdot 03 \text{ on a straight horizontal track,}$$

$$P = W \sin A + \cdot 03 \text{ W cos A on a straight gradient,}$$

where A = angle of inclination of the track to the horizontal.

For small gradients up to 1 in 20 the value for the cosine can be neglected.

p_1 can be expressed either as a co-efficient ·03 or as 67 lbs. per ton.

The trail was made on a straight track, and it will be understood that the rope friction is not included as the dynamometer was placed between the haulage rope and the trams. The author regrets that he could not get corresponding figures for curves, but if, as he hopes to be able to, he can get them at an early date he will have pleasure in communicating them. While on the question of electric haulages the author would like to mention a few points in their favour which are often overlooked. The saving in transmitting and transforming the energy are too well known to need emphasis, but collateral savings are not so obvious. In the case of electricity the power is always available, without any delay, by merely turning on the switch so that an odd journey can be run at will in the middle of the night without waiting for water to be drained out of pipes, etc. This facilitates small repairs to roads which would be postponed until really urgent and so makes for generally increased efficiency. The steady starting and hauling of the journeys decreases the amount of coal shaken out of the trams on to the roads or otherwise broken, and also lengthens the life of ropes, shackles, and trams. The ammeter, which should be fixed in view of the engine man on every haulage gear is a valuable indication not only as to the working of the machine, but also of the state of the road, and so promotes better maintenance of the roads.

At the same time the author would not recommend the universal adoption of electric haulages as the result of taking electricity into some places may cost more than any possible saving, to say nothing of the disturbed peace of mind of the management. There will always be a field of usefulness for compressed-air haulages in places outside the safe sphere of electricity.

In some quarters the driving of ventilating fans by electric motors is not received with favour, as at first sight the long-hour user and consequent elimination of stand-by losses seems to discount the saving due to electric driving. An up-to-date steam engine and boiler equipment will develop a brake horse power on a fan shaft for less coal per hour than would be necessary to deliver the same power generated and transmitted electrically. The cost of labour in attending to a steam plant is greater than for a motor-driven fan, but the chief reason for driving the fans from the power station is most appreciated when the effect of their steady load combined with the intermittent load of haulages, etc., is considered. The full advantage can then be obtained which is due to the concentration of the generation of power. The first fan of this group to be driven electrically was No. 3 at Bodryngallt. The pit had previously been ventilated by a furnace at the bottom of the shaft. A double inlet steel plate "Schiele" fan, 10 ft. diameter, with self-aligning bearings and ring oil lubrication, capable of exhausting 100,000 cubic ft. of air per min. at 4-in. water gauge when running at 255 r.p.m., was put down, and driven by cotton ropes from a motor of 125 h.p. running at a full-load speed of 720 r.p.m. At week-ends and holiday times less air is required than is normally called for. Unfortunately alternating-current motors cannot be regulated in speed with the same economy and facility as obtained in the case of continuous-current motors.

Two methods of regulating the amount of air dealt with were consideerd—

(*a*) Cascade, in which a second motor is thrown in series with the main motor so altering the number of poles and the speed of the main motor.

(*b*) Throttling, in which the volume of air moved is regulated by doors in the drift, the speed of the fan remaining constant.

Regulating by a resistance in the circuit of the motor was turned down as it was generally considered inefficient. Regulation by cascade was decided upon, and a small two-pole motor was fixed on the shaft of the main four-pole motor with suitable switches to give alternative speeds of 485 and 720 per min. Very soon after the main motor was started, and the ventilating furnace put out, the cooling of the shaft caused a heavy fall, which, going down the shaft like a piston, reversed the air-current, and pulled up the motors. The main motor was uninjured by the shock, which, however, burst the bands off the rotor of the small motor. The small motor was disconnected and the work immediately resumed with the large motor, and the facility for reducing the main motor speed to two-thirds at week-ends was for the time being abandoned.

The author later closely considered the characteristics of induction motors and ventilating fans, and came to the conclusion that the general antipathy to regulating by a resistance in the electric circuit was not well founded as regards fan motors. Introducing a resistance in the rotor circuit of an induction motor reduces the speed, but not the input or the torque, so is quite a convenient method for starting a motor, as it enables full-load torque to be developed at a reduced speed. The input to the motor remains practically unaltered, the balance of the energy not given off at the shaft being developed in heat and so lost. These conditions obtain in the case of a haulage or other work when there is a force opposing motion and so causing the motor to keep up the torque and maintaining the equilibrium for each particular speed. Hence we may determine the speed obtained on the addition of a resistance when there is a force opposing motion equal to the torque at that particular speed. If the slip with a given torque is 5% it will be 10% or 20% if the resistance in the rotor circuit is increased twice or four times. When a fan speed is varied the power varies (approx.) as the cube of the speed. Accordingly when a motor is driving a fan and its speed is reduced by inserting resistance in the rotor circuit, the torque due to the resistance is greater than is called for to turn the fan at the reduced speed, and the result is a compromise of a new speed and a lower torque with reduced current. Experiments were accordingly put in hand, the

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results of which were so satisfactory that permanent arrangements were made to regulate on these lines at No. 3 pit.

No. 9 pit is used as an upcast shaft for the ventilation of No. 9, No. 8, and part of No. 6 pits, so that although No. 9 pit is new, a good load was available for the fan to the relief of the "Schiele" fan at No. 6 which had previously ventilated Nos. 6, 7, and 8 pits. In view of the ultimate duty required, a "Sirocco" 98-in. double inlet fan was installed with duplicate 300 h.p. motors connected to it by 15 1¼-in. ropes on the first floor of a building, the ground floor of which is used as a switch house. In this case regulation by resistance is employed.

Two further "Sirocco" fans were put down in place of old steam driven "Waddle" fans at the upper and midde pits. The duties called for were—

Ultimate.

Upper .. 125,000 cub. ft. at 4·3 in. W.G.
Middle .. 150,000 cub. ft. at 3·5 in. W.G.

Initial.

Upper .. 111,500 cub. ft. at 3·5 in. W.G.
Middle .. 131,500 cub. ft. at 2·75 in. W.G.

A little sacrifice was made in efficiency for the sake of uniformity and duplicate plants put down in each case, the only difference being that while the upper fan ultimate speed is 337 r.p.m. the middle fan only runs at 307 r.p.m.

In each case the fan is of Messrs. Davidson's "Sirocco" type, 77 in. in diameter, double inlet. They are driven by means of 9 1¼-in. cotton ropes. Clutch couplings are provided on each side of the fan, so that the rope pulley at either end can be disconnected, and the ropes need not be taken off the pulleys when the load is changed over from one motor to the other. In this case again resistances, of the iron grid type, are used for regulating the speed and are designed to allow a continuous speed reduction of 30%. The pulleys at present on the motors are smaller than will be required to drive the fans at the speed called for to give their maximum output. In other words, the fans are ordered larger than are necessary for the present requirements of the pits. Before the middle fan was put on to the pit, an opportunity was taken to test it under fresh-air conditions on a temporary drift with an adjustable orifice, and to determine the losses in the rope drive. The motor running light by itself absorbed 5 kw. The motor driving the ropes and a short length of shaft carrying the pulley absorbed 15·5 kw. The difference between these figures is 10·5 kw. = 14·1 h.p., and represents the power absorbed in the rope drive including the friction of two fan bearings, the friction of the ropes on the pulleys, and the windage. As 14·1 h.p. equals 7·9% of the full output of the motor, we may take it in this case the friction of the rope drive is 8% of full load. In making these calculations it has been assumed that the power absorbed by the rope drive varies directly as the speed, this being near enough for the purpose.

Although the number of motors employed is somewhat large there is no special point of interset to which attention need be drawn. They are throughout of the three-phase induction type, generally of 440 volts, although in cases some of the larger motors are wound for 2,200 volts. In special places protected type motors have been used, and oil switches fitted with a maximum release are generally employed to obviate the necessity and delay caused by replacing fuses. The type of plant driven includes screens, elevators, saw mills, mortar mills, blowers for the smith shop and foundry, and various wood and ironwork machines in the wagon shop in which seven motors ranging from 30 h.p. to 5 h.p. are employed.

There are 12 pumps. The first pumps to be put down at Nos. 6 and 7 pits were of the three-throw type worked by slip ring motors through double reduction gearing. Latterly, wherever the conditions were suitable, Messrs. Sulzer's high-lift centrifugal pumps have been employed. In the case of No. 8 Upper Lodge the centrifugal pump was very urgently wanted, and after being put to work it was run practically continuously for 18 months, during which time it was never opened. When it was inspected a few months ago the tool marks were found to be still fresh on the wearing parts; the only deterioration that had taken place was a slight pitting between two of the cast-iron distance pieces which do not rotate. This pitting had taken place at the top of the pump opposite one of the ports, and is believed to be due to an air chamber in the pump casing.

Perhaps the most interesting point in this pump is the belt drive. A stock pump had to be taken on account of the urgency of delivery, and the speed had to be such as was called for to fulfil a particular duty. The range of speed with 25 cycle motors is limited, and the best combination that could be arranged gave a belt speed of 7,050 ft. per min. over a pulley 13¼ in. in diaemter. Such conditions hardly seemed to promise satisfactory working without a particularly pliable belt, and in view of the belt speed the author preferred to try a plain leather belt rather than a link belt. An orange tan belt 8 in. wide was supplied by Messrs. Tullis. It was put on at the start and was practically as good as new after running 1,500,000 miles and transmitting steadily about 110 h.p. The electrically driven centrifugal pumping plant that has been erected underground for dealing with the make of water in the lodges and sumps of the lower, middle and upper fan pits, provides some interesting points.

The two pumps are placed in a heading near the sump of the lower fan pit. Normally, one pump deals with the water from all three sumps, which is collected at the lower pit sump by pipe lines running from the upper and middle pit sumps.

The second pump deals with the water from the middle pit lodge and lower pit lodge, the suction mains being connected to a common main just prior to joining the pump.

The pumps are situated about 1,210 ft. below the surface. The head of water on the suction side of the second pump, due to the position of the middle pit lodge, is 955 ft., so that the real head of lift is 1,210—955, = 255 ft., and the pump is, as it were, working at the bottom of a "U" tube. The head of water on the suction side of the pump, due to the position of the lower pit lodge, is slightly more than 955 ft., and to prevent water finding its way from the lower pit lodge to the middle pit lodge, a non-return valve is placed in the main from the middle pit lodge.

The pumps are placed side by side at 40 ft. centres, and belt driven from two identical motors placed between them, each of which is fitted with two different size pulleys. By an arrangement of valves either pump can be put on either duty in case of an emergency, but as the actual heads of these duties are so different, namely, 1,228 ft. and 255 ft., the pumps are run at different speeds, depending on the duty required. The change of speed is effected by altering the diameter of one of the motor pulleys.

The pumps are of Messrs. Sulzer's high-lift eight-stage type; the duty when running at 1,800 r.p.m. is 150 gallons per min. against a manometric head of 360 ft., or 80 gallons per min. against a manometric head of 1,262 ft. at 3,000 r.p.m. The motors are connected to a three-phase circuit of 25 cycles, 2,200 volts, 720 r.p.m., the rated full load output of each machine being 62 h.p. They are mounted on slide rails and drive the pumps by means of belts 12 in. wide.

An automatic device for stopping the pump when the water level in the sump has been lowered to a certain level is erected in the form of a float, the wire connection to which actuates a relay switch and cuts out the motor by tripping the automatic switch.

The surface lighting is at 220 volts, continuous current. In most cases the supply is given from motor generators, but where existing dynamos were good enough they have been converted into motor generators by the addition of a direct coupled motor.

Small transformers have been put in the various switch rooms at the pit bottoms by which the energy is transformed to 100 volts. This comparatively low pressure was decided upon in view of the risk of shock and the impossibility of maintaining lighting circuits absolutely trustworthy under pit-bottom conditions.

The question as to whether the new winder for No. 9 pit should be steam or electrical received long and careful consideration. The sinking of the shaft was already in hand with a temporary winder, so that comparative merits of the two systems for sinking did not arise. It was decided to put down an electric winder on the Ilgner system, the contract being placed with the Lahmeyer Electrical Co., who carried out the whole of the electrical work, with Messrs. Fraser & Chalmers acting as their sub-contractors for the drum. The winder is of the cylindrical drum type and provided with a tail rope for equalising the weights.

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The winder being electrically operated and arranged on the Ilgner system, a fly-wheel motor generator set is placed in series with the load to equalise the demand on the station.

The cylindrical drum has a diameter of 16 ft. and a tread of 9 ft. Wrought-iron arms carry the shell by means of riveted angle iron rings. The drum shell is lagged with oak. At each end of the drum brake-rings are fixed in such a manner that the brake pressure is taken up by the arms. The drum shaft is of m.o.h. steel, while the motor shafts, which are coupled thereto, are of s.m. steel.

The shaft is in three parts, resting in four bearings, the middle bearings being provided with special oil lubrication from an oil tank fixed on the engine house wall, the two outer bearings are provided with ring lubrication only.

The emergency brake and the working brake are combined, and consist of two sets of Whitmore post brakes, one on each side of the drum. Under ordinary working conditions the brake is actuated by hand by means of the lever on the attendant's platform. The brake weight when falling brings the interlocking gear into action, which moves the controlling lever into zero position. The compressed air plant for operating the brakes consists of a small air compressor, driven by a 3-h.p. motor. This compressor keeps up a pressure of 70 lbs. per sq. in. in the air vessel, which is provided with a safety valve, from which the air is supplied to the single-cylinder brake engine.

The brake acts as an emergency brake as follows :—

1. When released by hand by means of the emergency switch placed in front of the attendant's platform.
2. When released by the depth indicator in case of an over-wind.
3. When released by the brake magnet if the exciting current fails.
4. When the compressed air supply fails.
5. When released by the automatic cut-out, which opens when the current exceeds the maximum permissible amount.

In every case the controlling lever is brought back into the zero position and held there by a spring.

The depth indicator is in the form of a vertical column, provided with two heavy square threaded spindles, which are driven positively by chain gear from the drum shaft. The rotation of these screw spindles causes the indicator travellers to move up and down, showing the position of the cages in the shaft at any instant.

As the cage approaches the bank the indicator traveller causes a gong to be sounded, which gives the attendant due notice to pull the controlling lever back to the zero position. Should the attendant fail to bring the lever back into the zero position, a roller on the traveller comes into contact with a curved lever which actuates a system of rods, forcing the controlling lever back nearly into the zero position, thereby automatiaclly reducing the speed of the winder.

In order to prevent the attendant pushing the controlling lever over too rapidly and so accelerating at an undue rate, a retarding gear is provided which has a curved lever in contact with the before-mentioned roller, so arranged that the roller has to be worked out of the way by the screwed spindle before the lever can be pushed over to the full-speed position. In the event of over-winding occurring, the traveller on the depth indicator releases a catch, which, by means of the system of connecting levers, causes the emergency brake to act and opens the automatic cut-out, and so cuts off the supply from the winder motors. The automatic cut-out at the same time closes a relay circuit which interrupts the supply of current to the brake magnet, so that its core falls, causing the emergency brake to come into action. If for any reason it is necessary to wind the cage above the bank, a spring catch on the emergency lever can be raised and the desired over-wind effected. In order to prevent the possibility of the attendant throwing the controlling lever right over while the brakes are applied, when the brake is put on it pulls a curved lever over, and so indirectly interlocks the controlling lever. The depth indicator also carries an ammeter, volt-meter, and an air-pressure gauge, thus telling the attendant at a glance the condition of his plant.

From the depth indicator spindle a small belt is taken to a Karlik recording speed indicator, which gives a complete continuous record of the number of winds and the speed of each wind throughout the day, the scale of the record being such that a rope speed of 1¼ meter per sec. corresponds to a height of diagram of 1 millimeter.

Two continuous current 250 volt separately excited motors are directly coupled, one on either side of the drum. These motors are electrically connected in series and fitted with carbon brushes and compensating coils, so that the position of the brushes is fixed, and the conditions of running are sparkless from full load to no load when the drum is revolving in either direction.

The Ilgner fly-wheel motor generator set stands at the end of the engine-room at right angles to the winding-drum shaft. It consists of an induction three-phase motor, a continuous current dynamo, and a fly-wheel. The motor has an output of 700 h.p. at 500 r.p.m., and takes the three-phase current at 2,200 volts, as generated by the power station. The continuous current dynamo is designed for 500 volts and is furnished with compensating poles. The excitation voltage is 220 volts, which can be raised to 240 volts for regulating purposes. Between the three-phase motor and the generator a flexible Zodel-Voith coupling is inserted.

The fluctuations in the load are equalised by means of the fly-wheel, which has an outside deameter of 12 ft., a width of face of 2 ft. 6 in., and weighs 30 tons. A magnetic coupling is provided between the fly-wheel and the generator in order that the former may be disconnected, if desired, and the motor generator set run without the fly-wheel. The fly-wheel shaft runs in heavy bearings, provided both with ring lubrication and forced lubrication. The oil pressure under the bearings is about 150 lbs. at starting and 50 to 60 lbs. after the set is running.

In order to stop the fly-wheel in case of emergency a Foucault magnetic brake is provided, by which the fly-wheel can be stopped in about 7 minutes.

In order that the fly-wheel may give up its stored energy during the fluctuations of the load, an automatic slip regulator is provided, which switches resistance in the rotor circuit of the three-phase motor as the load comes on. The contact apparatus is in the form of an induction motor, the stator frame of which is pivoted so that it is capable of partial rotation, and is kept in position by means of a spring. The rotor of the contact apparatus is driven by means of a flat linked chain direct from the motor generator shaft, and is connected to the high tension network through a transformer. The stator is connected in a similar manner with the slip rings of the three-phase motor. The smallest speed variation of the main motor causes a corresponding variation in the speed of the rotor of the contact apparatus. This speed variation determines the position of the floating stator, which makes contact at each end of the limited path through which it can travel, and so energizes the magnetic circuits on the resistance switch. The resistance switch consists of a contact switch in the form of a commutator, the separate segments of which are connected to the resistances which are located in the basement. In addition to the contact brushes, the switch is provided with three rollers which act as sparking pieces. In the foot of the frame carrying the commutator switch is placed a small motor which drives a rocking wheel, upon the edges of which teeth are cut. Centrally over this wheel double magnets are mounted, with pawls attached to their armatures. When no current is passed through the magnets both the pawls are disengaged from the teeth of the wheels. One or other of the pawls is brought into contact with the wheel as soon as the floating stator of the contact apparatus completes the circuit by making contact at the end of its path.

A small motor generator is provided for exciting the main generator and winder motors. This set has an output of 25 kw., and runs at 750 r.p.m. A switchboard to control the apparatus in the winder house is erected along the wall at the right-hand side of the attendant's platform. This board consists of five panels, the high-tension gear being the usual three-phase oil switches adopted elsewhere throughout the installation. The direction of rotation of the winder is regulated by the position of the controlling lever, a suitable contact on which reverses the current in the field of the dynamo of the motor generator set.

The important feature in the winding plant is its immunity from the effects of wrong manipulation on the part of the attendant so long as the parts are in working order. The safety devices allow the attendant a free hand so long as he keeps within the prescribed limits. As soon, however,

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as he oversteps the mark, either by running at too high a speed or neglecting to slow up at the proper time, the safety devices act. The human element is therefore eliminated as much as possible, and danger from faulty manipulation avoided.

To demonstrate the reliability of the safety devices, the winder has been repeatedly started up and then left to complete the wind of its own accord, which it invariably did without the slightest irregularity.

Special attention has been paid to the arrangement and erection of the plant with a view to accessibility for inspection or repairs.

The financial results are an all-important point in an engineering scheme, but the directors of a trading company frequently prohibit any disclosure of costs. In the present case the author while not being able to put the costs of the scheme and complete working details in the paper, by the kindness of the Ferndale directors is able to give some figures which he hopes will be of interest and service.

The scheme may be divided under two main heads :—

The supply and the user of electricity.

The power station is now supplying at the rate of 9,000,000 units per annum.

The Works Cost per Unit delivered at the pits	*d.*
with coal at 5s. 8d. per ton are..	·210
Interest and Depreciation..	·272
Total Cost..	·482

As regards the user of electricity a ready way to appreciate the value of the change is to consider the user of small coal at the collieries. The amount of coal consumed monthly at the power station is rather less than the amount consumed previously to make steam for the three fan engines, which have now been replaced by electric motors and "Sirocco" fans. That means that the same amount of coal which was used to drive three fans now supplies energy to run motors aggregating 8,000 h.p., including three motors driving the new fans, which are doing some 10% more volume than the fans which they have replaced.

The principal trouble exeprienced has arisen from the failure of insulators on the transmission line. At first stone throwing was suggested, but when it was found that in nearly every case the tops were burst clean off the insulators, it was difficult to sustain the claim. The first insulators put up were of particularly fine porcelain on iron stalks cemented in with sulphur and glass cement, which swelled and burst off the caps or cracked the insulators. On a shower of rain after hot weather, the cracks became leakage paths and an "earth" resulted. The surges due to the sudden "earths" burned up some transformers used for switchboard instruments and also put some of the 500 kw. transformers out of service. The interruptions to the supply were only short, but still were interruptions, so should be noted as such and duly guarded against as far as possible. The only other failure was in connection with a fan motor working on an upcast pit and without any stand-by, other than the old steam engine, which had been superseded but not removed. At times when the pit top was open the load on the motor was increased owing to the fan keeping up its speed on a reduced water gauge. This effect is not noticed in a steam driven fan, as the engine will slow up or at any rate has only a limited capacity for overload before it slows up, while an induction motor will exert from two to two and half times its normal torque before falling out of step. The ventilating ducts became blocked with fluff off the cotton ropes and dust, and the insulation gradually perished. One day it was stopped for cleaning, and on restarting a short circuit developed, probably through a crack made by the cleaning. The motor had to be re-wound ; meantime the old engine was put back into service and the extra coal consumed thereby was an eloquent plea for electric driving.

Another minor trouble in the power station is worth mentioning, as although slight in certain circumstances it might be serious. The setting of water-tube boilers to get good and smokeless combustion when burning bituminous coal has received much attention during late years, and the distance between the grate and heating surfaces has been increased with that object. When burning Welsh smokeless coal on underfeed stokers, the heat is very intense and local. It is not a case of caking fuel and "blow pipe" action at parts of the grate where the fuel cake cracks, but the general heat is so great that unless the tubes are kept especially clean they are damaged at the parts nearest the fire. Some tubes blistered, and when cut out were found to be in such a state as would generally be accepted as clean. The overheating was due to the close proximity of the tubes to the fire on one side and a slight scale on the other. Although the scale was principally magnesia its amount was certainly not sufficient to cause any anxiety under ordinary circumstances.

During the period of fixing and subsequent working, about five years in all, there have only been two bad accidents, which in view of the difficulties to be overcome is most satisfactory.

The paper contained various interesting tables, and was profusely illustrated.

TRANSFORMER NOTES AND CALCULATIONS.—I.

By ELECTRON.

While the theory and principle of action of the static transformer are fully dealt with in most text-books and are well-known by the average student, it is surprising that so much difficulty is experienced in solving transformer problems. For this reason the following typical examples, with solutions, have been prepared for students of alternate current working, with the hope that they may supply the missing link, as it were, between what is given in text-books and what one meets with in practice.

As is well-known, the essential elements of a st tic transformer are the two copper circuits interlinked with a closed magnetic circuit, and in the majority of cases it will be found that many of the ordinary transformer problems may be solved by applying the laws of electromagnetic induction and the fundamental principles of alternating current working. In what follows it will be assumed that it will be sufficient to state these laws and principles, since they are explained in detail in the *many* treatises on alternating currents, and attention will mainly be devoted to the application of the fundamental principles.

From first principles, for instance, it may be shown that the relation existing between the effective (virtual) value of the periodic E.M.F. induced in a coil of S spirals, which is interlinked with an alternating magnetic flux N at a frequency f is given by the equation—

$$\left.\begin{aligned} E &= \sqrt{2}\,\pi\, f\, NS\, 10^{-8} \text{ volts} \\ &= 4{\cdot}45\, f\, NS\, 10^{-8} \text{ volts} \end{aligned}\right\} \quad \ldots\ldots\ldots(1)$$

and if A be the effective area of cross-section of the iron (laminated) core and B_{max} be the maximum value of the flux-density interlinked with the S coils of wire, then

$$E = 4{\cdot}45\, f\, (AB_{max.})\, S\, 10^{-8} \text{ volts} \ldots\ldots\ldots(2)$$

In transformers with closed magnetic circuits, the E.M.F. induced in the primary winding is approximately equal to the difference between the E.M.F. applied and the drop in volts due to the resistance of the winding. It is also obvious that the values of E and f are generally fixed by the conditions of the supply, and from the efficiency point of view the value of B_{max} (which depends upon the capacity of the transformer, the frequency f and upon the volume of the iron core) is selected, so that the iron loss does not exceed 0·015 watt per cubic centimetre of the core. And since the same magnetic flux is interlinked with both the primary and secondary windings, the above formulæ may be applied to both windings, and the ratio between the number of primary turns and the number of secondary turns is approximately equal to the ratio between the (induced) primary and secondary voltages ; this ratio is known as the ratio of transformation, and

$$K = \frac{E_1}{E_2} = \frac{S_1}{S_2} = \frac{I_2}{I_1} \ldots\ldots\ldots(3)$$

Example 1.—An alternate current transformer has 200 turns in its secondary winding, and the induced E.M.F. is 102 volts, the frequency being 100 periods per second. Assume that B_{max} does not exceed 4,000 lines per square centimetre, and that 90% of the core is iron : (1) What is the cross-sectional area of the core, and (2) what is the E.M.F. applied to the primary, if there are 4,000 turns on the primary ?

Let A = gross cross-sectional area of the core

then $\frac{9}{10}$ A = net cross-sectional area of the iron, and by substitution we have

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$$102 = 4{\cdot}45 \times 100 \times (\tfrac{9}{10}A \times 4{,}000) \times 200 \times 10^{-8} \text{ volts.}$$

$$\therefore A = \frac{102 \times 10^8}{4{\cdot}45 \times 8 \times 10^6 \times 9} = 31{\cdot}835 \text{ sq. cms.}$$

$$\text{And since } \frac{E_1}{E_2} = \frac{S_1}{S_2}$$

$$E_1 = \frac{S_1}{S_2} \times E_2 = \frac{4000}{200} \times 102 = 2040 \text{ volts.}$$

Example 2.—In a certain transformer the ratio of the primary to the secondary turns is 20 : 1, and the output is 3·6 kw. at 100 volts at a power factor unity. If the efficiency is 90%, determine the primary pressure and current.

Since output = E_2I_2

$$3{\cdot}6 \times 1{,}000 = 100 \times I_2$$

$$\therefore I_2 = \frac{3{,}600}{100} = 36 \text{ amperes.}$$

and the primary current I_1 is

$$I_1 = \tfrac{1}{20} \times 36 = 1{\cdot}8 \text{ amperes.}$$

With an efficiency of 90%

$$\text{Input} = E_1I_1 = \frac{3{,}600}{0{\cdot}9} = 4{,}000 \text{ watts.}$$

$$\therefore E_1 = \frac{3{,}600}{1{\cdot}8 \times 0{\cdot}9} = 2{,}222 \text{ volts.}$$

During the process of conversion from high-pressure currents to low-pressure currents, or *vice-versa*, electrical energy is dissipated both in the copper and iron circuits. As regards the copper losses, the heat produced is proportional to the square of the currents and to the resistances of the windings, and

$$W_c = (I_1^2R_1 + I_2^2R_2) \text{ watts.}$$

and at full load $I_1^2R_1$ is approximately equal to $I_2^2R_2$.

The iron losses are due to hysteresis and eddy currents, and are independent of the load, being, in fact, constant from no load to full load. The hysteresis loss may be calculated from the formula

$$Wn = (\pi B_{max}^{1{\cdot}6} f \times \tfrac{1}{10^7} \times V) \text{ watts.}$$

where n is the coefficient of molecular magnetic friction, a good average value of n being 0·0024, and V is the volume in cubic centimetres of the iron core.

The eddy current loss is given by

$$W_e = V (f\, t\, B_{max}^2 \times 10^{-8})^2 \text{ watts.}$$

where t is the thickness of the iron plates in mils. The total iron loss is, therefore, given by

$$W_i = W_h + W_e = [\pi f B_{max}^{1{\cdot}6} \times 10^{-7} + f^2t^2B_{max}^2 \times 10^{-16}] \times V \text{ watts.}$$

Example 3.—A 1·5 kw. transformer, used to convert alternating currents from 2,000 volts to 200 volts, is known to have iron losses equal to 2½% of the full load output. The thickness of the plates is 20 mils., and the frequency of the currents supplied 50 periods per second. Determine the volume of the core of the transformer. Take B_{max} = 4,000.

Since output = 1·5 Kw = 1,500 watts

$$\text{the iron losses} = \frac{2{\cdot}5}{100} \times 1{,}500 = 37{\cdot}5 \text{ watts.}$$

$$\therefore 37{\cdot}5 = \text{Vol} \times \left[\frac{0{\cdot}0024 \times 50 \times 4{,}000^{1{\cdot}6}}{10^7} + \frac{50^2 \times 20^2 \times 4{,}000^2}{10^{16}}\right]$$

Let $x = 4{,}000^{1{\cdot}6}$

then $\log x = 1{\cdot}6 \log 4{,}000 = 1{\cdot}6 \times 3{\cdot}6021 = 5{\cdot}7634 = \log 580{,}000$

and $x = 580{,}000$

$$\therefore 37{\cdot}5 = \text{Vol} \times [0{\cdot}00696 + 0{\cdot}0016] = 0{\cdot}00856 \text{ Vol.}$$

$$\text{and Vol} = \frac{37{\cdot}5}{0{\cdot}00856} = 4{,}381 \text{ cu. centimetres.}$$

Example 4.—The total core loss in a transformer connected to a 500 volt supply at a frequency of 50 periods are found to be 300 watts, of which 70% is due to hysteresis, and 30% to eddy currents. Estimate what the total core losses would be if the transformer were connected to mains at 800 volts at a frequency of 100 periods.

On the 500 volt mains at a frequency of 50 periods—

hysteresis loss = 0·7 × 300 = 210 watts.

Eddy current loss = 300 − 21 = 90 watts.

Now, since $E = \sqrt{2}\,\pi\, f\, B_{max}\, AS\, 10^{-8}$, we have, as the value of the flux-density B^1_{max} when the transformer is connected to the 800 volt mains at a frequency of 100 periods.

$$\frac{800}{500} = \frac{\sqrt{2}\,\pi\, 100\, B^1_{max} AS\, 10^{-8}}{\sqrt{2}\,\pi\, 50\, B_{max} AS\, 10^{-8}}$$

$$\therefore B^1_{max} = \tfrac{8}{5} \times \tfrac{1}{2}\, B_{max} = \tfrac{8}{10}\, B_{max}$$

Consequently the hysteresis loss upon changing over will be given by

$$W_h = \frac{f^1 (B^1_{max})^{1{\cdot}6}}{f\, (B_{max})^{1{\cdot}6}} \times 210 = \frac{100}{50} \left(\frac{\tfrac{8}{10} B_{max}}{B_{max}}\right)^{1{\cdot}6} \times 210$$

$$= 2 \times 210 \times (\tfrac{8}{10})^{1{\cdot}6} = 2 \times 210 \times 0{\cdot}699 = 293{\cdot}6 \text{ watts.}$$

Similarly the eddy current loss upon changing over will be given by

$$W_e = \frac{(f^1)^2 \times (B^1_{max})^2}{(f)^2 \times (B_{max})^2} \times 90 = (\tfrac{100}{50})^2 \times (\tfrac{8}{10})^2 \times 90 = 230{\cdot}4 \text{ watts.}$$

$$\therefore \text{ total core loss} = 293{\cdot}6 + 230{\cdot}4 = 524 \text{ watts.}$$

An increase of 75%.

Example 5.—A 20 kw. transformer converts from 100 volts to 1,000 volts, and the copper losses are 1·5% of the output at full load. Determine the lengths and cross-sections of the primary and secondary windings, given that the current density in these windings is 150 amp. per sq. cm., and that the resistance of copper is 1·6 microhms per cm. cube.

Since output = 20 kw = E_2I_2

$$\therefore I_2 = \frac{2{,}000}{1{,}000} = 20 \text{ amperes}$$

and since current density is 150 amp. per sq. cm., the cross-sectional area of the secondary winding is

$$A_2 = \frac{20}{150} = 0.133 \text{ sq. cm.}$$

Similarly, since $I_1 = 10\, I_2 = 10 \times 20 = 200$ amperes, the cross-sectional area of the primary winding is

$$\therefore A_1 = \frac{200}{150} = 1{\cdot}33 \text{ sq. cm.}$$

The copper losses are $\frac{1{\cdot}5}{100} \times 20{,}000 = 300$ watts, and assuming that $I_1^2\, R_1 = I_2^2\, R_2$ we have

$$I_1^2\, R_1 = I_2^2\, R_2 = 150 \text{ watts.}$$

$$\therefore R_1 = \frac{150}{(200)^2} = 0{\cdot}00375 \text{ ohm.}$$

$$\text{but } R_1 = \frac{\sigma L_1}{A_1}$$

$$\therefore 0{\cdot}00375 = \frac{1{\cdot}6}{10^6} \times \frac{L_1}{1{\cdot}33}$$

$$\text{and } L_1 = \frac{1{\cdot}33 \times 3750}{1{\cdot}6} = 31{\cdot}17 \text{ metres.}$$

Similarly L_2 = 3117 metres.

(To be continued.)

ELECTRICITY IN THE COAL MINING INDUSTRY.*

Electricity is practically independent of distance. There is no other form of energy that is transmitted as efficiently and conveniently as electrical. The coal-cutting machine is no longer an experiment. A practical electrically-driven drill has been devised. Also a puncher, which can be operated either by direct or alternating current, has been manufactured, and is now operating on a commercial basis. Fans which the mine owners were originally afraid to drive by electricity are now replacing the steam-driven kind with their long and uneconomical and expensive steam line. We also have electrically-driven tipple machinery, and the electrically-driven pump in wet mines. Some of our most satisfactory box-car loaders are electrically driven, while at many plants the coke-drawing machines are also electrically operated.

The power house of to-day is rapidly evolving itself into

* Abstract of paper by F. C. Albrecht, Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., read before the West Virginia Coal Mining Institute.

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an alternating current proposition, becoming the central source of power for a number of mines. The difficulties that attended the initial introduction of alternating current have been largely eliminated, with the result that the polyphase system, which means either a two-phase or a three-phase system, of alternating current transmission—with its adaptability to large units and long distances—has proved itself a commercial success.

The modern switchboard will be equipped with its oil circuit breakers and oil switches, its various safety devices, together with meters, including volt-meters, ammeters, frequency meters, power-factor meters, etc. We must not forget our exciter set, consisting of a direct current compound-wound generator, usually wound for 125 volts and used for excitation of the generating units. This exciter set may be either engine or motor-driven. We also have transformers, which are used to raise the original generator voltage to the proper transmission voltage. In addition, there are installed lightning arresters, choke coils, disconnecting switches with their details, for protective apparatus, so that we now have our alternating current power house most complete.

Among the principal advantages of a central power station there is the great saving in copper, and also the maintenance of a steady-working voltage—especially where the workings are located considerable distances from the power house. The saving in copper more than balances in many instances the entire cost of the sub-station during the life of the equipment. In transmitting the power, alternating current is used. The main power house generally furnishes current at approximately 2,400 or 6,600 volts, although 3,300, 13,000, and other voltages are used. This current being for power service, should be a 25 cycle, 3,000 alternation, polyphase circuit, preferably three-phase. The current is transmitted from the power house to sub-stations, where it is transformed to a lower voltage, and then in turn by means of a rotary converter or a motor generator is transformed from alternating into direct current.

The lowering transformers are generally arranged to transform from 2,400 or 6,600 volts high tension to approximately 440 volts low tension. The approximate ratio of the alternating current to the direct current voltage is about 7 to 10. If the alternating current voltage on the rotary converter is approximately 160 volts, then the direct current voltage will be around 250 to 275 volts. Generally speaking, it is considered advisable to put in lowering transformers, even with motor generator sets, as that makes it safer for the operator. A further advantage is that the lowering transformers act as additional protective apparatus—having the high tension and low tension sides separated. This arrangement also has the additional feature that taps may be taken from the transformers to operate independent alternating current circuits. The sub-station equipment requires practically no attention, and is almost automatic, easily adjusting itself to the various loads and conditions. Sub-station equipment requires no special foundation and an anchorings. It is also true that the floor space required is considerably less than an engine and generator unit.

It is feasible to operate two circuits at a mine. Both alternating and direct current are used. The alternating current will operate the fans, crushers, tipple machinery, and pumps. Alternating currents have the additional advantage that any number of alternating current voltages may be obtained from the same generator, it being only necessary to use the proper transformer taps. The direct current will operate the locomotive and the direct current cutting machine. By this means, the operations are independent of each other. The sub-station, therefore, feeds both kinds of current simultaneously to the same mine.

As to mine locomotives, it is a better practice to have two 10-ton or two 13-ton, or even two 15-ton locomotives, which can be operated either separately or together in what is known as a "tandem arrangement," than to have a locomotive of 20-ton capacity or more. Too heavy a locomotive means heavy iron for the track, and such an engine is often unwieldly and inefficient.

There are also the reel and the gathering locomotives. This latter type, known as the "traction reel" or "crab type," does not go into the room at all, but a wire cable of from three-eighths of an inch to five-eighths of an inch thick and about 500 ft. long, is easily pulled in the room and fastened to the loaded car, which is then pulled out by means of a separate motor with its equipment of controller, resistances, hose and wire and other details. Both of the gathering types of locomotives are now being built so as to use one of the main hauling motors of the locomotive for gathering also.

As regards the cost of operating with electric haulage, it is obviously difficult to give exact figures which will apply in all cases, but it has already been pointed out that electrical haulage is cheaper than animal haulage. The life of the locomotive in the first place is longer than that of the mule, there being locomotives to-day in actual service which were installed 10 or 12 years ago. Against this, two or three years is the average life of a mule. The lengths of the haul and speeds required are also in favour of the locomotive.

The motors used for the operation of fans must be perfectly reliable, as on the successful operation of these depend the lives and efficiency of the men underground.

As regards the form of drive for fans, that is, whether the fan should be geared or belted or chain-driven, that should be carefully studied in each instance. Where there is a great fluctuation in voltage, either a belted or chain drive is desirable. If floor space is an item, then between these two the chain drive is the proper one. If the voltage is constant and good regulation secured, then a geared fan is proper. Coupled fans can also be seriously considered, and these are in actual operation. Variations in speed can be obtained by either variable-speed motors, or, in the case of belted machines, different pulley combinations can be used.

As regards the direct-current voltage in the mine itself, there has been, and still is, considerable discussion. Many are of the opinion that the voltage should not exceed 275 or 300 volts. On the other hand, there are just as many, if not more, who consider 550 to 600 volts not excessive. Certainly there is no getting away from the fact that with the higher voltage, there is a great saving in copper, and also that in most cases a better working voltage will be maintained. Looking at the question from the standpoint of safety, it is true the higher voltage is more likely to kill a man than the lower. But the point is to keep away from the wire. Especially in high coal this should easily be arranged. In many instances the trolley wire can be placed from 5 to 7 ft. above the rail, and should always be placed from 4 to 8 in. to the outside of the rail. With ordinary precaution this should be entirely safe. Where the coal is low, it might then be considered proper to put in the lower voltage, although it is by no means considered absolutely necessary.

It has been pointed out at various times by some operators that they consider the higher voltage safer than the lower. Their argument is that with the lower voltage the men get familiar and careless. On the other hand, they have considerable respect for the higher voltage, and are more careful and have fewer accidents. Local conditions will largely determine what voltage should be installed.

No matter whether 250, 275 or 550 volts is used, the conductor should be bare, uninsulated wire. Insulated wires in a mine are treacherous. The insulation will not last in a mine more than six months or a year at most. It deteriorates rapidly, and becomes a menace instead of an additional safeguard.

A system of wiring that meets with much favour where conditions will permit is the three-wire system. By this means 550 volts can be taken from the generator or rotary converter and divided in half, using two circuits of 275 volts each.

The three-wire system was originally introduced in order that a saving in copper might be obtained. The system has become in general use for both lighting and power distribution. It permits of a saving of 25% in copper in the feeder, when figured on a basis of current capacity; or a saving of 62% when figured on a basis of drop of potential, when the neutral wire is considered as equal in size to one of the outside wires.

Three-wire generators may be operated in parallel with each other, or in parallel with two-wire generators if required. By means of the three-wire system, it is possible to use the higher voltage; that is, 550 volts, for the stationary motors, such as pump motors, and 275 volts for the locomotives, considering the track as the neutral and return.

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CONTENTS.

	PAGE
Notes	565
American Electric Railway Scheme	566
Electrification of the Ferndale Collieries	567
Transformer Notes and Calculations	574
Electrification of Swiss Railways	577
Correspondence	578
Heat Transmission	578
Types of Transformers	581
Electricity from Refuse	583
Tasmanian Hydro-Electric Scheme	586
Electrical Energy in Factories	586
Concession for Electrical Shipments	586
H.M.S. "Collingwood's" Electrical Equipment	587
"Model Engineer" Exhibition	589
Wireless Telegraphy for Multiplex Working	590
Electric Fan Regulators	590
Publications	591
Books Received	591
Reviews	591
Diary of Events	591
Electric Organ Blowing Equipments	592
Secrecy by Radio-Telegraphy	592
American Notes	593
Tyneside Notes	593
Lancashire Notes	594
Underground Cable System	594
Companies' Meetings and Reports	595
Contracts Open	595
Lighting and General Notes	596
Traction Notes	597
East London Electrical Exhibition	597
Personal	598
Royal Commission on Mines and Electricity	599
Radiotelegraphic Stations	599
Electrical Actions in the Law Courts	599
Law Cases	599
Some Contracts	599
Bremer Arc Lamp Case	599
Patents	600
Companies' Stock and Share List	603

ELECTRIFICATION OF SWISS RAILWAYS.

Switzerland has shown wonderful enterprise in establishing electrical railways, the Federal Government doing everything possible to promote the movement short of giving direct subsidies. Having the goodwill of the central authorities there never seems to have been any difficulty in financing the schemes, thanks largely to two great organizations, the Swiss Railway Bank, now a branch of the Switzer Bankverein, and the Société Franco-Suisse pour l'Industrie Electrique of Geneva. According to the latest returns available, £4,160,000 are invested in these railways. All the undertakings are of a hydro-electric character. A still more formidable development is now contemplated. Six years ago the Federal Government appointed a Commission to study the question of electrification for the Government railways. The Commission consists of thirty-three members representing the Government Railways Department, electrical engineers, the electrical industry, railway companies, and financial interests. The Commission has been working by means of four sub-commissions, each such sub-commission having salaried expert associate-members. The first sub-commission's duty has been to study the general conditions: (1) length of lines, depots, gradients, permanent way, rolling stock; (2) administration: length of trains, time table, weight and character of rolling stock; (3) H.P. required to operate the Federal railways. The second sub-commission has been making a comparative study of different systems of electrification, both from the technical and financial sides, and with a view to arrive at a decision have visited many countries in Europe and have also been to the United States. The third has been engaged with the hydraulic question, ascertaining the total amount of water power still available in Switzerland,

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its distribution, economical exploitation, and the cost of generating electricity to the total H.P. required as determined by the first sub-commission. The fourth is practically the plenary body, its duty being to study the reports of the other sub-commissions and then elaborate complete schemes, showing applicability of electric traction, economic advantages and cost.

Practically the work is complete for the finishing touches to the final report, which is expected to be ready shortly. Meanwhile, Monsieur Wyssling, the general secretary of the Commission, has given publicity to certain facts and figures which are of great interest. He estimated that as regards electricity, 1,200,000 H.P. hours will be required, the turbines will have to generate 3,000,000 H.P hours, or 125,000 H.P. per 24 hours (although only 100,000 H.P. will be required in the slack season of winter). The water power still available largely surpasses this requirement of 125,000 per day, but its distribution presents considerable difficulties, for it is doubtful that the whole of it can be utilised economically. Two lines of research have, therefore, been undertaken: (1) on the one hand to see how far the power demanded can be reduced while maintaining efficiency and sufficient elasticity for future growth; (2) on the other, to see whether, by choosing chiefly high falls these will not suffice with the aid of accumulators. This seems to be the best solution, because it must be remembered that while the general average of power required is put at 125,000 H.P., and the winter average at 100,000 H.P., it is calculated that the maximum to be provided for is five times the minimum, or 500,000 H.P., and it is for such a power that the generating stations, lines and distribution, etc., have been planned. Whether economies could not be effected by co-operation, if not amalgamation, of the non-state lines, does not seem to have been considered so far. It appears that the system likely to be adopted is the single phase with low periodicity, at least for the main lines, though for the branch lines with steep gradients poliphase continuous current may be used. It is interesting to state that the Federal Railway Department has recently issued a rule that the periodicity of single-phase current for railways is to be 15, though where the power is taken from stations generating at between 40 and 50, some latitude is allowed, the minimum being 13·13 periods and the maximum 16·6. Doubt is still expressed concerning the equipment of generating stations, both as regards the hydraulic and the electrical plant. There has, indeed, been a rumour that some, at least, of the generating stations may not be hydraulic after all. But this seems extremely unlikely, for the water power is there abundantly and only requires skill in economical manipulation. The great charm of electrification to the Swiss is that it would free them from the necessity of expending large sums abroad for coal. The final report of the Commission will be awaited with interest, as this scheme for the electrification of a whole national system of railways is one of international, indeed, world-wide importance, owing to the lessons it may afford the scientific student and the practical engineer.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "THE EDITOR, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

LIGHTNING CONDUCTORS.

Sir,—When the Lightning Research Committee published its report in 1905, the Secretary sent me a copy, which I may regard as official, and I have since purchased copies to ascertain whether any amendments had been made later. I can assure "A. W. P." that I have read these very carefully, and it is very obvious that he has not, for the "rules" are not numbered, there is no "*see* Fig. 6" after the tenth or any other rule, nor are there any illustrations; and the very definite pronouncement as to "the old method which is condemned"—to which he attaches such importance—does not appear in the Report.

It is also obvious that he has been reading in Mr. Killingworth Hedges' book, "Modern Lightning Conductors," which purports to be the Committee's Report, but contains, over the signatures of the members, added matter that is not in the official report! It is to a portion of this added matter that "A. W. P." refers! It would be of interest to know how Mr. Hedges came to publish these additions without an explanatory note to justify their inclusion.

The fact that "A. W. P." has evidently been led to place a wrong construction on the effect of bends suggests the possibility that other electricians who hold *similar* views owe them, directly or indirectly, to the same source: and, if so, this explains what had been a rather puzzling feature to me. I am, therefore, glad that his letter has enabled me to draw attention to what appears to be a grave matter. The inaccuracies of the original Report are serious enough, but if we are to be favoured with other versions liable to still further disturb the public mind, scientific knowledge on this subject, already far from as clear generally as it should be, is not likely to be advanced.

I did not think that anyone now regarded the Report of the Lightning Research Committee as highly authoritative; but as you gave me a considerable space in your columns in May and June, 1905, for comments on the subject, I feel I have no right to ask you to let me trespass still further.

Yours, etc.,
ALFRED HANDS.

SIR,—"A. W. P." founds his remarks simply on the Report of the Lightning Research Committee, so it may be concluded he is not acquainted with the subject, or that Report would not be his *vade mecum*.

Hillside, Sparkhill, Birmingham. W. DALBY.

HEAT TRANSMISSION.*

By PROFESSOR W. E. DALBY, M.I.Mech.E., of London.

Transmission by conduction and convection is generally held to be conditioned by the fact that at the boundary of the hot gases in the fire-box and flues there is clinging to the plates a thin film of gas, in which convection currents do not apparently take place and which offers a high resistance to the passage of the heat other than radiant heat, since the heat can pass across the film by conduction only. There is a similar film of water on the water side of the plate, though the resistance to the passage of heat through it is considerably smaller.

Starting from a point in the interior of the mass of gas in the fire-box, the path of the heat flow to a point in the

* Abstract of paper read before the Institution of Mechanical Engineers.

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interior of the mass of water may be considered as made up of the following parts :—

1. The gaseous part of the path from the starting point to the gas film clinging to the plates.
2. The gas film itself.
3. The surface of contact between the plate and the gas.
4. The part of the path through the metallic plate.
5. The surface of contact between the plate and the water.
6. The water film.
7. The water from the film to the point in the mass of water.

If the plate be dirty, there must be added a layer of sooty deposit on the gas side and a layer of scale on the water side, on which there may be in some cases a deposit of oily matter. The method of transmission along this path differs in the different elements. Thus, starting from the assumed point in the mass of hot gas, the heat is carried to the boundary by a movement of the hot particles of the gas, caused partly by convection currents and partly by currents caused by the draught. Conduction plays a negligible part in transferring the heat along this element of the path. Transference across the bounding gas film, through the metal of the heating surface and across the water film, takes place by conduction, after which the heat is carried to the interior of the water mass mainly by convection.

So far as transmission is concerned, the part of the path which requires special consideration is the metallic plate with its film coatings. Transmission of heat along this path may be likened to a flow of electricity through a circuit made up of the elements of different resistances. The potential difference, which causes the current to flow along against the resistance of the elements of an electric circuit may be compared to the differences of temperature along the elements of a heat circuit. Just as it requires a large potential difference to force a current of electricity through a small element of circuit of high resistance, so it requires a large temperature difference to force heat to flow along a small element of path offering a great resistance. Difference of temperature may be regarded also as a "temperature head," by analogy with the flow of water ; with known data the temperature head could be plotted in a diagram.

It must be confessed that notwithstanding the large number of researches and papers bearing on the subject of heat transmission there is a general absence of complete data regarding the actual phenomena occurring in a steam-boiler when working under the ordinary conditions of practice. No data exists, for instance, which gives the temperature gradients at different parts of a boiler flue with accuracy ; isolated experiments furnish incomplete data from which the gradient may be roughly imagined, but researches and papers alike have had very little influence in modifying the general design of steam-boilers. The Cornish boiler is still of the same design as it was a century ago. The Lancashire boiler has been scarcely modified in any essential particular. The locomotive boiler of to-day is a magnified type of the Rocket boiler. The most important development of recent years has been in the gradual introduction and perfecting of the water-tube type, but even in this modern product the essential features of the old types persist. This general absence of complete data is in no way due to the lack of endeavour or to the dearth of able and distinguished men in this field of research, but rather to the inherent difficulties of the problem and to the enormous cost of carrying out complete experiments upon a large boiler under ordinary working conditions. Many valuable experiments on boilers have been made of the kind which have been made classical in the published researches and experiments of Kennedy and Donkin, but these experiments are incomplete in the sense that the temperature distribution in the apparatus was not one of the objects of the experiments. We can all appreciate the formidable difficulties which surround this kind of investigation, when we think of the enormous rate at which hot gases give up their heat. As an example, in 1884 some experiments were made on the Orleans Railway [Abstract 352] with a locomotive boiler. The temperature in the fire-box was 2,912° F., and in the smoke-box 752° F., corresponding to a drop of temperature of 2,160° F. along a tube length of 16·4 feet. The velocity of the gases was 164 feet per second, so that the gases traversed the tubes in $\frac{1}{10}$ of a second, and the heating surface therefore was sufficiently efficient to cause this large drop of temperature, namely, 2,160° in $\frac{1}{10}$ second. The costly nature of the experiments may be gathered from a recently published set made by the Steam Engineering Division of the Technological Branch of the United States Geological Survey, an abstract of which is given in the Journal of the Western Society of Engineers, U.S.A., vol. 12, pp. 285 and 661, 1907. These experiments cost 100,000 dollars, and cover a large part of the field of research in connection with this subject. Some of them were made on small multitubular boilers, heated electrically. It may be desirable to give here a brief account of the experiments. Stefan's law was used to calculate the proportion of heat transmitted by radiation, and the transmission by conduction and convection was assumed to vary as the difference of temperature. Groups of from 15 to 30 tests were made under constant conditions, the groups forming a series in which the conditions of working were varied for each group. The effect of varying the initial temperature and the flue dimensions was studied together with the relation between the velocity of the air passing over the heating surface and the rate of heat transmission. The results show—

(1) That the heat absorbed by the boiler varies almost directly as the calculated velocity of the air.
(2) That the rate of heat absorption does not rise as fast as the initial temperature.

The curves given show that as the velocity of the air increases the true boiler efficiency of the boiler drops at first very rapidly, but after a certain velocity is reached it becomes nearly constant with a low initial temperature, and varies little with a higher initial temperature. The velocity at which for any initial temperature the true boiler efficiency curve becomes nearly horizontal is called the critical velocity, and the critical velocity varies with the initial temperature. These experiments are well worth careful study.

The most complete set of experiments made on a locomotive boiler is that recently conducted by Professor Goss, and published by the Carnegie Institute of Washington in 1907. The boiler was of the usual American type belonging to a 4-4-0 engine, and contained 1,322 square feet of heating surface. Ninety-seven individual experiments were made, divided into six groups, the boiler pressure being maintained constant in each group, and ranging from 120 to 240 pounds per square inch. In each group the cut-off of steam in the cylinder was varied. The records furnish a mine of exact information concerning the working of a locomotive boiler from the practical point of view.

Professor Nicholson, in a Paper before the Junior Engineers records and discusses some experiments he has made in connection with a Cornish boiler which lead him to recommend radical changes in boiler design.

In none of these recent experiments, however, has any attempt been made to measure directly the temperature gradient.

Considering the mass of work which has already been done, the century of accumulated practical experience in the design, construction, and working of steam boilers, the numbers of able engineers who have devoted their attention to boiler construction and design, and the distinguished men who to-day control and influence the industry, it would almost seem that present practice represents the survival of the fittest and that there is hardly a necessity for further research. But recent years have been fruitful in researches in other directions, and Professor Callendar, by his brilliant work in platinum thermometry, has placed at the disposal of engineers a practical way of measuring temperatures unknown to early experimenters. We have now a means of accurately measuring the temperatures at different parts of a boiler directly. The author ventures to suggest, therefore, that a research might be undertaken by the Institution in which steam boilers of different types working under practical conditions may be made the subject of experiments in which all the elements of their working are measured, together with temperature measurements for the purpose of establishing the temperature gradients at different parts of the heating surface. Such a research would be very costly, but would be well worthy of the Institution.

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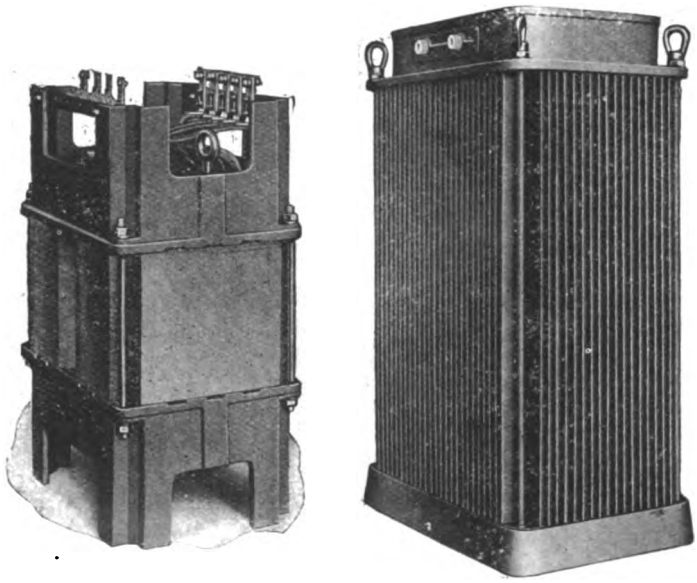

Westinghouse Oil-insulated self-cooled single-phase Transformer (Type PD), one of seven 190 K.V.A. 25 ∽ Transformers for Glasgow Corporation.

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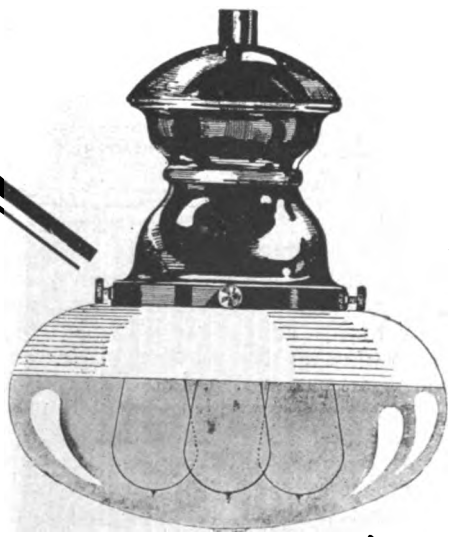

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

TYPES OF TRANSFORMERS.

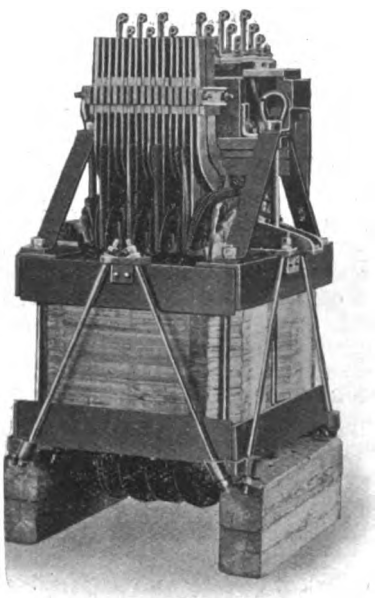
In another column will be found the first of a series of three articles entitled "Transformer Notes and Calculations." Although written mainly for students, the notes and formulæ will be found of use to a far wider circle. The problems touched upon are those which call for solution in actual practice under varying circumstances. In order to add to the value of these "Notes and Calculations," we give below a few brief particulars of the leading types of transformers, adapted for different purposes.

THE BRITISH WESTINGHOUSE.

Quite a number of types of transformers have been developed by the British Westinghouse Electric and Manufacturing Co., Ltd., London and Manchester. One of the accompanying illustrations shows a Westinghouse special heavy current Transformer for furnace work. It is designed for 1,200 k.v.a. 50 periods and 5,000 volts primary voltage. The secondary voltage can be regulated between 30 and 50 volts by means of taps on the high tension side and the arrangement is made such that the full output can be obtained at all these voltages. The secondary current is from 40,000 to 24,000 amperes. The low tension winding consists of 8 coils, each of one turn, which are all connected in parallel with each other. At the average voltage (40 volts 30,000 amps.) the efficiency is 98·3% and the short circuit losses (1·05%) are only 23% larger than the copper losses calculated from their resistance of the primary and the secondary winding.

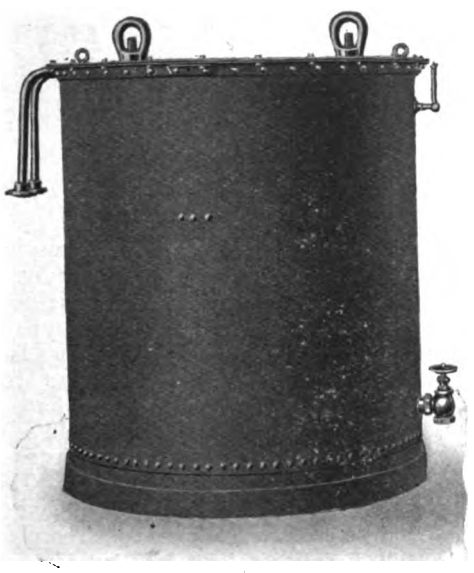
The above figures are for the transformers being hot.

In actual working the eddy losses will be still smaller than obtained from the short circuit test as all low tension coils are separately connected to the terminals of the furnace by copper bars. The arrangement is made so that the reactance and the resistance of the copper bars are as similar as possible. The transformer is cooled by means of a cooling coil in the upper part of the transformer tank through which water is circulated. The cooling coil inside the tank has only welded joints. The especially solid construction of the transformer body and of the case was chosen to enable the transformer to be shipped, erected and connected up in its own case. The transformer as packed in this manner had a long sea voyage and several re-shipments without suffering any damage. The Westinghouse Co. have built quite a number of these transformers with different cooling arrangements.



Transformer for Furnace Work.

The Westinghouse oil-insulated self-cooling three-phase Transformers are designed to operate on circuits of any frequency and all voltages for sizes up to about 1,500 k.v.a. or voltages up to 7,000; they are made in numerous standard sizes ranging from 5 to 100 k.v.a. of the type shown below.



Transformer for Furnace Work.

Oil-insulated Self-cooling Three-phase Transformer.

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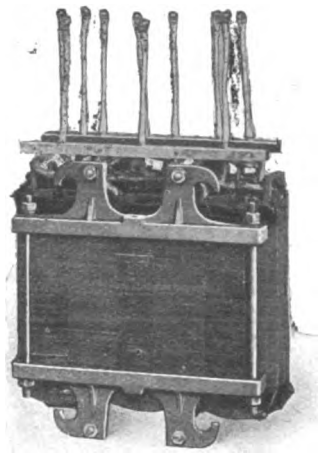


Oil-insulated Self-cooling Three-phase Transformer.

The transformer is of the core type and is entirely immersed in oil. The containing tank, which is fitted with a drain plug, consists of a corrugated sheet-iron case supported by a cast-iron base and surmounted by a cast-iron top. The corrugations provide a very effective cooling surface, and the combination of the cast-iron mountings and sheet-iron body results in construction of great strength and lightness.

BRUSH ELECTRICAL ENGINEERING CO.

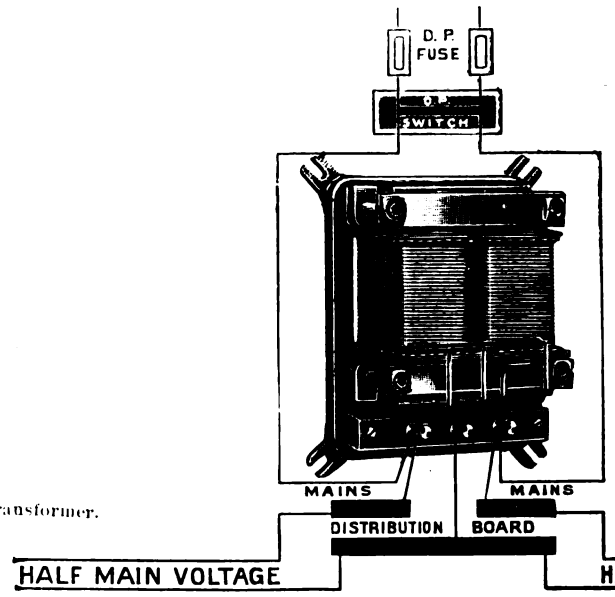
A very high grade of core transformer is being made by the Brush Electrical Engineering Co. The Brush transformer is manufactured in both single and three-phase types. The primary and secondary coils are each wound independently on formers. The high tension winding is divided into several coils to keep down the voltage between layers and reduce risk of breakdown. Each coil is separately taped up with oiled linen. The insulation between primary and secondary, and between secondary and iron consists of tubes of special material. This method of winding and insulating is calculated to result in a much lower space factor than in the older types, but it is really most practical and economical. Over the iron core is slipped a tube of insulation on which the secondary coil is wound. Then over the secondary coil is slipped another tube of insulation, and over this are slipped the various primary coils, which are then connected up in series.

BIRCH BROS.

The Birch Transformer merits attention as one of the best and lowest priced on the market. Scientifically designed and of high-class workmanship, it is of the core type, air cooled, with protected terminals, and has a guaranteed efficiency.

It is simple, strong, economical, reliable, perfectly insulated, and absolutely silent. The dimensions of the Birch Transformer are moderate and the apparatus is of long life.

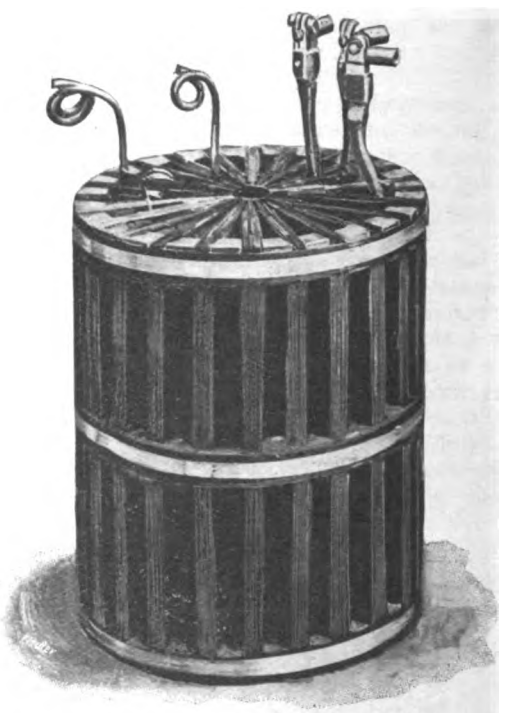
It has protected terminals, low hysterisis losses, low copper losses, low eddy current losses, short magnetic circuit, small magnetic leakage, and small magnetising current, combined with high permeability of core, good voltage regulation, on inductive and non-inductive loads. **Messrs. Birch Bros. (3, Brunswick-place, Leeds), make transformers in watertight and other cases for working in conjunction with arc lamps for street lighting and other purposes.**



Connections for Two Circuit Balancer Birch Transformer, cover removed.

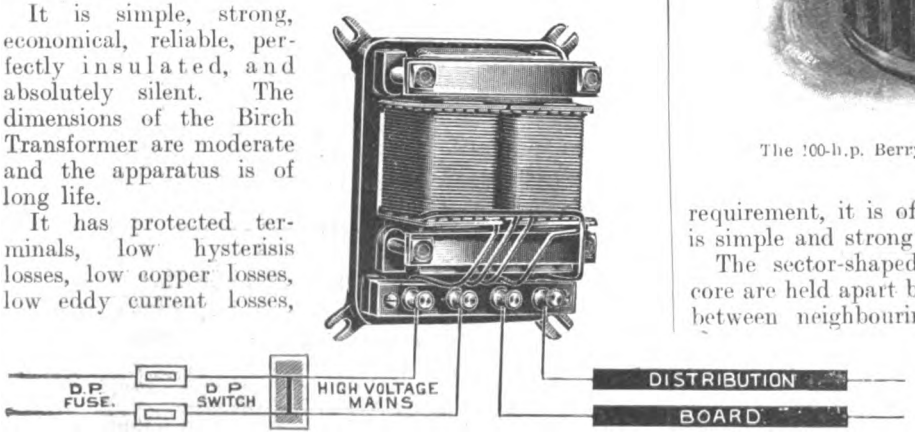
THE BRITISH ELECTRIC TRANSFORMER CO., LTD.

The "Berry" Transformers manufactured by the British Electric Transformer Co., Ltd., continues to be in high favour. The firm specialize in transformers and their shops at Hayes are among the most up-to-date in existence. The Berry Transformer embodies the improvements suggested by long experience of its manufacture at home and abroad. Easily adapted to meet any special requirement, it is offered at a comparatively low cost; it is simple and strong and secures a safe supply.



The 100-h.p. Berry Transformer Single-phase Iron-clad.

The sector-shaped bundles of iron-plate forming the core are held apart by wedge-shaped spacing blocks placed between neighbouring sections. Steel bands or wires passing completely round the transformers, immediately over the spacing blocks, hold all together in an arch-like construction that is perfectly rigid. This "iron-clad" arrangement gives complete protection against mechanical drainage. The plant is built by highly skilled workmen, and only time-tested material is used.



Connections for Single Circuit Birch Transformer without cover.

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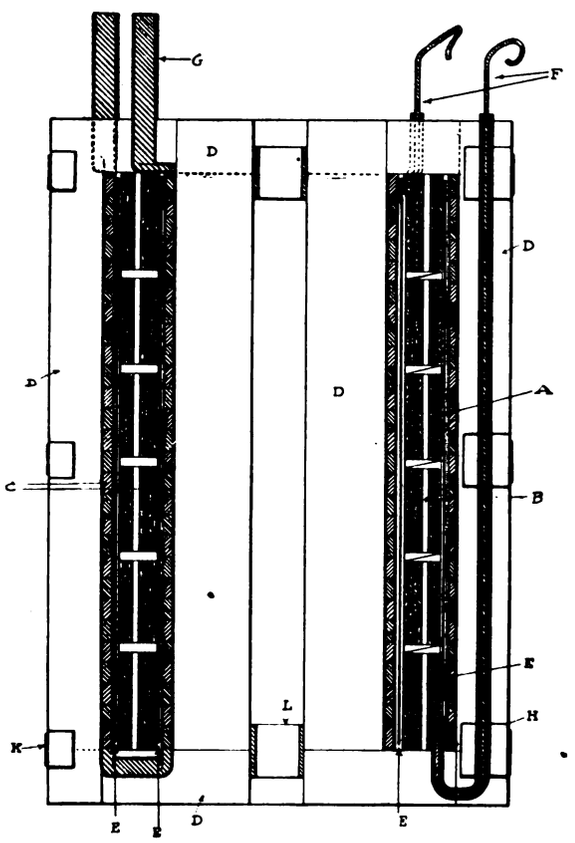
The Berry Transformer is actually a radiator—vertical ventilating ducts are uniformly disposed through the copper and sub-divided iron circuits, so that the cooling area is enormous. Whether the transformers are used with air-cooling or oil these ventilating channels are of the utmost



A	PRIMARY COILS TOGETHER WOUND IN SECTIONS
B	AIR SPACES IN SAME
C	SECONDARY COILS WOUND ON CORE
D	IRON CIRCUIT
E	EARTH SHIELD
F	PRIMARY INSULATED LEADS
G	SECONDARY CONNECTIONS
H	SPACING BLOCKS
K	STEEL BANDS
L	CORE RINGS

Vertical Section of Berry Transformer.

value in permitting the maximum duty to be obtained from each pound of active material. It has the advantage of being able to work at high temperatures in emergency, and moreover is valuable "alive" and intrinsically "valuable" even after years of use.

LAHMEYER ELECTRICAL CO.

The Lahmeyer Electrical Co., Ltd., also make a special feature of transformers. The firm have a world-wide reputation for single and three-phase transformers for all voltages and capacities. These transformers are either cooled naturally by ventilation, or artificially by oil or oil and water. They are of the core type, a type in which the iron, for the most part, is enveloped in the surrounding winding. The single-phase ventilated transformers have two and the three-phase transformers three vertical cores. The cores are built up of exceedingly thin metal stampings coated with paper.

These stampings are of such dimensions as to reduce the production of eddy currents in their mass to a minimum. The parts of the transformer holding the stampings together and their insulation are so arranged as to avoid additional loss. The cores are yoked at both ends, top and bottom, thus forming a closed circuit. Each core is provided with primary and secondary windings lying concentrically one above the other. The single and three-phase transformers are constructed normally for one secondary voltage only, but alternating current transformers can be built with secondary windings connected with terminals so arranged that the windings may be placed in parallel or in series with one another, whereby the transformer may be used for two secondary voltages. The oil immersed and the oil-cooled transformers are also of the core-type construction. The great advantage of the oil-immersed transformer is its capability of dealing with overloads. Another important point is that the oil-immersed windings of the transformer are protected from the oxidizing effect of the air and that their insulation therefore cannot become brittle. High efficiency, small "iron loss," small drop in potential, are outstanding features of the Lahmeyer transformers.

ELECTRICITY FROM REFUSE.

The work of installing a new destructor in connection with the electric light station at Melbourne, Australia, has now been completed. The contractors for the work were the Horsfall Destructor Co., the amount of their tender £17,000. The building adjoins the electric light station, at the corner of Spencer and Lonsdale-streets. It is a substantial brick structure, the main bay being 134 ft. long by 37 ft. wide and 45 ft. high; whilst the boiler house is 84 ft. long by 20 feet wide and 23 ft. high. In describing the installation, the *Australian Mining and Engineering Review* says the destructor consists of six large cells and combustion chambers, with three water tube boilers, arranged so that each pair of cells with its boilers can be worked independently. This arrangement of independent "units" permits of a section of the plant being shut down for repairs or cleaning without interfering with the working of any other unit. By firing the two cells of each unit alternately, a steady steam pressure is maintained in the boiler, while the combustion chamber is also kept at a sufficiently high temperature to thoroughly cremate the noxious gases which escape from the newly-charged refuse. Although six cells have been installed, it is thought that four cells will be ample to do all the work at present required, but the third pair will serve as a stand-by, and also allow for the expansion of the city.

The furnace grates, which slope from back to front, have each an area of 25 sq. ft., and are constructed to efficiently burn 135 cub. ft. of refuse at one charge. The grate bars are perforated with a large number of small holes, and a high pressure blast is forced through these by means of electrically-driven fans. It is generally recognised that, to ensure a complete combustion of colonial refuse in destructor furnaces, an air-blast system is the best, but hitherto the blast has been delivered at comparatively low pressure. The grates and fans are constructed for a specially high pressure, and are fully expected to show a distinct gain in efficiency over the older system. The Sirocco fans, of which there are three, are coupled direct to British Thomson-Houston variable speed motors of the totally enclosed type. The starting and regulating switches are fixed conveniently near the fans, and immediately under control of the workmen. The refuse is delivered to the furnaces without handling of any kind, and, while effecting a saving in the cost of labour, ensures a degree of cleanliness which is truly remarkable, having regard to the nature of the material dealt with. For the treatment of the residual clinker, an electrically-driven crushing and screening plant has been installed in close proximity to the destructor house, and is so arranged that the various grades of clinker can be delivered into carts instantly and without any handling.

CATALOGUES AND LISTS.

From the General Electric Co., Ltd., comes their latest list, describing and illustrating shop lighting fittings, including lanterns, reflectors and advertising signs.

OBITUARY.

MR. P. A. JONES.

The death took place at Perth of Mr. P. A. Jones, Superintendent and Acting Manager of the Perth Electric Tramways Co., and inventor of the water jet for cleaning tram rails.

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ADAMS FOR ALL PURPOSES

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CONTRACTS.

COUNTY OF LONDON.

The LONDON COUNTY COUNCIL invites tenders for an installation of electric lighting at the Buxton Street Elementary School, Whitechapel, now in course of erection.

Full particulars, and also information as to the conditions to be observed by tenderers, will be given in the London County Council *Gazette* of October 25th, 1909. The *Gazette*, which is published weekly, contains particulars of all the tenders invited by the Council, and can be obtained from Messrs. P. S. King & Sons, 2 and 4, Great Smith-street, Westminster, S.W., price 1d., post free 1½d. an issue, or for the whole year a prepaid subscription of 6s. 6d.

Tenders must be upon the official forms, to be obtained from the Chief Engineer of the Council, Mr. Maurice Fitzmaurice, C.M.G., at the County Hall, Spring Gardens, S.W., on and after October 25th, upon payment to the Cashier of the Council of the sum of £1 for the specification, etc. This deposit fee will only be returned if a *bona fide* tender is submitted. No tender received after 11 a.m. on NOVEMBER 3rd, 1909, will be considered.

The Council does not bind itself to accept the lowest or any tender, and it will not accept the tender of any person or firm who shall on any previous occasion have withdrawn a tender after the same had been opened, unless the reasons for the withdrawal were satisfactory to the Council.

G. L. GOMME,
Clerk of the London County Council.

County Hall, Spring Gardens, S.W.
October 19th, 1909.

COUNTY OF SOUTHAMPTON.

NEW OFFICES, ST. JAMES' STREET, WINCHESTER.

To Electrical Engineers.

PERSONS desirous of Tendering for the INSTALLATION of ELECTRIC LIGHT at the above Building may, on deposit of £2 2s. see Plans, Specification, and General Conditions of Contract, and obtain all other information at the Office of Mr. W. J. Taylor, County Surveyor, The Castle, Winchester, on and after Monday, the 18th October, 1909, between the hours of nine a.m. and 5 p.m. (Saturdays nine a.m. and one p.m.).

No information will be sent by post.

A copy of the plans will be handed to Contractors.

All deposits must be by cheque, made payable to HANTS COUNTY COUNCIL and crossed BANK OF ENGLAND.

Tenders, on forms to be obtained from the County Surveyor, are to be endorsed "New Offices, Electric Wiring," and delivered to me not later than ten a.m. on Monday, the 25th October, 1909.

The County Council do not bind themselves to accept the lowest or any Tender.

H. BARBER,
Clerk of the County Council.

The Castle, Winchester.
14th October, 1909

INSTALLATION WANTED.

By a Large Firm in Yorkshire,

QUOTATIONS FOR THE INSTALLATION OF ELECTRICAL DRIVING

all through their Works.

Anyone applying for this work must be prepared to quote for the Plant on loan for a five or seven years' lease, with a penalty for stoppage.

Apply, Box 41a, c/o. THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

PATENTS.

THE PROPRIETOR OF LETTERS PATENT No. 27,449, of 1904, relating to "Method and Apparatus for Electrostatic Separation," desires to dispose of the Patent or to grant licences to interested parties on reasonable terms, with a view to the adequate working of the Patent in this country. Enquiries to be addressed to—CRUIKSHANK & FAIRWEATHER LTD., International Patent Agency, 65-66, Chancery-lane, London, W.C.

THE PROPRIETOR of the PATENT No. 21,181, of 1905, for "Improvements relating to Electrical Measuring Instruments," is desirous of entering into arrangements by way of licence, and otherwise, on reasonable terms for the purpose of exploiting the same, and ensuring its full development and practical working in this country.

All communications should be addressed in the first instance to:—

HASELTINE, LAKE & CO.,
Chartered Patent Agents and Consulting Engineers,
7 and 8, Southampt n-buildings,
Chancery-lane,
LONDON, W.C.

INVENTIONS: CAPITAL REQUIRED.

M.INST.E.E. REQUIRES FINANCIAL ASSISTANCE TO START MANUFACTURE OF ENTIRELY NOVEL LINE OF SMALL MOTORS; to be made in large quantities like cycle parts. Difficulty of winding for 220 and 400 volts overcome. Can be placed on market at about half present prices. New types of small starters. Resistance units and Magnetos can also be made. A financial man with some technical training preferred. —Apply to "GAMMA RHO," c/o THE ELECTRICAL ENGINEER Offices, 149, Fleet Street, London, E.C.

THE PROPRIETOR of the PATENT No., 29363 of 1904, for "Improvements in and relating to Electrical Measuring Instruments," is desirous of entering into arrangements by way of license, and otherwise, on reasonable terms for the purpose of exploiting the same, and ensuring its full development and practical working in this country.

All communications should be addressed in the first instance to HASELTINE, LAKE & CO., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

J. G. WHITE & Co., Ld., Electrical Engineers & Contractors

9, Cloak Lane, Queen Street, E.C.

See advertisement on front cover last and next week.

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WANTED for High Tension Electric Plant, at large mine South Europe. Healthy climate, one Central station attendant, and one assistant to look after outside plant, motors, etc. Age 25 to 35, single preferred. Address, stating full particulars of past experience and salary expected to "C.P.P.," c/o Streets, 30, Cornhill, E.C.

LAMP Exhauster Wanted; good berth for suitable man.—Box No. 1, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

EMPLOYMENT WANTED.

ELECTRICIAN.—Speciality—Armature Winding.—Box 10, c/o THE ELECTRICAL ENGINEER, 149, Fleet Street, E.C.

CONSTRUCTIONAL FOREMAN. Telegraph and Telephone fittings in all its branches. Home or Abroad.—Box P, c/o THE ELECTRICAL ENGINEER, 149, Fleet Street, E.C.

SWITCHBOARD Attendant, junior; five years with City of London and L.C.C. Generating Station.—Box A, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

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SALESMAN or Traveller.—Advertiser, experienced in Electrical, Mechanical, Power-house and Sub-Station work, desires post in any capacity.—Box C, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

FOREMAN.—Experienced in charge of Bitumen Department; own mixings; refs.—Box D, c/o THE ELECTRICAL ENGINEER.

FITTER.—(Englishman), age 27; experienced in repair and construction of Dynamo and Motor parts, Power-board work, Resistances Electric Light fittings, and Railway work. Can speak Spanish and French fluently.—Box E, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

POWER Station Assistant, or Electrician on private estate; experienced in Water Turbine Installation, Gas, Oil and Petrol Engines, and test-room in instrument-makers' factory.—Box F, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

SWITCHGEAR Draughtsman, age 23; thoroughly accustomed to designing Switches, Fuses, Circuit-heaters, etc.—Box G, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

ELECTRICAL Engineer.—Fully qualified Engineer, practical experience in all Electrical work; Marine experience as Chief Electrical Engineer. Board of Trade certificate.—Address, Box H, THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

ELECTRICAL and Mechanical Engineer, Bachelor Science; extensive experience Cable Testing, desires post in Consulting Engineers' office or workshop.—Box I., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

CLERK of Costs and Estimates; experience with B.W., G.E.C., and B.T.H. Coys.; age 37; salary, £2 weekly.—Box J., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street.

TESTING Room Assistant, well up in high-tension work for X-Rays and Wireless Telegraphy.—Box K., c/o THE ELECTRICAL ENGINEER, 147, Fleet-street, E.C.

COIL and Battery Maker or Wireman; 10 years in last sit.—Box L., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

ENGINE Driver, 20 years' experience with steam engines, boilers, dynamos, and pumping plant; can do repairs.—Box M., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

ENGINEER or Electrician; experienced in ship lighting and wiring; has had entire charge of Union Castle Line vessels.—Box N., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

PLANT WANTED AND FOR SALE.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words. 4d.

WANTED TO PURCHASE, 5 or 6 h.p. Motor, single phase, (for alternating current), good second hand.—TURNER, 117, Putney Bridge Road, S.W.

GAS ENGINE, Crossley, 9 B.H.P. and compound dynamo carbon brushes, 220 a, 15 amps, sliding rails and belt, £30. Stockport Gas Engine, about 25 B.H.P, equals new, all fittings, £24.—28, Haslescott Road, Nunhead, London, S.E.

WANTED, METALS, RUBBER, LAMP TOPS, MERCURY PLATINUM, FALSE TEETH, etc.—WASTE AGENCY, 2, Jackson Road, Holloway.

PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DEBBY AND CO., LTD., 44, Clerkenwell Road, London, E.C. N.B.—Platinum Sold.

WANTED—A. C. Motors ∽ 50, any voltage, ¼ to 3 h.p. Also Electric Air Compressor for A. C. State full particulars and cash price.—Box Q, THE ELECTRICAL ENGINEER, etc., 149, Fleet-street, E.C.

MISCELLANEOUS.

MEN OUT OF EMPLOYMENT in all branches of the Electrical Trade should write to Box No. 20, c/o THE ELECTRICAL ENGINEER, 149, Fleet Street, London, E.C.

AGENTS Wanted, Private Christmas Cards; books free; large profits.—CHIPCHASE, "Cardex," Darlington.

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TASMANIAN HYDRO-ELECTRIC SCHEME.

The hydro-electric plant of the Pioneer Tasmanian Mining Co., Bradshaw's Creek (Tasmania), has recently been completed and is working very satisfactorily. The total cost of the installation was £38,080, says the *Australian Mining Standard*.

The dam from which the power is obtained is 623ft. long, 51 ft. deep to bye-wash level, and 54 ft. deep over all, its capacity being 420,000,000 gallons. The dam is founded partly on solid rock and hardpan, and constructed of loose rock in pieces up to five tons in weight dumped in place. The up-stream slope is 1 to 1, and down-stream slope 1½ to 1, the former being hand laid and well packed with spalls for a distance of 12 ft. in, and faced with rubble concrete, 2ft. 6 in. thick at the bottom, tapering to 6 in. at the top which is 11 ft. wide. This concrete facing is carried down in a deep trench across the front of the dam, and acts as a cut-off wall. The down-stream slope is left rough. The bye-wash, 178 ft. in length and lined with 3in. of concrete, is situated in the embankment, which at this point is founded on solid rock. Water is drawn off in a concrete culvert 30 in. in diameter through the base of the dam, and in the up-stream end of the culvert is built a wrought iron pipe with a heavy flange, to which is attached the sluice gate, operated by gearing from a tower built of cast iron piping in the dam, and reached by a foot-walk. From the dam the water is brought through a race 1½ miles to the pressure box at the head of penstock, which is of wrought iron 36 in. in diameter, and 1,200 ft. long, from the end of which it issues to the turbine nozzles under a pressure of 189 lb. per sq. in.

The generating plant consists of three units, one being a spare, comprising Voith impulse turbines (with two nozzles) direct coupled to A.E.G. generators of 325 kw. running at 500 revolutions per minute. The system used is three-phase, and current is generated at 6,500 volts, at which pressure it is transmitted to the motors, no transformers being used except those for the instruments and lighting. From the turbines the water passes through a measuring weir to the race three miles long, which delivers it to the main nozzle column at an elevation of 250 ft. above the mine. After transmitting the current a distance of four miles to the mine the line branches in two, and each branch encircles the workings to a point opposite the barges, where it terminates in the lightning arrestor gear (mounted on poles) and mast switch. From the latter an armoured cable 110 yds. long, laid on the surface of the ground, carries the current to the motors on the barges. The switchboards are of the carriage type and constructed of steel, all the instruments being mounted on travelling carriages forming the inside of each panel, which can be withdrawn on to a small truck for inspection, thus obviating the necessity for attendants to go behind the board. Variation in speed of the motors driving the gravel pumps is obtained by a liquid controller which gives a speed variation of 15 per cent. For greater variations in speed, split rope pulleys of dffierent diameters are provided for the motors. Power station and barges are equipped with all necessary instruments and safety devices, and an automatic voltage regulator at the former keeps the voltage constant at the mine independent of variations of load. The lighting at the mine is controlled from each electric barge, while on No. 1 steam barge a changeover switch enables all lighting circuits, in the event of a breakdown at the power station, to be driven off the dynamo, which is kept as a standby on that barge. Provision is also made by an arrangement of the head-races, that a breakdown of the new head race carrying the power water will not interfere with the working of the steam plants. The completion of the hydro-electric plant necessitated a re-arrangement of the barges under which the old No.1 steam plant has been dismantled, the barge cut in half, and converted into two electric barges, each of which is more powerful than the steam plant replaced, though only about one-quarter of its weight. These two electric barges are now working in conjunction, No. 2 lifting the lower bench ground to the sluicing level of No. 1 electric, which in turn pumps to the tail race on the surfaces.

ELECTRICAL ENERGY IN FACTORIES.*

By MR. H. O. WRAITH, M.I.E.E.

Discussing the 1909 Home Office regulations for the generation, distribution, and use of electrical energy in factories—which use has been certified, in pursuance of Section 79 of the Factory and Workshop Act, 1901, to be "dangerous," the author said that the number of accidents from the use of electricity apparatus was small as compared with those on the engine and boiler plant. This spoke very well, indeed, for the safety of electrical power transmission, as well as for the soundness of the apparatus used. It seemed, if one might judge from these statistics, that the use of electricity in factories was not so dangerous as many other kinds of machinery, though if badly designed and carelessly looked after there was no doubt that an electrical installation was a source of great danger; and, in view of this, an attempt had been made in the new regulations not to hamper the user of electric energy, at the same time giving the Home Office a handle for insisting that his electrical installation should be a safe and properly conducted one. At this early stage, before the effect of the regulations had had time to show itself, and before the weak or contentious points had actually arisen in practice, it was very hard to know exactly how to deal with a number of them, or what their exact meaning might turn out to be. One point which was noticeable in connection with them was that they were crammed full of such qualifying phrases as "where necessary to prevent danger," "so far as reasonably practicable." This, while it made the regulation less rigid, at the same time might be a very great evil. Who was going to decide whether any proposed or existing apparatus was "necessary to prevent danger," or was "reasonably practicable"? As they were at present, certainly the Home Office, with all due respect to them, were not competent to do so all over the country at once. It was not the properly equipped installations, with up-to-date apparatus and competent men, that would be affected by the regulations; it was to the hole-and-corner places, which were not properly installed or looked after, that they would make a difference, and rightly so. The author did not think they would find any properly installed and conducted installation in the country which did not conform, if not in the letter, wholly in purpose, to the regulations, and he had no doubt that as time went on they would be placed in the hands of properly qualified electrical engineers to administer, who would be sufficiently acquainted with the installation and use of electric power to recognise what conformed to safe and good practice and what did not. As far as he could find out, among the crowds of public authorities, private ventures, and manufacturers that were represented at the inquiries held when drawing up these regulations, no single representative of the working or artisan classes was present. One of the chief objects of the regulations was to ensure reasonable safety for men working on electrical installations, and he thought they guarded against every conceivable danger that might arise to the men working on electrical installations. It spoke volumes for the honesty of purpose and open-mindedness of the controllers of electric power and manufacturing works in this country that in no case during the inquiries was any attempt made to sacrifice safety of men to cheapness, but, on the contrary, every attempt was made to draw up the regulations so that the safety of workmen was the first consideration.

CONCESSION FOR ELECTRICAL SHIPMENTS.

We hear that the National Electrical Manufacturers' Association has obtained a concession from the South African Steam-Ship Conference regarding the freight of electric light glass shades. Hitherto, these have been rated in the first class rate, while gas lamp shades were carried at the second class rate (a lower rate). The matter was taken up with the conference by the Association, and the South African lines in the conference have agreed that in future common glass shades for electric lights, packed in cases, shall be carried at the second class rate.

* Abstract of paper read at opening meeting of Session, 1909-10, of Sheffield Society of Engineers and Metallurgists.

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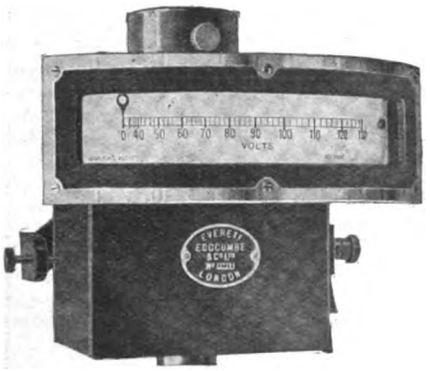
The Student's Guide to Knowledge.—*Chap. V.*

ELECTROSTATIC VOLTMETERS.



LOW TENSION PATTERN.
30 to 1,500 volts.

These instruments possess the following advantages:—

They **absorb no energy**, have **no temperature error**, are **unaffected by stray magnetic fields.** They can be used on **direct** or **alternating current circuits** and are **unaffected** by variations in **wave form** or **frequency.**

They are made in three patterns:

(a) **Low Tension Pattern** for voltages from 30 to 1,500 volts.

(b) **High Tension Pattern** for voltages from 800 to 25,000 volts.

(c) **Extra High Tension** pattern for voltages from 6,000 to 200,000 volts. A complete chain of instruments of the electrostatic type is thus provided giving a **total range of 10 to 200,000 volts.**

Full Particulars in Catalogue Sheet 15.

HIGH TENSION PATTERN.
1,000 to 25,000 volts.

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87, Victoria Street, WESTMINSTER, S.W. AND CO., LTD., Collindale Works, HENDON, N.W.

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WANTED TO PURCHASE from Electric Lighting Companies and Electrical Engineers. — **Dynamos Motors, Cable, Wire, Instruments,** and every description of Electrical Material, also Manufacturers **Surplus Stocks.** The bulk being for re-use, High Cash Prices can be paid.—A. VEREY & Co., Dover Telegraphic Address: "Verey, Dover."

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CHIEF OFFICE IN CANADA: BAY ST., TORONTO. **64, CORNHILL, LONDON.** A. VIAN, Secretary.

H.M.S. "COLLINGWOOD'S" ELECTRICAL EQUIPMENT.

The usually well informed on matters maritime, *Western Morning News*, says that electricity will be used on board the *Collingwood* to the fullest possible extent, one novel application being that of dropping lifebuoys electrically from the navigating bridge should a man fall overboard. The latest electrical appliances for controlling the firing of the boilers are also being fitted, and by their use the men attending the fires will know exactly when to replenish them, thus ensuring uniform intensity of heat. Every possible operation, in fact, including water-pumping, air-compressing, ventilating magazines, firing the guns and torpedoes, hoisting in and out heavy boats and torpedo nets, coaling ship, and providing power for the wireless apparatus will be performed by electric motors.

The searchlight equipment of the *Collingwood* will be the most powerful yet installed, consisting of no less than 20 projectors, mounted in pairs, in positions which are designed to give a maximum concentration of light on all angles, acting in co-ordination with the 4-inch guns by means of an efficient system of control. The rigging is being fitted with a new pattern insulator, in which porcelain is substituted for wood.

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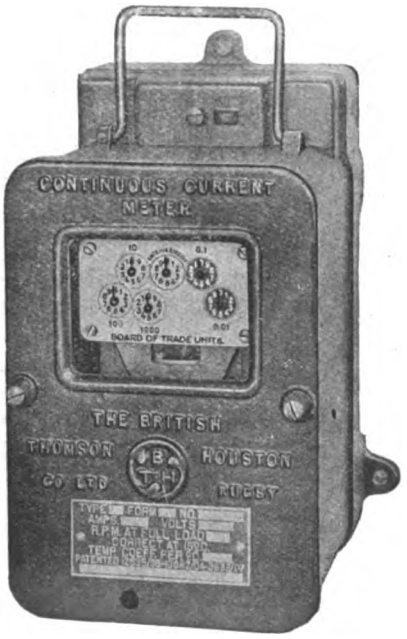
B. T. H.
MERCURY AMPERE HOUR METERS



of the house service type for C.C. circuits are superior to any other ampere hour meter now in use

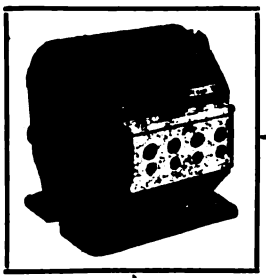
They have the highest possible ratio of torque to weight; all parts are made of metal and will not warp with changes of temperature or excessive heat. The total losses have been reduced to an extremely low figure, and all parts are made standard and interchangeable.

The curve of this meter approximates to nearly a straight line. Compounding, with its attendant troubles and losses, is avoided.

The British Thomson-Houston Co., Ltd.,

Electrical Engineers and Manufacturers.

Head Office & Works: Rugby, England. London Office: 83, Cannon St., E.C.



A FEW FACTS

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Reasonable Prices.

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Telegrams: "Fosteraco, London, S.W."

Electric

LIGHTING PLANTS

From 100 to 1,000 Watts.

Steam, Gas or Petrol.

Stuart Turner, Ltd.,

Engineers,

HENLEY-ON-THAMES.

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"MODEL ENGINEER" EXHIBITION.

ELECTRICAL NOVELTIES AND SPECIALITIES.

Electrical novelties and specialities are among the leading features of the Model Engineer Exhibition, which opened at the Royal Horticultural Hall, Westminster, S.W., on the 15th inst., and closes to-morrow, the 23rd. Sir Hiram Maxim performed the opening ceremony in the presence of a large gathering. Sir Hiram is himself an inventor, and he was the recipient of a model in silver of the steam aeroplane invented and built by him some twenty years ago, a machine which was really the pioneer of the aeroplane as it exists to-day, and the first heavier-than-air flying machine to lift itself from the ground. The presentation was made by Mr. Percival Marshall, editor of *The Model Engineer*, a founder of the Society of Model Engineers, by whom the Exhibition has been so admirably organised.

Working model steam and electric railways, model engines, electric clocks and motor, and numerous kindred productions are shown in large numbers in the competitive and loan sections; while the London Society of Model Engineers have a workshop for demonstrating how models are constructed. The model locomotives on view vary from 16 in. to 16 ft. in length. In the model-making competitions there are upwards of 200 entries, the models coming from various parts of the country, and representing the work of all classes of society. Electric gyroscopic steering gear for model steamers made by an Army officer, model electric locomotives and tramcars, a miniature Wheatstone Bridge P.O. pattern (sent by a Naval lieutenant), an electric lamp for facilitating dental extraction, a balancer transformer, electric motors, and an adjustable mercury interrupter are a few of the specimens in one of the competitions. Then there are electrically-driven models of motor boats, torpedo boats, yachts, launches, and even a model torpedo boat destroyer (electric). Miniature aeroplanes appear well to the fore, over fifty specimens representing the latest types of construction having been attracted in one competition alone.

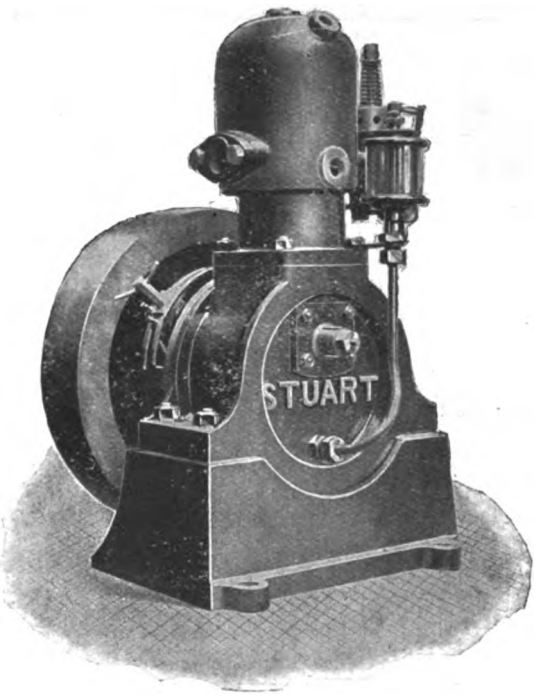
A notable feature of the loan section is the special exhibit by Dr. William Wilson, of the China Inland Mission, illustrating the electrical work done by his native students in the far interior of China, 1,500 miles from the coast. Among this collection of apparatus made by Chinese science students, using only native material, will be found an electro-magnet, an electric bell, a needle telegraph instrument, a Marconi wireless telegraph receiving apparatus, a telephone receiver, and a shocking coil. We understand that the whole of the materials employed were prepared on the place, even to the cotton insulation of the copper wire. In the main exhibition hall one of the Model Engineer Society's model railway tracks has been erected, and several of the members' locomotives, both electric and steam, are shown running at intervals during the evenings. A new pattern heliograph, lent by Messrs. C. Hollis & Co., has attracted considerable attention; and another noteworthy exhibit is a receiving set for wireless telegraphy sent by Mr. R. P. Howgrave-Graham. Three of the members of the Victoria Model Steamboat Club show electric launches, which figure prominently in the collection of members' work; while the Clapham Steam Sailing Club also exhibit some electric boats, including one of the paddle type.

In the Demonstration Room the various systems of telegraphy, as used in the Inland and Submarine Cable Services, can be seen in operation. A complete long-distance installation of the Marconi system is shown working to a distant station some few miles away, the apparatus being operated by students from the British School of Telegraphy. A special feature is made of receiving in the hall messages from transmitting stations in various parts of the country. The "Gell" typewriting telegraph, now being extensively used in the postal service, is to be seen under actual working conditions for the first time in public.

Not only the amateur, but also the professional, engineer will find much of interest in the trade section. Of the 35 stands, a good proportion are devoted to electrical appliances, and at some of the stalls demonstrations may be witnessed at intervals.

At the first stand, Messrs. Stuart Turner, Ltd., of Henley-on-Thames, have a very effectively arranged display of the up-to-date and reliable products of the Shiplake Works. Mr. Stuart Turner is a pioneer of high grade model engine castings, and the selection on view, in sizes ranging from a model engine of $\frac{3}{4}$ in. bore to a double compound motor engine of 30 h.p., well merit inspection. Working models of several sizes of engines constructed by the firm add to the interest of the exhibition. The specialities shown by the firm also comprise small electric light plants from 100 watts up to a fine direct-coupled 1 kw. set, the engine of which we illustrate.

This engine is of the two-cycle type, *i.e.*, valveless, and the explosions take place at every revolution. The cylinder is $3\frac{1}{2}$ in. bore by $3\frac{3}{4}$ in. stroke, and at a speed of 600 revolutions will develop about $1\frac{1}{2}$ h.p. with gas, and with petrol 2 h.p. Electric ignition is used, but magneto can be fitted if required. Messrs. Stuart Turner are supplying this engine mounted on a large cast-iron base, direct coupled to a dynamo, giving an output of 1 k.w., at a speed of 750 revolutions, when running on petrol, or with a somewhat lower output if gas is used. This set needs no special foundation, and can be bolted to any good floor.



Stuart Turner Engine

Near by is exhibited Dr. Dinshah P. Ghadiali's "anti-forge" automatic electric desk and pen, recently referred to in our columns. The invention is based on the power of high-tension electric sparks to pierce physical matter which offers resistance to their passage and on their caloric property. One secondary wire of an induction coil of suitable spark size is joined to a polished smooth metallic plate, set in an insulating block, upon which plate the writing paper is placed. The coil may have a condenser to intensify the spark and render it thicker and more effective, and it may be worked by a suitable primary current from a given source. The other pole of the secondary is joined to a metallic point inserted in a pencil-like instrument of insulating material. On writing with the pen on the paper placed on the metallic plate the sparks jump across the paper resistance, perforating it, and by a simultaneous carbonization of the paper fibres produce the permanent and indelible writing without ink. By turning a screw, the electric current can be so modified that it only perforates tiny holes without scorching the edges, making the writing invisible till held up to the light.

Another popular centre of attraction is the ingeniously-arranged exhibition of Messrs. W. J. Bassett, Lowke & Co., the model manufacturers of Northampton and London. The firm show at two stalls, "Northampton" and "London" respectively. The one end is represented by a tunnel mouth 20 ft. wide, and the other by a replica of the Doric entrance at Euston. Between the two stands are tracks, with scenery behind the rails. These tracks are laid with electric third rail, miniature L.N.W.R. trains being despatched from one end to the other. Among the new models are several official L.N.W.R. locomotives as used at the "White City." One of the interesting novelties consists of an electric mechanism complete, with motor wheels, frame, and collecting shoe, round which the amateur can build a model tramcar, locomotive, or motor coach without doing any wiring whatever. The motor has a permanent field, and, therefore, is reversible, like the other models mentioned, from any point in the track; and, as demonstrated, the trains can be started, controlled, and shunted by a combined reversing switch and resistance without the necessity of touching the engine.

Fastnut, Ltd., have a striking display of their "Fastnut" washer, as supplied to H.M. Dockyards and leading railway companies.

Model and large sized corrugated aerocurve aeroplane propellors attract attention to Messrs. Cochrane & Co.'s stand; Mr. Percy Pitman shows a fine collection of apparatus, including his "hydro-electric charging set"; the L. S. Starrett Co. make a strong feature of small tools for engineers; and at the Twining Aeroplane Co.'s stall will be found a Wright machine to scale of $1\frac{1}{4}$ in. to 1 ft., fitted with electro-motor in petrol case.

Practical demonstrations are given of the various uses and advantages of the Fluxite Soldering Paste by the Auto-Controller and Switch Co., ; Messrs. Darton & Co. exhibit a selection of electric models for various purposes; and the Synchronome Co. show some of their Electrical Impulse Clocks.

HALFORD STEVENS PETROL-ELECTRIC.

Messrs. W. A. Stevens, Ltd., are showing one of their demonstration patent petrol-electric vehicles, fitted with a private omnibus body, at Blackpool during the aviation week.

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WIRELESS TELEGRAPHY FOR MULTIPLEX WORKING.

An invention, which has just been patented in Berlin by F. van der Wonde, has for its object, states the *Post Office Electrical Engineers' Journal*, the adaptation of wireless telegraphy to multiplex working. The antenna is joined to a spiral device carrying a number of contact arms, which, when revolved, makes the following connections: (1) Transmitter joined up; (2) antenna earthed; (3) transmitter cut out; (4) receiver joined up; (5) earth disconnected; (6) receiver cut out. The speed of action is such that several revolutions take place during the time necessary for the sending of a Morse dot.

ELECTRIC FAN REGULATORS.

There is an impression which has been widely current even among engineers (says the *Indian and Eastern Engineer*) that the fitting of a regulator to an electric fan of the ceiling type results in no economy of current, as the resistance takes up all the balance of current which would have otherwise passed through the fan motor. To set the question at rest, Messrs. Balmer, Lawrie & Co.'s Electrical Department, Calcutta, asked Mr. A. K. Taylor, Electrical Inspector to the Government of Bengal, to carry through a series of tests of consumption of current with a fan motor stopped down with the "Short" Regulator, a patented device invented by Messrs. Balmer, Lawrie & Co.'s Chief Electrical Engineer (Mr. F. M. Short). The result showed that, with the fan stopped down to low speeds, the economy of current consumption is very marked indeed—some 50% in fact.

There are other advantages in the use of a regulator, such as economy of wear on moving parts, hence longer life in the fan, and again in starting up and switching off through the regulator the strain on the insulation of the motor is extensively reduced. There is, therefore, good reason for fitting every fan with an accompanying regulator.

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REVIEWS.

"The Patent Road to Fortune." By a Successful Traveller on it. (Hull: Burtt Bros. Price 3d.).

Probably the author takes a rather sanguine view of the success that awaits inventors, but he writes interestingly, gives sound enough advice and some practical information. To those inventors who possess little or no knowledge of patents' laws and practice, this little book will prove a serviceable introductory guide to what is a very intricate and thorny pathway.

"Jack Carstairs of the Power House." By Sydney Sandys. (London: Methuen & Co. Price 6s.).

Since Mr. Kipling made his fictional irruption into certain bye-paths of engineering, a fashion has arisen to break away from the ordinary run of novel writers' stock scenery and lay figures, and to invade the realms of industrial activity in search for "copy." Mr. Sandys has chosen the electrical world, and undoubtedly his descriptions of engineering experience, whether in the remote Scottish power-house, the South of England municipal generating station, with the quaintly "shoppy" talk of his characters, affords excellent reading. There is evidence, too, that he can create a character, but taken as a whole, the work is a dismal failure, because the author wrong-headedly forsakes the realms of reality for the lurid regions of melodrama. It is thoroughly incongruous in a work dealing so largely with electrical engineering to find the "long arm of coincidence" so frequently brought into play. In the main, the story is one dealing with the struggle between good and evil. Carstairs is the good principle, his friend Darwen the evil. The latter is a physical and intellectual giant, who murders and mutilates, charms with his smile, his music, and his beauty, while he cheats and robs with effrontery, enjoying the game as a master of high art. These two fall in love with a gipsy maid, who is really the stolen daughter of a disreputable baronet, and sister of Darwen, so they fall out as friends, and the most grotesque events ensue. Intermixed with all this is a running commentary on the incompetence or knavishness of most station engineers, and a wholesale libelling of municipal councillors and officials. In a catch-penny note on the cover the publishers describe the book as "the healthy story of a young engineer, with his failures and successes, and his struggles with municipal corruption." It is a good idea spoilt by muddle-headed economics and politics.

BOOKS RECEIVED.

"Rose's Universal Code Eeconomiser." By Sydney A. M. Rose, A.M.Inst.E.E. London: Sedgwick & Jackson, Ltd. Price, 10s. 6d.

"Elements of the Differential and Integral Calculus." By A. E. H. Love, M.A., D.Sc., F.R.S. Cambridge University Press. Price, 5s.

"Arithmetic of Electrical Measurements." By W. R. P. Hobbs, R.N., A.I.E.E. London: Thomas Murby & Co. Price, 1s.

PUBLICATIONS.

"The Physical Review." September. (New York: The Macmillan Co.)

Several papers of electrical interest appear in this interesting double number of the American Physical Society's journal. Mr. T. P. Irving has a suggestive article on "The Electrical Character of the Source of Light Radiation," giving results of experiments which may prove of considerable practical value. Mr. V. Bjerkins deals with "The Absolute Measurement of Electromagnetic Quantities"; Mr. Jacob Kunz with "The Photoelectric Effect of Sodium-potassium Alloy and its Bearing on the Structure of Ether"; and Mr. C. D. Child with "Counter Electromotive Force in the Electric Arc."

"The Electron." Price 6d.

The September number of the official organ of the Siemens' Stafford Institute contains, as usual, a varied assortment of articles, all worthy of note. The part played by electricity at the Maidstone Sewage Works is dealt with in a brief paper, well illustrated. One of the latest innovations in electric traction, the use of motors fitted with special commutation poles, is described in an eight-paged article, also with illustrations. Mr. F. E. Read continues his description of the Continental Siemens' firms, the illustrations of the apprentices' schools giving a good idea of the thorough way in which these works are equipped for attaining and retaining a leading place in electrical engineering.

DIARY OF EVENTS.

WEDNESDAY, OCTOBER 27.

STEPNEY.—At 3 p.m., opening of new generating station, Blyth's Wharf, Narrow-street, Limehouse, by Mayor of Stepney.

INSTITUTION OF ELECTRICAL ENGINEERS (Leeds Local Section).—At 7.15 p.m., at Leeds University, presidential address by Mr. W. M. Rogerson, M.I.E.E., also "Notes on Superheated Steam," by Mr. A. B. Mountain. M.I.E.E.

FRIDAY, OCTOBER 29.

FERRANTI, LTD.—At 12 o'clock at Basildon House, Moorgate-street, London, fourth annual meeting.

INSTITUTION OF MECHANICAL ENGINEERS.—At 8 p.m., extra meeting to resume discussion on Professor Dalby's report on "Heat Transmission."

FRIDAY, NOVEMBER 12.

INSTITUTION OF ELECTRICAL ENGINEERS (Birmingham Local Section).—At the Grand Hotel, Culmore-row, annual dinner.

TUESDAY, NOVEMBER 16.

INSTITUTION OF ELECTRICAL ENGINEERS (Glasgow Local Section).—At 8 p.m., at Glasgow Technical College, Chairman's inaugural address.

TUESDAY, NOVEMBER 23.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Students' Section).—At Municipal School of Technology, Manchester, "The Testing of Electrical Machinery," by Messrs. R. F. Blackmore and V. W. Newman.

WEDNESDAY, DECEMBER 1.

INSTITUTION OF ELECTRICAL ENGINEERS (Glasgow Local Section).—At the Grosvenor, Gordon-street, eighth annual dinner.

THE ELECTRICAL ENGINEER TERRITORIALS (London Division).—Officer Commanding, Col. R. E. B. Crompton, C.B. For week-ending October 31st. Monday, 25, "A" Co., Hopkinson Cup competition, 7 p.m.; Tuesday, 26, "B" Co., Hopkinson Cup competition, 7 p.m.; Wednesday, 27, Gymnasium 6.30 to 9.30 p.m.; Thursday, 28, "C" Co., Hopkinson Cup competition, 7 p.m.; Friday, 29, "D" Co., Hopkinson Cup competition, 7 p.m.—(Signed) P. H. Campbell, Capt. R.E., and Adjutant, for O. C., E. E., L. D.

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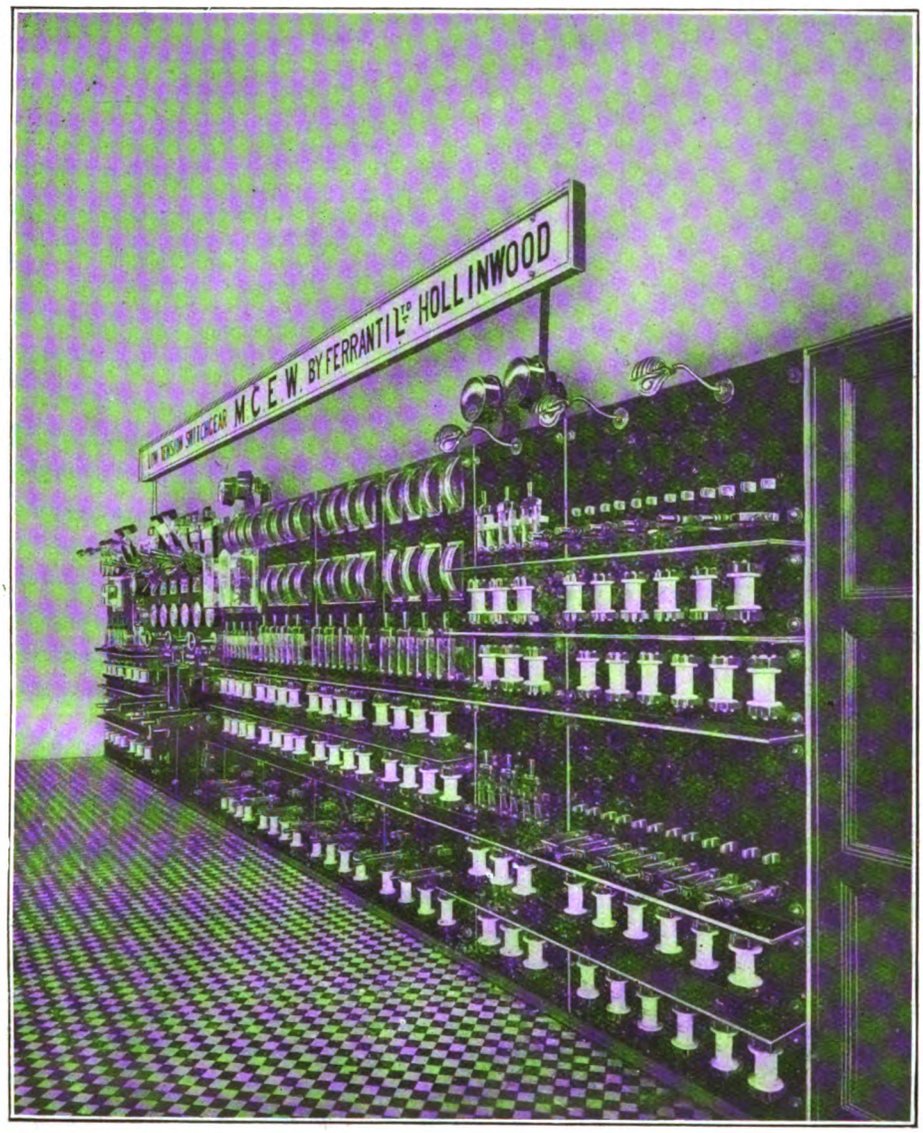

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ELECTRIC ORGAN BLOWING EQUIPMENTS.

The Adnil Electric Co., Ltd. (Marples, Leach & Co., Ltd.), who specialise in electric blowing installations for church and public hall organs, have recently been favoured with a number of important orders, including the following:—*Direct Current:* Brunswick United Methodist Church, Burnley; St. Chad's Church, Stafford; Parish Church, Colne, Lancs.; St. George's Schools, Ascot; St. Mark's, Surbiton; the Chapel, Welbeck Abbey (for His Grace the Duke of Portland); Earl of Cadogan's Church, Culford; the residence of Mr. R. W. Hawkey, Chiswick; Christ Church, Chester; Tonbridge Schools, Tonbridge, Kent; and chamber organ at Messrs. Chappell's warehouse, New Bond Street. *Alternating Current.*—St. Matthew's Church, Southsea; St. Anthony's Catholic Church, Forest-gate; and St. Edmund's Church, Roundhay, Leeds. Marples' Patent System of regulation is employed in all the direct current installations, and the "Adnil" single-phase, self-starting alternating current motor in the alternating current installations.

SECRECY BY RADIO-TELEGRAPHY.

A Norwegian captain named Hovland has, says the *Post Office Electrical Engineers' Journal*, invented a system of secret type-printing for radio-telegraphy, and lately gave a demonstration of it in Melsomvik, Norway, to the local authorities and pressmen. "Wireless" telegrams were exchanged between a station erected by the inventor and a station at Tjömö, belonging to the Norwegian Navy, over a distance of 20 kilos. By the experiments Hovland showed how it was possible by means of his system to ensure absolute secrecy of communication and how easily ordinary type could be automatically converted into secret characters. The characters are transmitted by means of a key-board similar to that used on an ordinary type-writing machine. On reaching the receiving station the telegram may be received at will in secret or ordinary type. Hovland is a Norwegian naval officer, and has had considerable aid in perfecting his invention from the naval authorities of Norway, at whose disposition he has placed the results of his labours.

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AMERICAN NOTES.

(From our Correspondent.)

NEW YORK.

Probably the most important electrical development on this Continent during the past week is an ordinance introduced into the Chicago City Council by Alderman Bernard Snow, Chairman of the Finance Committee, providing for the compulsory electrification of all City railways within an 8 mile radius of the centre of Chicago. The ordinance, if adopted (as to which no doubt seems to prevail), will come into force in January, 1912. It may not be without interest to your railway readers if I cite the essential clause of this ordinance.

The Essential Clause.

This is the second clause of the ordinance, and it provides that: "Every railroad company now operating or propelling cars or trains of cars in the city of Chicago or now authorised by ordinance so to do shall within one year after the passage, approval, and publication of this ordinance, submit to the commissioner of public works of the city of Chicago plans and specifications for operating and propelling all of its cars or trains of cars in the city of Chicago by means of electrical power. If the manner in which any railroad proposes to operate its cars by means of electricity, as indicated by said plans and specifications, is one which, in the judgment of the commissioner of public works, is reasonably safe, the commissioner of public works shall approve said plans and specifications, and thereafter the railroad company presenting plans and specifications so approved shall proceed within six months to electrify its line of road as in and by plans and specifications provided, and shall continue said work with reasonable diligence."

Anticipated by Engineers.

Although it has provided some of the daily newspapers with plenty of material for demonstrating their resources in the matter of scare-headlines, the electrification ordinance cannot be said to have taken engineers altogether by surprise. In fact, it has already, my Chicago correspondent tells me, been anticipated in many quarters, and plans laid accordingly. Meanwhile, within a few months, all the Illinois Central tracks within the city limits of Chicago will be ready for electrical operation. The electrification will proceed in six sections, namely: First, suburban tracks, Randolph-street to 63rd-street, from steam to protector third rail; second, express tracks to South Chicago, third rail; third, electrification Kensington tracks; fourth, electrification suburban and through passenger tracks to Burnside; fifth, passenger and freight tracks between Park Row station and Burnside; sixth, passenger and freight tracks to Riverside.

A Colossal Project.

Nevertheless, the project is a colossal one. It is something (but not quite) like a Local Government Board Act demanding the immediate electrification of all your London terminals—Euston, Marylebone, Paddington, St. Pancras, King's Cross, Victoria, Waterloo, Charing Cross, Holborn Viaduct, Cannon-street, London Bridge, Liverpool-street, Broad-street. What an outcry there would be on the part of the Companies concerned! But, on the other hand, what a difference it would make in the smoke-laden atmosphere of your grimy Metropolis! It is on this smoke question that Alderman Snow takes up his stand. In the matter of smoke Chicago can easily beat London, and the Alderman not only believes that the city can use its police powers to abate the smoke nuisance by compulsory electrification, but can, if necessary, fall back upon an unrepealed section of the old City Charter of 1863, which gives the Council power "to regulate and prohibit the use of locomotive engines within the city, and require railroad cars to be propelled by other power than that of steam."

America Ahead of Europe.

Probably one of the reasons why the electrification ordinance has made less stir here than it would in the Old Country is the fact that in our newer atmosphere we take more kindly and naturally to big changes, especially in the matter of anything concerned with electric energy. Mr. E. W. Rice, the vice-president of the General Electric Co., who has just returned to New York from Europe, is quoted as declaring that while electrical development there is progressing satisfactorily, "progress is not so great as in this country, and the adoption of electrical appliances is slower. I expected to find railroad terminals, especially in the large cities, applying electricity, as is being done in this country, but such is not the case. The application of electricity for terminal purposes must come sooner or later in such cities as London, Manchester, Birmingham, Glasgow and other large cities. The smoke nuisance is terrible in those cities, and in some of the long tunnel approaches. It is more a disinclination to depart from the old custom than a question of expense that delays the change, but it will surely come soon."

Inter-urban Trolley Lines.

With regard to the proposed inter-urban trolley system to connect all the cities of the Piedmont section of North Carolina, it is announced that a company will be formed with the present Piedmont Carolina Railway Co. as a nucleus, and the trolley line being built by this company from Salisbury to Concord *viâ* China Grove and Kannapolis, will be one of the links of the big trolley system. The principal line will extend from Greensboro to Charlotte, a distance of 98 miles, connecting between these cities High Point, Thomasville, Lexington, Concord and Salisbury. A line will be extended to Winston-Salem, a distance of slightly more than 25 miles, and other lines will be extended to Gastonia and Monroe, each about 30 miles distant. The total estimated expenditure is set down at $4,500,000.

Some Large Orders.

Recent orders received by the Crocker-Wheeler Co. include one from the Southern Iron and Steel Co., of Rogers, Ga., calling for two 250 kw., engine-type, 550 volt, direct-current generators and 275 h.p. in 500 volt, direct-current motors. This is in addition to a recent order for 1,450 kw. in engine-type generators and 1,200 h.p. in slow speed motors from the same concern. The Republic Iron and Steel Co., Youngstown, Ohio, placed an order for a 600 kw., engine-type, 250 volt, direct-current generator which will be added to a plant consisting of two 300 kw. Crocker-Wheeler generators. Another order has been booked from the Nonquit Spinning Co., New Bedford, Mass., covering 375 kw. in 250 volt Crocker-Wheeler type D direct-current generators. One 250 kw., 250 volt, engine-type, direct-current generator and two 50 h.p. motors are to be installed in a wooden mill for the Southwark Mills Co., of Philadelphia, Pa. Two 75 kw., engine-type, 125 volt, direct-current generators will be installed in the factory building of Goodman, Loeb & Co., Philadelphia, Pa.

Single-Phase Motor Device.

Among the patents of the week is one obtained by Mr. H. B. Scheibe, protecting a switch arrangement for automatically opening the auxiliary starting circuit of a single-phase induction motor when the rotor has attained a predetermined speed. The device is actuated by the cross magnetising flux produced in the primary core by secondary magnetomotive force when the rotor has reached the proper speed. Use is made of a plunger electromagnet for operating the switch for disconnecting the auxiliary starting circuit. This is located within the primary field core with its plunger ends at points of equimagnetic potential so far as concerns the magnetomotive forces of the main and auxiliary starting circuits. As the rotor accelerates from rest there is produced, in space-quadrature with the main field flux, a flux which exerts a pull on the plunger of the electromagnet, which, it is claimed, is sufficient to open a switch in the auxiliary starting circuit when the rotor has reached the predetermined speed.

TYNESIDE NOTES.

(From our Correspondent).

NEWCASTLE-ON-TYNE.

The prospects of general manufacturing, and incidentally of electrical engineering, upon the Tyne are steadily improving. The basis of the better conditions is the staple industry of Tyneside—the building of ships; and recently placed orders are putting the shipyards in a very much more hopeful position. Messrs. Palmer's Shipbuilding & Iron Co., Ltd., of Jarrow, for example, are in receipt of an order from the Government to build a battleship, and, in this connection, Messrs. Siemens Bros.' Dynamo Works Co., Ltd., have the order for electrical wiring and other plant. Messrs. Swan, Hunter & Wigham Richardson, Ltd., have an order to build a destroyer, and this is interesting as being the first ship of war built by this firm. Messrs. Armstrong, Whitworth & Co., Ltd., are at their Elswick works commencing operations upon a second-class cruiser for the British Government. These warships will involve a considerable amount of orders for electrical plant, such as winches, ammunition hoists, fans, and auxiliary machinery generally. There is, therefore, a prospect of renewed activity among the electrical firms represented in Newcastle.

Synchronised Time-Service on Ships.

A rather interesting feature which promises to develop a new sphere for electrical applications on board ship is a new master clock for time-service installations. It is independent of the usual pendulum, and has been manufactured by Messrs. Gent & Co., Ltd. The contrivance is at present being exhibited at their Newcastle depôt. It is obvious that a large passenger boat, with its great number of compartments, is in need of a system by means of which all the chronometers can be synchronised and kept to time. The difficulty has hitherto been in the application of the electric impulse mechanism to the ship's chronometer. This has been overcome by Messrs. Gent & Co. by an ingenious addition to the usual balance-wheel escapement action, and the electric impulses passing to the clock gears are, therefore, independent of any rolling of the ship. Means are also provided on the master clock for accelerating or retarding the movement of the hands at will, in order to compensate for the effect of latitude on time-indications.

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Extension at South Shields.

During a discussion by the Electricity Committee of the Borough of South Shields upon the Engineer's Annual Report, the question as to the best manner of providing for future increases in the magnitude of the demand arose, and one of the Councillors suggested that, in place of increasing the capital costs of the undertaking by ordering fresh generating machinery, the Corporation should take steps to determine under what conditions a supply of electricity in bulk could be obtained from the power company operating in the area surrounding South Shields. It will be remembered that the County of Durham Electrical Power Distribution Co., Ltd., has already an extensive system of mains feeding Harton, Whitburn, and other adjacent localities. The Town Clerk, however, pointed out that the Power Distribution Co. would not be able to enter the borough as, except for the purpose of supply to the mines of the Harton Coal Co., Ltd., it had no Parliamentary powers to enter that area. Under the circumstances, therefore, the matter was allowed to drop.

A Far-Reaching Problem.

The reply of the Town Clerk of South Shields, which was a perfectly correct one, raises an example of present disabilities which should be removed if the Electric Lighting Acts Amendment Bill, now before Parliament, is passed. It will be remembered that the Bill is a modification of a measure which has been brought up annually for consideration since 1903. This year, however, the chances of its becoming law are more hopeful, as it has passed the controversial stages of debate. In the provision which it contains for the purpose of allowing supply authorities in adjacent areas to make such agreements with each other as to supply in each other's areas without proceeding to Parliament for a special Bill, it deserves the support of all members of the electrical industry. If this were passed, a borough such as South Shields, faced with the necessity of obtaining more electrical power, could avoid the purchase of further plant by negotiating with a neighbouring undertaking whose better diversity factor or larger plant could enable it to give power on satisfactory terms. It should be clearly understood that such overlapping of power supplies would not take place without mutual consent. The present position at South Shields is, therefore, of interest throughout the United Kingdom.

LANCASHIRE NOTES.

(From our Correspondent).

MANCHESTER.

During the last few days several meetings of interest to engineers generally have been held here. Mr. J. H. Stubbs opened the present session of the Manchester Association of Engineers. He gave a stirring presidential address on "Engineering Efficiency," and made some strong comments on England's slackness and indifference in connection with trade and commerce.

Institute of Metals.

This society, only 20 months old, has already over 500 members, and is the only society of its kind in the world. The second annual conference opened at the Municipal School of Technology, when three very able papers of indirect interest to electrical engineers were read. The first, by Messrs. J. H. Andrews and C. H. Edwards, dealt with ternary alloys, and is the result of a long series of original investigations. From the constitution and appearance of the alloys it is clear that those possessing reasonable mechanical strength must contain more than 86% of copper, or more than 85% aluminium. There is, theoretically, no advantage in adding tin to alloys containing about 10% aluminium and 90% copper. Probably an alloy with 6·5% aluminium, 5·5% tin, 88% copper, would have the same properties as the 10% aluminium, 90% copper alloy, but such a ternary alloy would be cheaper and have a lower specific gravity. Alloys containing the compound $Cu\,Al^2$ with tin may be found useful as bearing metal, for when made under certain conditions it consists of hard constituents embedded in a soft matrix of tin. The other papers were on the "Surface appearance of solders," and "Causes of the corrosion of copper and brass." A visit was paid to the Victoria University, and the visitors, who were accompanied by Vice-Chancellor Hopkins, Prof. H. C. H. Carpenter, and others, were greatly interested in the new engineering laboratories (recently opened by Lord Morley).

Blackpool Aviation Week.

Owing to the great use that is being made of electricity during the flying week, manufacturers in the district have received some very urgent large orders, particularly for arc lamps and lighting material. In one case a large firm obtained an order for a series of lamps, but being unable to supply their own choke coils in the short time, had to obtain these from their biggest rivals in the district. The Town Hall and the approaches to the aviation course are beautifully illuminated, the scheme being prepared by the Borough Electrical Engineer. In addition there are extensive private illuminations, and the contractors have had a very busy time.

The Cotton Trade.

Naturally, this is a subject of never-failing interest to us here, and there are many examples of electrically driven cotton mills in the county. One of the most interesting of these installations belongs to the Kearsley Spinning Co., and was built about four years ago for electric driving. The prime movers are two 750 kw. horizontal Curtis turbines 3,000 r.p.m., each direct coupled to a three-phase generator. The whole plant was supplied by the Electrical Co., and has proved highly satisfactory. Steam is supplied by a battery of four Lancashire boilers, and is superheated to 550° F. River water is used for cooling, and also in the boilers to make up waste, a jet condenser being in service. Cheap coat of poor calorific value is obtained from a local colliery, and the cost of power is stated to compare very favourably against the ordinary slow speed mill engine. The turbines and generators are all water-jacketed, and a stream of water keeps them cool. A full station switchboard is installed with panels for generators, parallelling and distributing. The motors are all of large output, about 450 h.p., one being employed on each floor, directly coupled to one end of the main shaft running down the centre of each spinning room. The mules are belt driven from these shafts. The motors themselves are mounted outside the spinning room, on platforms built where the rope race would be in a steam driven mill, and are thus working under the best conditions. Extensions on each floor are easily made by lengthening the shaft at the far end, and the only limit to this is the shaft's strength (and, of course, the capacity of the motor). The speed of the electric drive is about 50% greater than for steam. The mill is lighted by D.C. current supplied by a small Browett Lindley Westinghouse set, the wiring being one the three-wire system. I understand several mills in the district which have been stopped are re-starting under new management. The Wilton Spinning Co., Radcliffe (now in liquidation), is also stated to be re-starting. Additional machinery and full equipment is to be installed as early as possible. Trafford Park continues to grow as the home of factories. The latest arrival is the Rubber Regenerating Co., of America. A second American "hive" works is being rapidly built, and its seven sections are already let.

UNDERGROUND CABLE SYSTEM.

Steady progress is being recorded in the extension of the underground telegraph cable system. The line to Glasgow has been in successful operation for some time. Warrington is now joined to Liverpool and Manchester by underground cable, and the line is being pushed on to Leeds. Meanwhile, says the *Times Engineering Supplement*, work to join this cable is proceeding south from Newcastle, on which section the underground main has been completed as far as Stockton. The West of England line is now practically completed to Penzance, the route followed being by way of Bristol. From Birmingham a section of another underground route has been completed as far as Worcester, and from Bristol the southern end of this section has been finished to Berkeley. Yet another cable route is in progress from London to Birmingham by Watford and Coventry, the work being now finished to Hunton Bridge, two miles north of Watford. There has been an underground line to Chatham for some time past, and it is intended to carry the wires underground to Dover. Other connections and branches of the main routes outlined are projected. An underground telegraph system has been planned for Ireland between Belfast, Dublin, and the south and west, but none of the work has yet been put in hand. In Great Britain the need for extension of the underground trunk telegraph routes has been, and, indeed, still is, a matter of necessity, not merely for the greater efficiency of telegraphic business, but owing to the growth of telephonic communication; and it has only been made possible to develop the trunk telephone system, and to maintain efficient working, by the main trunk overhead wire routes being relieved of the telegraphic work through the extension of the underground telegraph cable lines. In connection with the improvement of telephonic communication, the Post Office authorities have just ordered a new type of cable for the London-Paris telephone service, which, as measured by the standard cable used for testing purposes, is three and a half times more efficient than the last cable laid for the cross-Channel service. This high efficiency is attained by the loading of the line with Pupin coils which are inserted at every knot. Experiments are also being carried out in the treatment of underground telephone cables, which it is hoped will have the effect of increasing their efficiency. The difficulty, hitherto, has been to overcome the troubles arising from the increased capacity due to proximity to earth.

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COMPANIES' MEETINGS AND REPORTS.

ORIENTAL TELEPHONE AND ELECTRIC CO., LTD.

The directors of the Oriental Telephone and Electric Co., Ltd., have declared the following interim dividends: 3% on the 6% Cumulative Preference Shares for the current year, less income tax; and 3% on the Ordinary Shares, free of income tax, payable to those shareholders whose names were on the share registers of the Company on October 13. The warrants will be posted on 30th inst. The share transfer books will be closed till the 27th inst. inclusive.

UNITED ELECTRIC RAILWAYS OF CARACAS.

The annual report of the United Electric Railways Co. of Caracas covers 18 months to the end of June, and includes the first period of operation since the converted system has been handed over by the contractors. Up to March 15, 1908, the lines were worked by the contractors, who bore all the expenses, but since then operation has been under the control of the local concern, the share and Debenture capital of which the United Co. owns. The local undertaking earned a net revenue of £10,300, and the amount received by the United Co. was £13,200, which permits of the Debenture service being met, the payment of administration expenses and the carrying forward of £900. The lines did not do quite so well as was expected, but circumstances were not wholly favourable. Since the end of June the use of the tramways has considerably increased and operating expenses have been reduced.

CITY ELECTRIC LIGHT COMPANY, LTD., BRISBANE.

The report of the City Electric Light Co., Ltd., Brisbane, for the half-year ended July 31 last states that the output amounted to 1,035,429 units, as against 960,715 for the corresponding period of 1907, being an increase of 7½%. Comparing the revenue from the sale of electricity for the same periods, the increase was 11¼%, while the revenue from all sources increased 7½%. The results of the half-year's working were such that, after placing £500 to the credit of the Franchise Purchase Sinking Fund Account, £150 to the Accident Insurance Account, and a substantial sum to the credit of Renewals, Replacements, and Contingencies Account, there remained a credit balance of £2,686 6s. 2d.; which, with the balance brought forward from last half-year, made a sum of £4,621 12s. 11d. to be disposed of. The directors recommended that a dividend, at the rate of 6% per annum, be paid on the Preference shares, and a dividend at the rate of 7% per annum be paid on the Ordinary shares, in proportion to the amount paid thereon; they also recommended a bonus at the rate of 2% per annum on the Ordinary shares, in proportion to the amount paid up thereon. The payment of the above-mentioned dividends and bonus, together with the dividend duty, would absorb £3,217 15s. 3d., leaving a balance of £1,403 17s. 8d. to be carried forward. During the half-year, all the machinery and plant, as well as the underground mains, worked well, and had been maintained in a state of high efficiency, and the thanks of the shareholders were again due to the staff for the good work performed. During the half-year the 700 kw. turbine plant mentioned in the last report was installed, and had now been taken over from the contractors. The anticipation of the directors had been justified in connection with this plant, as the maximum load in the station increased 27% during the half-year. Good progress had been made in the extension of mains in the Valley area, and also in the laying of ducts for feeders from the new power house to the Queen-street area. The plans for the new waterside (William-street) power house had been completed by the company's architects, who were now calling tenders for its erection.

FERRANTI, LIMITED.

The report of the directors of Ferranti, Ltd., for the year ended June 30 last, states that the profit on trading was £29,218 4s. 9d., and, after crediting discounts and interests and transfer fees, and deducting general establishment charges, repairs and renewals, legal expenses, bad debts, and directors' and trustees' fees, there remains a balance of £12,239 13s., which has been applied as follows:—Interest on Prior Lien Debentures, £817 10s.; Interest on First Mortgage Debenture Stock, £5,000; Interest on Bank Loan, £1,115 1s. 7d.; and amount charged in respect of depreciation, £5,000; making a total of £11,932 11s. 7., and leaving a balance of £307 1s. 5d. This sum has been deducted from the balance standing at the debit of Profit and Loss Account at June 30, 1908, reducing the amount to £1,829 15s. 7d. The commercial depression has continued during the whole of the financial year, and the results show a falling off as compared with the previous year. The directors who retire by rotation are Mr. S. Z. de Ferranti and Mr. Arthur Whittaker, who, being eligible, offer themselves for re-election. The auditors of the company, Messrs. W. Bolton & Co., chartered accountants, also retire, and offer themselves for re-election.

CLEVELAND AND DURHAM ELECTRIC POWER.

The annual report of Cleveland and Durham Electric Power, Ltd., states that during the year to June 30, investments in the associated companies have increased by £7,987. Capital expenditure on works has amounted to £14,064; this small expenditure is due to continued trade depression, which has diminished the amount of new business. The gross profit for the year amounted to £2,098. After providing for Debenture and other interest there remains a debit balance of £4,909. From this has to be deducted the amount brought forward, viz.: £1,252, leaving a debit balance of £3,657 to carry forward. The connections to the system aggregate 29,849 h.p. This is an increase of 9,744 h.p. connected during the year, as compared with 10,933 h.p. connected the previous year. An additional 3,500 h.p. has been contracted for. In addition to the two waste-heat stations at Spennymoor and Middlesbrough mentioned in the last report, the company has arranged to operate a third at the works of the Tees Bridge Iron Co., Ltd., at Stockton. This has recently been put into commercial service.

CONTRACTS OPEN.

HOME.

ALTRINGHAM.—County High School.—Electric lighting and wiring. October 23.

DUNDEE.—Corporation.—Steel tramway rails. October 23.

LEYTON.—Urban District Council.—Electric light installation at Canterbury-road schools. October 26.

MOUNTAIN ASH.—Urban District Council.—Annual supply of electrical stores. October 25.

OVERSEAS.

BATAVIA.—Colonial Government.—Extension of Atjeh tramway. Est., £100,000. (Part., Ministère des Colonies, The Hague).

BOLOGNA.—Material for extension of electric tramways (Soc. An. des Tramways de Bologne).

BRUSA.—Municipality. Construction and exploitation of electric tramways. November 30.

CHRISTIANIA (Norway).—Norwegian State Railways.—For the supply of transformers and electromotors for the Drammen Railway Works. October 25.

CONSTANTINOPLE.—Post and Telegraph Department.—Insulators, dynamo meters, and other telegraph material. October 28.

LEGHORN.—Tramway construction.—Material and rolling stock (Soc. An. des Tramways de Livourne).

MELBOURNE—Deputy Postmaster-General.—Two sets of accumulators. By 3 p.m., November 23. Postmaster-General.—To supply coin attachments (for coins of different values) for telephones. Spec. No. 184. 370 50 c.p. metallic filament lamps, with bayonet cap fittings, for 110 volts A.C.; 630 25 c.p. ditto; 160 16 c.p. Linolite carbon filament lamps, 110 volts A.C.; 1,000 16 c.p. T.H. screw socket carbon filament lamps, 110 volts A.C.; and 100 32 c.p. metallic filament lamps, with bayonet lap fittings, 200 volts A.C. December 7.

SPAIN.—The Ministerio de Fomento.—Tenders for a 60 years' concession for the construction and working of an electric tramway from Sans to Coll-Blanch (Barcelona). Tenders must be enclosed in sealed envelopes, bearing on the outside the name of the tenderer, and addressed to the Dirección General de Obras, Públicas, Madrid, where they will be opened at noon on November 20. To qualify any tender, a deposit will be required of 1,295 pesetas (about £47), which should be enclosed in a separate envelope. An application respecting this concession has already been submitted by the Compañía General de Tranvías, who have certain preferential rights in the competition.—For a 15 years' concession for the working of the urban telephone system at Oviedo, the present lease expiring on October 31, 1909. Tenders will be opened by the Dirección General de Correos y Telégrafos, Madrid, at 11 a.m. on November 8, but they must reach that address not later than noon on November 2. The concessionaire is to have the right to modify or extend the present telephone system within a radius of 15 kilos.—The Compañía Nacional de Tranvías have applied to the Dirección General de Obras Públicas, Madrid, for a concession for the construction and working of an electric tramway in Barcelona, called the Sans Extension, being an extension of the Company's existing lines. One month from the 4th inst. is allowed for the presentation of competing offers at the above-mentioned Dirección.—The *Gacetas*, containing further particulars, may be seen by British firms interested on application to the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C. *Local representation is necessary in each case.*

SYDNEY.—Postmaster-General.—Switchboard apparatus for subscribers' premises. Particulars of all Australian contracts, 72, Victoria-street, Westminster, S.W. January 10, 1910.

TOULOUSE.—War Department.—Electric motors. October 30.

VALENCIA.—Harbour Board.—Six one-ton electric cranes for timber unloading. November 2.

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BUSINESS NOTES.

LIGHTING AND GENERAL—Home.

ABERDEEN.—The Corporation Electricity Committee held a meeting to consider the dispute that has arisen with the Suburban Tramways Co. on the question of the arbiter's award in the reference on the matter of the price to be charged for electrical energy and the duration of the proposed agreement. In view of the terms of the award and the question as to whether it was within the terms of the reference, a sub-committee appointed to inquire into the matter recommended, with a view to avoiding litigation, that the Electricity Committee should without prejudice to the award fix a price at which energy should be supplied, and if necessary confer with the directors of the company to secure an amicable agreement. After considerable discussion the sub-committee's report was adopted by the casting vote of the chairman.

ASPULL.—The seal of the District Council was attached to the agreement handing over the Electric Lighting Order to the Lancashire Electric Power Co. The Clerk said the total amount which the Company would have to pay was £308, and out of that the Council would get £250. Mr. Alker observed that this would be the finish of the Order, and so far as the Council was concerned, it was quite satisfactory.

BARROW.—The supply of appliances for heating and cooking by electricity came under discussion at the Council meeting. Alderman Smith stated that the appliances were made in small numbers, and were, consequently, expensive; but by combination with other municipalities it was believed some of the articles could be obtained at about one-half the present cost, for some large firms would lay down plant for the manufacture of such articles. They did not want to interfere with local enterprise, and would very much prefer the local people to supply the articles. If, however, outside firms by getting a combined order could supply these articles more cheaply, they could supply the local contractors with them at practically cost price, with perhaps 5% added to cover expenses. It was desirable they should join this scheme, which would tend to increase cooking and heating by electricity, and thus benefit the Corporation's undertaking.

COOKSTOWN.—By 38 votes to 17, a public meeting adopted a resolution in favour of the installation of electric light, and calling upon the Urban Council to take steps in the project. Mr. J. B. Gunning-Moore, D.L. (Chairman of the Urban Council) referred to a scheme outlined by Messrs. T. L. Miller, Wilson, and Pegg, Belfast. Mr. Pegg's report, he said, estimated the cost of installation at £3,665, with an annual (estimated) expenditure of £578 and an annual (estimated) income of £925, showing a substantial annual net profit which would go to the relief of the rates. The revenue estimate was based on the assumption that there would be a considerable demand for private consumption, otherwise the Council would not be justified in carrying out the scheme. Mr. John M'Nally, J.P., a member of the Urban Council, submitted that electricity would be a better light; and, on Mr. Pegg's figures, would not only be cheaper than gas, but would ultimately tend to the relief of the rates.

DUNDEE.—The Town Council, after consideration of the relative merits of electricity and gas, and also of reports by the engineers on the subject, have unanimously agreed that High-street, Lochee, should be illuminated by electricity.

EDINBURGH.—The City electric lighting accounts for the year 1908-9 shows that the aggregate receipts were £127,853 7s. 11d., and the expenditure £66,118 8s. 9d. Out of the net surplus a sum of £9,794 15s. 2d. was contributed towards the relief of the rates and £747 carried to Reserve Fund. The electricity sold for the year ended May 15 last totalled 15,255,465 units, of which 9,833,301 were for private lighting, 3,589,527 for motor power, 1,806,946 for street arc lamps, and 25,691 for street incandescent lamps and stair lighting.

FAREHAM.—Mr. Hawes, of the firm of Messrs. May & Hawes, consulting engineers, reported to the Urban Council respecting the progress of the work in connection with the new electric works. He said that it had been a very trying time for all of them on account of the delay in the erection of the generating plant, and in consequence it was not quite in satisfactory order. The delay which had kept back the work was largely attributable to the alternator section. They did not see any hope of getting the plant in satisfactory working order for some considerable time. They could not start the general supply with one set of plant; they must have a proper reserve, and they could not allow any work to be started for the public lamps until they could see a reasonable prospect of giving them current. It was proposed to take temporary measures in connection with the arc lamps until they were fairly ready for the current, and then new lamps could be put up promptly. They proposed to order forward 1,000 pairs of carbons, 10 tons of crude fuel oil to be delivered at convenient times, and a cask of petroleum. With regard to the change over of the system, there was a considerable amount of work to be done in connection with the alteration, embracing the alteration and reconstruction of the old transformers and the alteration of meters.

GRASSINGTON.—Electric light has been introduced for illuminating purposes at Grassington., the current being taken from a generating station erected on the banks of the river, the water in the river being used as the prime mover.

GREENOCK.—The Electrical Engineer (Mr. J. A. Robertson, M.I.E.E.), in his report to the Corporation Electricity Committee for the year ended June 30 last, states that the chief feature of the year's working has been the substantial reduction in working costs, and although this was partly counterbalanced by increased loan charges, the nett profit of £1,045 may be considered quite satisfactory. The total income amounted to £23,709 6s. 1d., of which £8,663 12s. 4d. was received from lighting, £9,299 2s. 5d. from power, £4,002 9s. 8d. from traction, and £946 15s. from public lighting. The current used by free-wired installations and motors amounted to 286,357 units, and the receipts to £2,368 18s., being 10·4 and 13·2% respectively of the totals for the whole undertaking (exclusive of traction supply). Terms have been arranged for a supply to Messrs. Scott's shipyards, estimated at 1¼ million units per annum, and to the Admiralty Torpedo Factory at Battery Park. In order to cope with the additional demand, an extension of the generating plant at Dellingburn Works has been ordered, comprising one turbo-generating set of 1,000 kw. capacity, with water-tube boiler, condensing plant, switchboard, and sub-station transformers. It is estimated that the new plant will be in operation early in January next. The turbo-generator is of the Parsons-Westinghouse type, and will generate high tension current, which will be transformed to suitable working pressures in sub-stations on the consumers' premises. The coal contracts for the coming year have been placed on a slightly more favourable basis, and, as the concentration of plant at Dellingburn will enable the whole output to be generated there during six months of the year, a further reduction in operating costs may be confidently expected.

LEEDS.—With regard to the electricity undertaking, mention was made at the Tramways and Electricity Committee meeting of a proposed extension to Thwaite Gate. This, it appears, will probably have to be carried out soon. Among other matters to be taken into consideration are the supply of electric power for the sewage plant on the new estate at Templenewsam, and a similar supply to the Waterworks Committee for pumping purposes at Headingley. The tramways manager (Mr. J. B. Hamilton), presented a half-yearly statement, showing not only satisfactory results to date, but the promise of another good financial year. An application from Otley that the tramway system might be extended to that township from Guiseley was referred to the new Traffic Sub-committee.

LOWESTOFT.—The Electric Lighting Committee reported to the Council that there were now connected to the mains 1,168 consumers, representing 53,388 8 c.p. lamps. The seal of the Council was affixed to a policy of insurance between themselves and the Municipal Insurance Co., Ltd., for the insurance of the Electric Light station. The Engineer submitted tenders for third party and workmen's compensation insurances. The tender of the Ocean, Accident Insurance Co. for third party insurance at the rate of £5, and that of the Law, Car, and General Insurance Co. at 7s. 6d.%, were accepted. On the recommendation of the Engineer, it was decided to provide two Babcock & Wilcox chain grate stokers to No. 1 and 2 boilers, at a cost of £330; and that application be made to the Local Government Board for sanction for a loan for the sum of £400 to cover their cost, and the expense of the necessary alterations.

PORT GLASGOW.—At a private meeting the Council agreed to approach the Greenock Corporation with a view to obtaining a supply of electricity from that burgh.

REDDITCH.—The Urban Council resolved that the electricity works Manager be authorised to purchase 12 flatirons, 8 kettles, and 3 hot plates; that current be supplied free of cost; and materials in stock be lent for lighting purposes at a bazaar in Mount Carmel Church room; that 2 barrels cylinder oil, 2 cwt. waste, 250 Osram lamps, 2 dozen turn-down lamps, 1 gross files, etc., be ordered. The Works Manager having reported upon the cost (estimated at £5,000) of providing means for passenger traffic between Redditch and the surrounding towns and villages, the Committee, while not prepared to undertake an electric omnibus scheme at present, offered to co-operate in every possible way in the promotion of such means of transit by a syndicate, company, or private individual.

ROYTON.—To the Urban Council the Clerk read an application from the Oldham Electricity Committee to supply electricity within the Royton district. Councillor Smethurst inquired if a provisional order would be required by Royton. If so, he thought they ought to give consent if Oldham paid for the order. The Clerk pointed out that they were already tied at Royton by the Lancashire Electric Power Co. Consideration of the matter was adjourned.

SOUTH SHIELDS.—Answering outside criticism on the electricity undertaking, Alderman Rennoldson explained to the Council that at the end of March last the capital expenditure on the concern was £182,300, and the amount contributed to sinking fund and interest was £46,400. The amount paid to

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reserve fund was £13,400, making a total of £59,800. Deducting that sum from £182,300, there was left a balance of £122,500. In addition to that, there was a sum of between £18,500 and £18,600, being expenditure on land, buildings, etc., upon which they were not entitled to write off depreciation, because the land had appreciated more than the buildings could have depreciated. This made a balance of £103,500, which might be considered to be subject to further depreciation. During the 12 years the undertaking had been fairly on its feet the gross profits had been no less than £99,448. They might add to that the amount paid in interest and to sinking fund, which was £2,700, and this brought the total profits to £102,000. When the plant was put down they went ahead of the times, and it was doing its work as well, if not better, now than it was when the undertaking was started 13 years ago. The undertaking was absolutely secure and essentially sound, and it was undoubtedly one of the best of its character in the country. In view of the increasing demand for power, the Council resolved that the plant be extended at a cost of £8,500.

WESTMINSTER.—At Westminster City Council it was stated that Oxford-street was regarded as the best lighted thoroughfare in London. The Council has made arrangements to provide an improved kind of arc electric lamp for the illumination of Regent-street.

WIDNES.—The Town Council asked the engineer to prepare plans, etc., for an electrical station, at an estimated cost, including land, of £4,100. Mr. Clarke explained that about four years ago the Corporation obtained an Electric Lighting Order, and the time had come when they would have to do something or else the Order would lapse. A short time ago a Company representing the Salt Union, or a portion of that Company, proposed to erect a large generating station at Weston Point, and they submitted certain proposals for the supply of electricity in Widnes. Those proposals did not satisfy the Committee, and they made fresh proposals which were to be laid before an expert. In the meantime, the Widnes Corporation still held the Order. If satisfactory arrangements were come to with the Salt Union, then the Corporation scheme would not be proceeded with.

LIGHTING AND GENERAL—Overseas.

AUSTRIA-HUNGARY.—The Società Adriatica d'Elettricità has been formed in Fiume for the purpose of erecting a central generating station equipped with an installation capable of developing 45,000 to 50,000 h.p., which may, if necessary, be increased to 80,000 h.p. The capital of the Company will be about £1,000,000. The motive force will be obtained from the powerful waterfalls of the river Gaska, near Otociac, on the Croatian frontier. The energy generated will be utilised for lighting and industrial purposes.

WELLINGTON (New Zealand).—The report of the Engineer and Manager (Mr. Stuart Richardson, M.I.E.E.) to the Power Stations and Tramways Committee of the City Council on the working of the City tramways for the year ended March 31 last states that the gross revenue from all sources amounted to £136,436 1s. 1d., as compared with £125,010 14s. 4d. for the previous year, an increase of £11,425 6s. 9d. The traffic revenue, including Karori and Nuramar mileage dues, amounted to £129,032 13s. 9d., an advance of £10,226 12s. 7d. over the preceding year. The excess of revenue over working expenses totalled £44,763 2s. 1d., and, after allowing for interest, sinking fund, and depreciation, there remained a net surplus on the year's working of £5,934 9s. The total capital outlay to the end of the year was £564,354 5s. 8d. The passengers carried on the city lines during the year numbered 21,679,902, or 1,574,179 more than last year. The generating plant at the power station was worked to its full capacity during the year, and the Council placed an order for additional plant with the Electric Construction Co., of Wolverhampton. The contract included a Belliss and Morcom high-speed engine, coupled to an Electric Construction Co.'s generator, with a capacity of 750 kw. output, with the necessary condensing plant, electrical and other accessories, and a main switchboard panel. Two Lancashire engines, manufactured in Wellington, have also been supplied. Rail corrugations were generally evident over the whole of the routes, but most apparent in Lambton Quay, where the noise caused by cars traversing the line became very annoying. The only remedy at present adopted has been to grind the corrugations out—a tedious and expensive process. This method has been adopted in the City, the apparatus being attached to a car and the work done after traffic hours. The attachment was constructed at the Newtown Car Sheds, from designs by the Car Shed Superintendent, who also supervised the grinding operations, which, up to the present, have been a great success. The Engineer's report on the lighting undertaking shows that the gross receipts amounted to £44,321 8s. 2d., and the working expenses, including renewals of plant, £25,018 19s. 2d. After providing for interest and capital charges and depreciation, there remained a net surplus of £4,272 6s. 6d. The units generated totalled 2,571,688. The tender of Messrs. C. A. Parsons & Co., of Newcastle-on-Tyne, for the supply of a 1,500 kw. turbine generating set was accepted. During the year the consumers increased in number from 3,683 to 4,136, being a record increase in electric lighting in Wellington in any one year.

TRACTION—Home.

LONDON.—It has been resolved to proceed at once with the Harrow-road electric tramway extension. The new line of tramway will form a connecting link between the large network of tramways serving the north-western district and the terminus of the Bakerloo tube, bringing to the tube traffic from Kensal Green, Willesden, Sudbury, and so on.

TRACTION—Overseas.

GEELONG.—The Melbourne Electric Supply Co. have been invited by the Town Council to instal a trackless trolley service for the Barwon ward.

INDIA.—The Madras and Southern Mahratta Railway Co. have under consideration the question of introducing the Renard road traction on the Mysore-Siddapur-Tellicherry and Mercara-Siddapur roads, a total distance of about 140 miles. Theobald's block instruments for train signalling were recently installed at the Kumbakonam station on the South Indian Railway in connection with the Mahamagam festival. Up to December 31, 1908, the points and signals were interlocked at 49 out of 262 stations on this line. The List and Morse system was in force at 25 stations; Winter's system at 14 stations; Dutton's at 6 stations, and 4 stations were fitted experimentally. Winter's block and ticket issuing instruments for train signalling were in use at 24 stations, and Theobald's train key instruments at 16 stations. The Oudh and Rohilkhand State Railway are reported to be arranging to fit Stone's system of electric lights and fans to 12 more upper class coaches next year. Stone's electric lights and fans are to be fitted to the existing upper class carriages of the North-Western State Railway, the work being spread over a period of five years. At present, most of the vehicles on this line are fitted for lighting with gas, namely, 2,204 coaches of kinds, while 34 vehicles were fitted for electrical lighting and 279 vehicles were not fitted for lighting on either of these systems.

SWITZERLAND.—A decree has been issued granting to the St. Gall-Speicher-Trogen Railway Co., of Trogen, a concession for the construction and working of a single-track, metre-gauge electric railway, 5½ miles long, on the St. Gall-Walzenhausen route, *via* Trogen and Heiden, with a branch from Kaien to Rehetobel. The concession will expire on May 16, 1949. The line is to be built in two sections: (1) Trogen to Heiden, including the above-mentioned branch, and (2) Heiden to Walzenhausen. The first section must be completed within two years from the commencement of operations, and arrangements relative to the completion of the second section will be made later. The total cost of the work is estimated at 1,075,000 francs (£43,000).

EAST LONDON ELECTRICAL EXHIBITION.

Three of the Metropolitan Boroughs—Hackney, Shoreditch and Stepney—have set a notable example to other towns and districts by co-operating in the promotion of a large exhibition for popularising the use of electricity. The exhibition, which is attracting crowds of visitors to the Pitfield-street Baths, Shoreditch, was inaugurated on Monday, the 18th inst., and will remain open till October 30th. Some five years ago an electrical exhibition in the same building drew 24,000 people and the organizers are hopeful of an even larger attendance on this occasion. The management has been wisely entrusted to Mr. C. Newton Russell, A.M.I.C.E., M.I.E.E. (Borough Electrical Engineer, Shoreditch), who has the cordial assistance of the Borough Electrical Engineers of Stepney and Hackney, Mr. Wm. C. P. Tapper, A.M.I.E.E., and Mr. L. L. Robinson, A.M.Inst.C.E., M.I.E.E., M.I.M.E.

Mr. W. M. Mordey, M.Inst.C.E., M.I.E.E., came specially to perform the opening ceremony and he warmly commended this educational work by the Borough Councils. His view was that they were wise in having a specialists' exhibition of that description. He would not say that the time had passed for holding large international or national exhibitions, but he maintained that a great deal in a way more useful work could be done by bringing before the public in the different districts of London and the various towns throughout the country the developments in special branches of art or industry. The districts, representing practically one-tenth of London, were fortunate in having, by accident or design, the same system of electrical supply. That would make co-operation, when the time came for it, much easier than might otherwise have been the case. The public seemed to be very well served in those districts. The average price for electricity for the whole of London was 2·9d. per unit, as compared with 1·85d. in the three districts represented at the exhibition. The revenue from electric light consumers in London was probably not more than one-third of the income derived from gas; yet as a domestic light

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there could be no doubt whatever that electric light possessed enormous advantages over the other illuminant. The introduction of the metallic filament lamp had at one stroke, as it were, doubled or trebled the value of electricity as regards lighting. With a maximum force of 4d. per unit flat rate, the consumer could have with the metallic filament lamps a 20 c.p. light for four hours a day all the year round at a cost of only 12s., or something less than a half-penny a day. Mr. Mordey also laid emphasis on the value of electricity for power purposes. "In my opinion as an engineer," he observed, "the electric motor has no competitor from the point of view of advantages for power purposes." Electricity was by far the cheapest means of supply for power. As to heating and cooking by electricity, he predicted that there would be very great development in these directions in the next few years. "This business of electrical distribution is only just beginning," continued Mr. Mordey; "Borough Councils must be prepared for very large extensions of machinery and expenditure. I feel convinced that in the future the consumption of electricity will be eight times as great in these districts as it is to-day." Finally, he repudiated the idea that any other country, particularly Germany, was ahead of England in electrical distribution or electrical engineering. The consumption of electricity in London was 37 units per inhabitant as compared with 13 in the large towns in Germany, and whereas they paid on an average price of 1·85d. per unit, the cost in the German towns averaged 4¼d. "We are far and away the leaders in Europe in electrical distribution and we ought to get much further ahead."

The exhibition merits description as one of the most attractive and interesting of its kind yet held in London. There are upwards of forty exhibits effectively arranged in the two spacious halls, showing the latest developments in the application of electricity for industrial and domestic purposes. Here can be seen demonstrations of the advantages of electricity for the industries carried on in the three boroughs, as well as the more recent improvements which have made electricity the cheapest and the safest and most hygienic of all lighting systems. Experts are in charge of working machinery, electrically driven for the various branches of the wood and timber trade, and plant for the manufacture of ice, tobacco cutting, etc., by electricity is also on view. Domestic electrical appliances such as cookers, and heaters, and useful novelties are shown in endless variety and at prices to suit all tastes. In the central pavilion an Information Bureau has been opened, and visitors are readily supplied with information relating to every kind of supply in the respective boroughs, together with the official tariff of charges.

A show-board demonstrating the application of the O. S. Wiring system to economical house wiring forms one of the leading features of the displays by Messrs. Siemens Bros. & Co., Ltd. The show-board is illuminated with some of the latest types of Tantalum lamps. The firm are showing for the first time a watt meter change-over switch for three-phase circuits unbalanced loads. By using this switch the necessity of a second watt meter is dispensed with. The new pattern switch is made for any current and insulated for 10,000 volt circuits. Another new production takes the form of a flush type edgewise instrument with plain scale, by means of which, it is claimed, errors due to parallax are avoided.

Electric heater appliances for factory use, and domestic appliances are shown in great variety by Simplex Conduits, Ltd. There are electric irons for laundry work and tailoring, soldering irons and glue pots, electric kettles and electric heating apparatus, suitable for the factory, office, or home. The Simplex Metal Filament lamps illuminate the exhibit.

A completely automatic push-button electric lift is shown in operation by Messrs. Marryat and Place. A 500 amp. Moissan type electric furnace is another feature of the stand.

A "Country House and Hotel" refrigerating plant is on inspection at Messrs. G. J. Worssam & Son's stand; and electric cooking and heating apparatus on the "Ruartzalite" system are exhibited by Messrs. Thomas L. Scott & Co., Ltd.

At Tyler and Freeman's stand is shown their patent enclosed electric winch, which is specially suitable for use in very dusty or wet positions. The motor is entirely inside the hoisting barrel, which, in fact, is the revolving field of the motor. The armature revolving within it is geared thereto by internally cut reduction gear designed for any required hoisting speed. The barrel is supported on large ball bearings, enclosed with housings, which, with the end covers similar to those of the ordinary enclosed motor, make the winch impervious to anything short of actual flooding. The armature is also mounted on ball bearings and ample lubrication is provided for the gearing, so that the mechanical efficiency is very high. A starting and reversing controller of the Oram type is used.

Electrically driven wood-working machines attract attention at Messrs. Kirchner & Co.'s stand. One of the best types is the H. N. A. Kirchner new patent band-sawing machine. It is designed on unique principles, the principal feature being outside bearings of new design to the pulley shafts of both upper and lower wheels. Specimens of improved general woodworkers and automatic plane iron grinding machines are also in the collection.

Switch-gear motor starters distribution boxes, fuse boxes and instruments are shown to advantage by Messrs. Ferranti, Ltd. Ordinary wire resistances are discarded in the construction of the Ferranti motor starter, a non-metallic resistance substance being utilised. The power-distribution fuse-boxes on view are built on the Ferranti Section system. The cases permit of displacement at either end and the addition of extra units. The Ferranti electric regulator merits particular mention. The use of this regulator enables the consumer to control the amount of light given by any lamp as easily as is the case with an ordinary gas jet. It may be used with any make of incandescent lamp, and with small electric fans, no matter what the source of supply.

The National Boiler & General Insurance Co., Ltd., are showing a collection of patented appliances and fittings; Messrs. J. G. Ingram make a special feature of india-rubber electrical gloves and other goods, and the Albion Clay Co. Ltd., give prominence to Syke's Patent Stoneware Conduits for the protection of underground electric cables.

Shown on the stand of Messrs. Babcock & Wilcox, Ltd., is a model of a patent water-tube boiler, suitable for all industries, using all kinds of fuel and for the utilisation of waste gases. The model is fitted with the Babcock & Wilcox patent steam superheater for superheating the steam produced by the boiler to practically any degree. The firm are also exhibiting one of their patent chain grate stokers, designed for the efficient and smokeless combustion of semi-bituminous fuel. A model of a water-softener on the Lassen and Hjort system is also on view. The water-softener is designed for the purpose of removing, by chemical means, the scale-forming matter from water prior to its use, thus keeping the boiler free from scale and obtaining the maximum of efficiency.

The Willcox-Penberthy "automatic" injectors, "auto-positive" injectors and other steam specialities are exhibited by Messrs. W. H. Willcox & Co., Ltd., and a visit to the stand should not be missed. The "auto-positive" injector is especially suitable for compound road locomotives, steam road rollers, etc. It will start on a short lift at 25 to 30 lbs. steam pressure, according to size, and operate to 190 to 200 lbs. pressure, water 74 degrees Fahr., or summer temperature, and at winter temperature it works to 240 lbs. pressure. This injector is of very simple construction, consisting of only five working parts, and is operated by a single globe valve in the water supply pipe. Oils, plunger pumps, die stocks, are among other stores supplied by the firm.

"Quick Grip" spanners comprise the special line shown by Messrs. A. G. Taylor & Co. Mr. Haydn T. Harrison, M.I.E.E., is exhibiting a patent D.P. switch-fuse; and Messrs. R. Becker & Co. have brought together a fine collection of wood-working machines, a number of which are driven by separate electric motors.

The Thorpe meter (dial type), time lag circuit breaker and motor starter, described and illustrated in the last issue of the ELECTRICAL ENGINEER, are displayed by the Thorpe Meter Syndicate, Ltd., and are attracting a good deal of attention.

A combined installation set, consisting of a miniature type of electrolytic meter, pair of fuses and sealing trough, is one of the latest productions placed on view by the Reason Manufacturing Co., Ltd. It is neat and compact and can be used for either concentric or twin cable.

Name plates in metal and other material are shown by Messrs. Dewin Bros., who are specialists in this branch of work.

Mr. S. F. Huxley has a very interesting display including a wide range of the "Metalik" Tungsten filament electric lamp of Messrs. G. M. Boddy & Co., as recently described in our columns.

Some of the latest productions in electroyl radiators are to be seen at Messrs. Purcell & Nobbs' stand. These radiators are useful for large buildings equally with small dewlling rooms and offices. Extremely low working cost, hygienic treatment of air, 100 per cent. efficiency in working, are among other advantages of the "Electroyl."

Other exhibitors also include Messrs. Rashleigh Phipps & Co., who are showing a Kaleidoscopic Electric sign, etc.

PERSONAL.

Mr. F. A. M. M'Carty, of Queen-street, Melbourne, Australia, who came from America to supervise the installation of the Freemantle Tramway and Lighting scheme, has decided to devote special attention to consulting work in electrical engineering.

Mr. Clifford Coffey, who recently completed a three years' course in electricity at the Bendigo School of Mines, Victoria (Australia), has been appointed Manager of the Electrical Supply Co.'s power-house in that city.

Mr. T. W. Ellis, electrical engineer, of Swansea, has become a member of the South Wales Institute of Engineers.

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ROYAL COMMISSION ON MINES AND ELECTRICITY.

The Committee appointed by the Royal Commission on Mines to inquire into the causes of means of preventing accidents from falls of ground, underground haulage and in shafts, has just issued its report. This is a bulky volume, with many diagrams and tables, but there is very little said as about electricity. It is clear, however, that the members of the Committee approved of electrical winding engines. They remark that "the motive power almost entirely employed in the United Kingdom for winding purposes is steam, directly applied, and although two or three electrically-driven winding engines are in operation, electricity has not been adopted to anything like the extent that it has in Germany and France, where, since the invention a few years ago of the arrangement known as the Ilgner-Halske System, its use has been attended, in some cases, with considerable success. In the former country there are between 50 and 60 'Ilgner sets' at work. We were particularly impressed with the electrical winding appliances at the No. 11 Pit of the Compagnie des Mines de Béthune, where the Ilgner-Halske set, driving a Koepe drum winds a cage of two decks, weighing 5 tons 9 cwts. from a depth of 510 yds. The drum, or sheave, is 8 yds. 2 ft. in diameter, and a steel rope 2-24 in. in diameter, made up of seven strands, each 1-18 in., makes only one half turn, lying in a birch 'trod,' or groove way, the friction of steel against birch affording sufficient grip to prevent slipping. The 'trod' was built up of blocks of birch, keyed, the brake being applied to the rims on the bottom half of the sheave. The output from this colliery in 1906 was 1,640,451 tons. It is interesting to note that at Béthune the brake was worked by compressed air—an arrangement which is usual in Germany also—as the electric automatic brake depending on electro-magnet, is not sufficiently certain in its action to allow of its being used except in cases of emergency." As regards haulage, the Committee paid little attention to the question of electricity in this connection, deeming that they need not go behind the "Special rules." But, as we know, since their labours were undertaken, a special home office inquiry into this aspect of mining has been ordered. The Committee, however, remark that "the electrical conditions underground at some collieries, especially in Scotland, leave room for much improvement." It is added that this was no doubt largely the outcome of a lack of knowledge of electrical engineering on the part of those in control. They were impressed with the necessity of employing really competent electricians, instead of mere "handy men," who might or might not know how to wire a lamp fitting.

RADIOTELEGRAPHIC STATIONS.

An official list of radiotelegraphic stations open for international traffic has been issued by the International Telegraph Bureau, Berne. The countries included are the United Kingdom, Germany, Russia, Austria, Italy, Spain, Denmark, Sweden Norway, Belgium, Holland, Japan, Uruguay, and Chile. Unfortunately, the catalogue does not include stations in the United States, Canada, or France. Of the 690 installations, 124 are coast stations, the majority being open to the general public, and the remainder to messages from ships in distress only. In the latter class are the naval and military coast stations and those on lightships. The list does not include any inland stations, these not coming within the purview of the convention. The distribution of the stations on the coasts of the various countries is as follows:—Great Britain and Ireland 35, British West Indies 4, Gibraltar 1, Malta 1, Italy 23, Germany 15, Tsingtau 1, Russia 13, Denmark 7, Japan 5, Norway 4, Austria 3, Holland 3, Chile 3, Spain 2, Uruguay 2, Belgium 1, Brazil 1, Rumania 1. Even without counting the British stations in Canada, and elsewhere, which do not appear in the list, it is clear that Great Britain has realised that wireless telegraphy is of far greater importance to her than to any other country. In the matter of ship stations she is also well ahead, the totals for Great Britain and Germany being:—Great Britain, warships 176, merchant vessels, 86; Germany, warships 95, merchant vessels 53. Among the coast stations in Great Britain four conduct the ordinary telegraphic business of the Post Office, taking the place of a wire or cable. These stations work in pairs, one pair communicating across the Wash and the other between Mull and the Outer Hebrides. The British Post Office is the first among the signatories of the convention to use wireless telegraphy in place of the older methods as a regular means of communication.

ELECTRICAL ACTIONS IN THE LAW COURTS.

A number of cases of electrical interest are down for hearing in the Law Courts. The Donnersmarckhütte Oberschlesische Eisen-und Kohlenwerke Akt.-Ges., of Zabeze, Germany, are bringing an action against the Electric Construction Co., Ltd. The ground of their complaint is alleged infringement of two Ilger patents for automatic control of electrical fly-wheel sets in the driving of reversing rolling mills. The case will come before Mr. Justice Warrington, but is likely to be adjourned pending the result of an application regarding the validity of the patents. An action is being brought by the British Thomson-Houston Co., against the Midland Railway Co., for alleged infringement of patents relating to the multiple unit system for electric traction. The Llandudno Urban Council are bringing an action against the Llandudno and District Electric Tramways, and the question and an agreement for current supply; and another interesting case in the list is the action by Messrs. J. H. Holmes & Co., Newcastle, against the Associated Newspapers, Ltd., in reference to alleged infringement of a patent printing press control system. Lloyd's action against the Marconi is also included in the list.

SOME CONTRACTS.

A contract to supply power house equipment has been placed by the Municipal Tramways Trust, Adelaide, Australia, with Messrs. Wm. Adams & Co., Ltd., agents for Messrs. C. A. Parsons & Co.

We hear that the Home Board of the G.I.P. Railway, India, have placed an order with Messrs. Brown, Boveri & Co., Ltd., for two "Aichele" train lighting equipments, type C, each for an output of 375 watts at a tension of 24 volts. Messrs. Greaves, Cotton & Co. are supplying for the Nizam's Guaranteed State Railways an "Aichele" train lighting set, type C, but for a tension of 32 volts. This equipment is intended for fans only, installed in the Agent's saloon, and will work in conjunction with an L.T. 6 "Lux" battery by the Chloride Electrical Storage Co., Ltd.

LAW CASES.

BRITISH ALUMINIUM COMPANY.

The petitions of Dick Kerr & Co., Ltd., and A. Schonfield & Co., for the compulsory winding-up of the British Aluminium Co., Ltd., came before Mr. Justice Swinfen Eady in the Companies' Winding-up Court.

Mr. Younger, K.C., who appeared for the company on both petitions, asked that they should stand over for another month. The petitions were originally presented in July last. The company was of very great magnitude, and was doing a very great business so it was desirable that there should be a proper reconstruction, the figures to be dealt with being enormous. A scheme of arrangement had been sanctioned, and it was necessary that the arrangements should be further matured.

Mr. Martelli, for the first petitioners, did not oppose, while counsel for the other petitioners said he only asked that his clients should be acquainted with what was being done.

Mr. Younger promised there would be no difficulty in this, and his Lordship agreed to the hearing of the petitions standing over.

BREMER ARC LAMP CASE.

Mr. Justice Joyce delivered reserved judgment in the case of the British Westinghouse Electric and Manufacturing Co., Ltd., *v.* G. Braulik, in which the plaintiffs alleged infringement of the Bremer arc lamp patent.

Mr. Justice Joyce said: The invention claimed by the patent in this case is, "An arc lamp having downwardly pointed electrodes and provided with both downward and horizontal feed mechanism so arranged that a certain amount of operation of the horizontal feed mechanism takes place before the downward feed mechanism is permitted to operate, subject to the disclaiming note." The disclaiming note is: "The lamps to which this my invention applies, are of the type in which the current is supplied to the electrodes through electrode holders in which the upper ends of the electrodes are firmly clipped, and which are capable of being lowered simultaneously through the same distance, and about one of which the corresponding electrode can swing under the action of a device acting near its lower end, and I limit my claim to lamps of this description." Apparently the original claim

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was too wide, and by the disclaiming note the plaintiffs restrict the application of their invention to a particular kind or particular kinds or to a specified type of arc lamp, in such arc lamp claiming any and every arrangement whereby a certain amount of the operation of the "horizontal feed mechanism," a term previously defined, takes place before the "downward feed mechanism," a term also previously defined, is permitted to operate. He does not claim some specified or any particular apparatus or mechanism to effect the purpose indicated. The patent is not for any particular contrivance or device to effect a certain object, but generally for every mode of effecting that object in any arc lamp having certain specified characteristics. The specification by letterpress and drawings, in which it is admitted on the part of the plaintiffs, for it could not be denied, that there are several errors and inaccuracies, purports to show a mechanism quite easy to contrive, the object being given whereby such an arrangement as claimed can be effected in the particular type of arc lamp to which the invention is intended to apply, but it does not claim this specific mechanism or any other particular mechanism.

Now assuming the validity of the plaintiff's patent, if I rightly understand what the defendant is doing, it appears to me that their lamp is an infringement. But I think the real and serious question in the present case is the validity or otherwise of the plaintiff's patent, and this is impugned upon two grounds:—First, it is said that this patent is invalid for want of subject-matter; and, further, that the patent was completely anticipated by the invention claimed in Graham's specification. As has been said, and as I have said before, I do not intend to describe and explain the details of these various lamps or to discourse upon the scientific nature of what I do not understand. Lord Justice Bowen pointed out in the Fleet Case in 2 Times Law Reports, it is no part of the function of the Court to qualify itself as an expert. The Court, in such a case as this, has to act upon the evidence of experts whose qualifications and opinions are tested by cross-examination, and the Court weighs the evidence so given and tested. Thus proceeding, to my mind the result of the evidence is this: That there being a well-known contrivance or arrangement, common, if not universal, in the kind of arc lamps in ordinary use, this patent is taken out for the application of such contrivance or arrangement *mutatis mutandis* to a precisely similar, if not the very same, purpose in a particular specified type of arc lamp, namely, that described in the claim as limited by the disclaiming clause. This contrivance or arrangement as employed in the vertical arc lamp in common use at the date of the patent is variously described in the evidence. To make use of it in the manufacture of any new or other type of arc lamp, I think was a perfectly natural and the obvious thing to do, and there does not appear to have been the slightest difficulty in doing it. It might, no doubt, have been done in various ways, in any one of which there might possibly be invention, and, consequently, subject-matter for a patent; but, in my opinion, there could not, in the circumstances, be a good patent merely for the use in any new or special kind of arc lamps of that which was already known and commonly adopted in ordinary arc lamps for practically the same purpose. Rightly or wrongly, I think the objection founded on want of subject-matter to be, in the circumstances, a good and valid objection to the patent, and that in what is claimed there is no invention to support the patent, and, consequently, in my opinion, this action fails.

As to the other objections, I do not think it can be denied that the invention described in Graham's American specification is within the claim of the patent in question, and that the lamp described in such specification would work in the manner which the patentee claims as his invention, and for which he has obtained his patent.

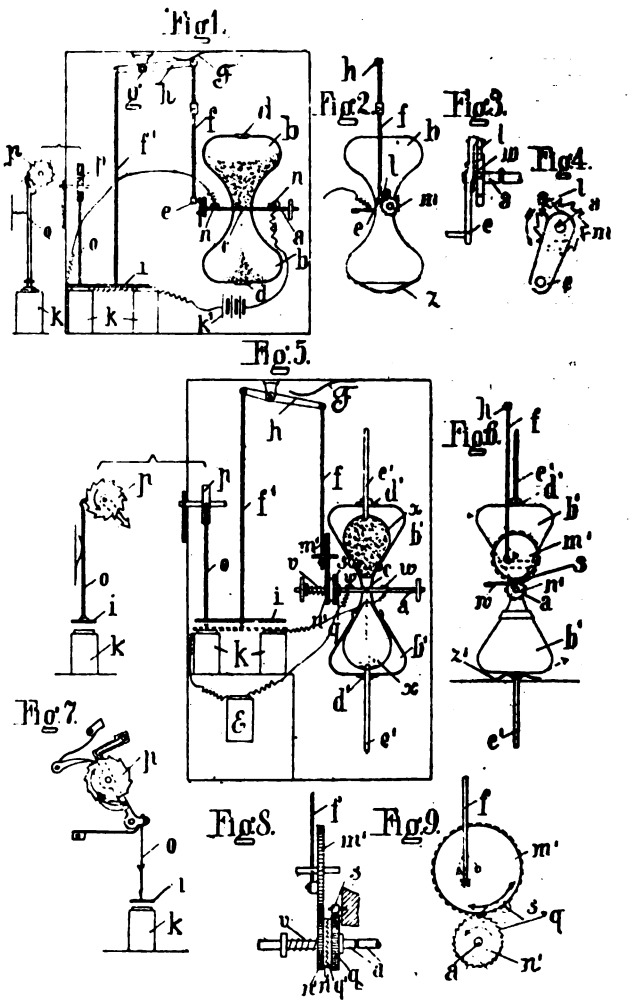
Upon the whole, I think that the plaintiffs' patent, if otherwise valid, has been anticipated by Graham's patent, if not by others; but the ground upon which I decide this case is, that in the so-called invention of the patentee as claimed, there was no real invention or subject-matter to support a patent. The result is that I dismiss the action with the usual consequences.

The British Westinghouse Electric and Manufacturing Co., Ltd., have entered notice of appeal.

PATENTS.

Producing Periodical and Intermittent Motion.

19151.—1908.—W. Vetter & C. Murer, Hagen I.W. This is an electric device for producing periodical and intermittent motion, either for the sake of recording time or for actuating any other mechanism in which such motion is required. Fig. 1 shows a diagram of a device in which the sand-glass contains an electrically-conducting material. Fig. 2 a sand-glass with rotating mechanism. Figs. 3 and 4 a side and front view respectively of the mechanism, Fig. 5 a diagrammatic view of a device in which the sand-glass contains an electrically non-conducting material. Fig. 6 a sand-glass, and Figs. 7, 8 and 9 details of this construction. On a shaft *a* which is divided into two parts, two pear-shaped vessels *b* are arranged so as to form together a kind of sand-glass. These vessels communicate with each other through an opening *c* formed between the approaching ends of the parts of the shaft. Through one of the openings *d* which can be closed, an electrically-conducting granular mass, such as iron filings, is introduced into the vessel. A conducting liquid may, however, also be employed. A certain, exactly determined time is required for the conductive material to pass from the upper vessel into the lower one. At the end of the shaft *a*, a crank *e* is loosely mounted and connected by drawrods *f* and f^1 and a lever *h*, pivoted at *g* to a plate *i*, serving as an armature for the electro-magnets *k*. The crank *e* is connected to a pawl *l* which engages a ratchet wheel *m* rigidly mounted on the shaft *a*, so that the oscillating movement of the armature *i* causes the shaft with the vessels *b* to rotate in one direction. Two contacts *n*, loosely



mounted on the shaft *a*, are connected to an electric battery k^1 and to electro-magnets *k*. As long as the electrically-conducting contents of the vessel *b* is running from the upper to the lower part, a contact is formed between the ends of the shaft parts in the opening *c* and the armature *i* is consequently attracted and retained by the electro-magnet, Fig. 1. As soon as the upper part of the vessel is emptied, however, the circuit is broken, the armature *i* released, and the lever *h* pressed down by the spring F, whereby, by means of the pawl *l* and the ratchet wheel *m*, the vessel *b* is turned so that the empty part is placed in the lower position. A spring *z* clamps the lower part of the vessel and holds it in upright position. A rod *o* is also attached to the armature *i* and adapted to advance a ratchet wheel *p* of the mechanism intended to be actuated by the device. Another construction of the device is shown in Figs. 5 to 9. The vessels b^1 are here provided with

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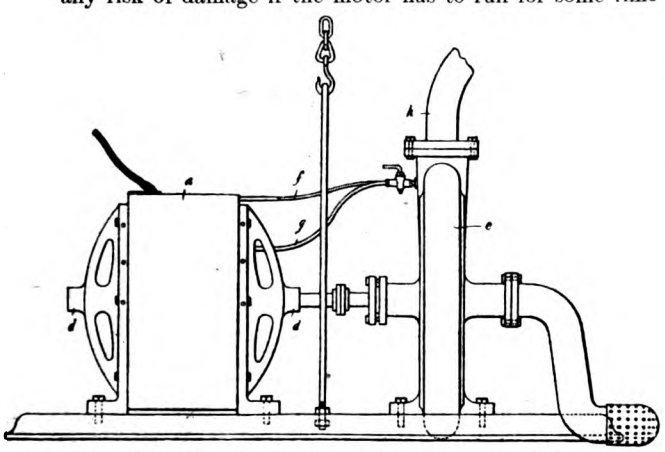
collapsible bags x containing a non-conductive material; for instance, finely grained sand. Lancets e^1, slidably guided in the ends d^1 of the vessels b^1, are attached to the bags so that their points are located inside them. Two spring actuated contacts w, sliding on the shaft a, are connected to the windings of the electro-magnet k and to the current generator E. A plate i serving as an armature for the electro-magnet k is connected through the rods f and f^1, and the lever h to a toothed wheel m^1. This meshes with a toothed wheel n^1 loosely mounted on the shaft a, and provided with a ratchet ring n^2 which engages a corresponding ring q^1 attached to a ratchet wheel q. The latter is rigidly secured to the shaft a. A spring v, pressing against the wheel n^1 holds the ratchet rings n^2 and q^1 in engagement, so that when the wheel m^1 is rotated in the direction of the arrow, the vessels b are turned with it. At the return movement of the wheel m^1, the vessels are retained by a stationary pawl s engaging the ratchet wheel q. The armature i of the magnet is connected to a draw-rod o which actuates a ratchet wheel p of a clock. The bags x are always emptied in the same time, and the lancet e^1 of the upper vessel, resting with its point on the sand, descends in proportion as the bag is emptied. When the bag is quite empty, the lancet enters the opening c between the parts of the shaft a and closes the electric circuit. The armature i is consequently attracted, and the shaft a is turned by the described arrangement in the direction of the arrow, together with the vessel b^1. But as soon as the vessel b^1 has been turned over, the lancet e^1 drops. The current is then interrupted, the armature i released and the gearings returned to their initial position by means of the spring F pressing on the lower h, while the vessels b^1 are retained by the pawl s and the spring z^1. On the attraction of the armature to the magnet, or according to the construction, on releasing it, a mechanism may be actuated; for instance, the wheel-works of the indicator may be moved forward a certain distance, say, the division of a minute on the dial. Fig. 7 illustrates an electric clock-work driven by the armature of the magnet.

Electric Motors for Driving Submerged Pumps.

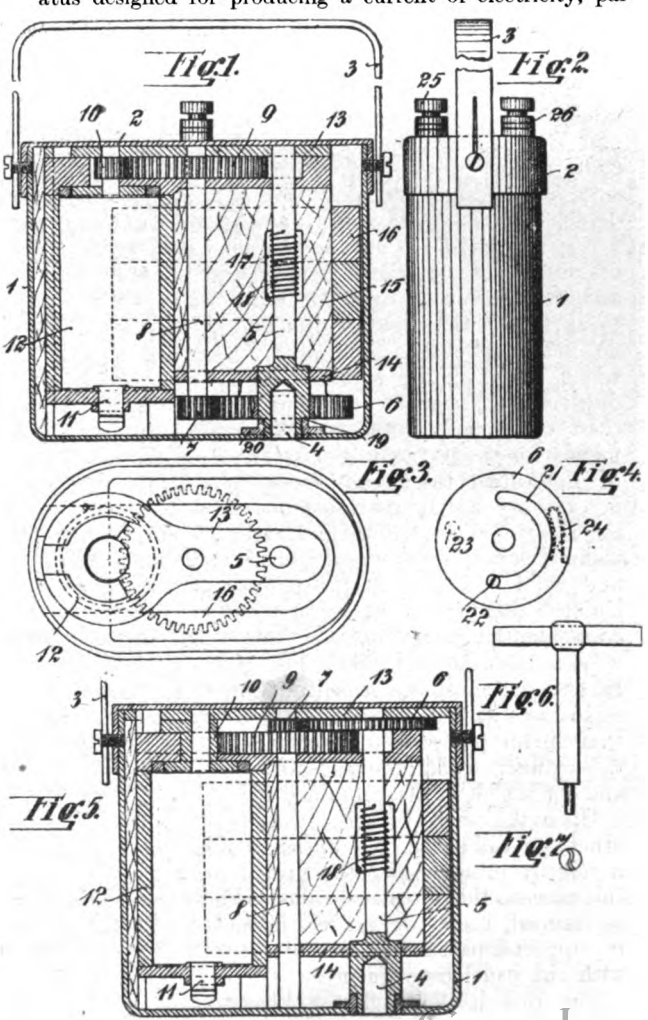
19384.—1908.—W. MACDONALD, Twickenham. In salvage works a difficulty is frequently encountered in removing water from a sunken ship on account of the depth at which the vessel lies. A suction pump cannot be made to raise water from a greater depth than 30 ft., since a column of water of that length will balance the atmospheric pressure on an area equal to its cross section. In practice, naturally the limit of useful operation is even a good deal lower than 30 ft. It, consequently, happens that when water has to be pumped from a greater depth than this, the pump must be sunk right down to the level of the wreck and operated so as to force the water upward instead of sucking it. It is then very difficult to drive the pump, because long shafting is required, and as this has to operate in water, its use is not very desirable. The present electric motor can be submerged and operated in water without the use of any enclosing casing, and can operate without any risk of damage if the motor has to run for some time



unsubmerged. Economic design is attained by taking advantage of the presence of the water as a cooling means, and allowing a correspondingly high current density in the conductors, and to avoid risk of super-heating the motor is provided with a pump, by which it continually throws a stream of water over its windings. The motor is shown in the accompanying diagram, but in its mechanical outlines it is similar to motors already in use. It is of the induction type, current being supplied only to the winding of the stator a. The rotor has conductors passing through it which are short circulated at the ends by metal rings. These rings are enclosed in insulating material, and the rotor conductors are also insulated from the core, preferably with rubber. The shaft of the motor is mounted in lignum-vitæ bearings d, which are unaffected by the water. It is necessary that the conductors should have specially good insulation, and the insulating material is best vulcanized rubber, which will withstand the action of water. The large amount of insulation necessary results in a very small space factor in the slots of the machine. This, however, is compensated for by the large increase in the current density which can be allowed in the conductors owing to their being surrounded by water. The stator and rotor body are made from stampings which have been sherardized so as to resist the action of water. For the rest, the design of the machine should be such that there are no exposed metal parts having a large potential difference between them, so that there will be no considerable leakage currents through the surrounding fluid. The rotor body and the part of the stator near it should have completely smooth surfaces, as otherwise the windage loss in the denser medium would be considerable. It is also necessary to prevent large E.M.F's. being set up in the fluid itself, and for this reason the voltage between the ends of the rotor when running normally should not much exceed that required to decompose the water. It is obvious that the motor thus designed for running under water would rapidly become over-heated if used in air. Therefore, a pump e is permanently connected to the motor shaft, and connections f, g are made between the outlet h of this pump and the motor body, whereby, when necessary, the fluid driven by the pump can be distributed over the machine. The stream of water should particularly be directed through the air gap as by the pipe g, and if considerable in volume, requires no further guidance. If a somewhat small stream is employed, however, casings and partitions may be provided to guide it to the parts where heat is generated, exactly as the air for air-cooling is guided in ordinary machines. In the case illustrated, side branches from the outflow pipe h suffice to supply cooling water, since no cooling is necessary save when the pump is in operation, the load at other times being small. The use of this water circulation is only essential when the motor is working in air, though it slightly increases the capacity of the motor even when submerged. Commonly, however, the motor is half-submerged, and when pumping is liable to bring the level of the water down below it by its own action. In general, therefore, the water circulating device should always be left in action.

Firing Electric Igniters.

14126.—1909.—F. ELEKTRISCHER ZUNDER, G.m.b.h., Cologne. The object of the improvements in magneto-electric apparatus designed for producing a current of electricity, par-



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ticularly for exploding mines, is to obtain a high efficiency in as compart a form as possible. Fig. 1 is a vertical section of the apparatus, Fig. 2 a side elevation, Fig. 3 a plan of one construction, Fig. 4 a side elevation of the end contact, Fig. 5 a vertical section of a second construction, Fig. 6 a side elevation of the key, and Fig. 7 an end view of the key. The whole apparatus is enclosed in a box 1, closed at the top by a lid 2, and carried by a strap 3. In the box there is an opening through which a key, such as that shown in Figs. 6 and 7, can be inserted into the corresponding opening 4 of the driving shaft 5. On the shaft 5 is fixed the spur-wheel 6, which engages in the spur-wheel 7, provided on the shaft 8, on the top end of which the spur-wheel 9 is secured, which meshes with the spur-wheel 10 on the shaft 11 of the armature 12. The shafts 5 and 8 are journalled in the playes 13, 1a, between which there is a wooden block 15 in the space between the limbs of the permanent horse-shoe magnets 16. In the wooden block 15 there is an opening 17, in which a recoil spring 18 is provided, the ends of which spring are attached to the block 15 and shaft 5 respectively. Near the bottom the shaft 5 is turned down to a smaller diameter, so that a flange 19 is formed, which fits in the sleeve 20 fastened to the inside of the box 1. In the spur-wheel 6 there is a segmental slot 21, through which projects the stop 22, secured to the plate 14. The wheel 6 also carries a contact piece 23, which in the end position of the wheel 6 comes into contact with the contact spring 24, by which means the circuit of the binding screws 25 and 26 is switched into the circuit of the armature 12. If desired, the spur-wheels 6, 7, 9 and 10 can all be provided at one and the same end of the apparatus, and the key can then be applied at the bottom of the box, as shown in Fig. 5. In operating this apparatus, the key is inserted into the hole 4 and turned smartly in one direction. By so doing, current is generated in the armature, which, when it has reached a maximum, is switched into the outside circuit of the binding screws 25, 26 by the contact piece 23 coming into contact with the contact spring 24. As soon as the key is released the shaft is turned back automatically into the first position.

Electric Arc Lamps.

19395.—1908.—H. J. J. Jaburg, Amsterdam. The electrodes are arranged side by side, and one of them is surrounded with a part of less dense carbon, which may be reduced by a lower temperature than the other parts of the electrode. This less dense part rests on a rotatable support which is fixed above the points of the electrodes at a position where the temperature is just sufficient to reduce such less dense part. An electro-magnet is arranged either vertically between the electrodes or in a horizontal plane under the arc in order to assist in keeping the arc constant.

Electric Telegraphy.

19450.—1908.—A. Muirhead, Shortlands. The working of the cable relay employed in connection with the re-transmission of telegraphic signals in submarine cables is claimed to be much improved by fixing the vibrator to the bridge of the suspension piece of the apparatus, and one end of the conducting fibre at a point on the armature of the vibrator in a line with the fibre of the suspension piece, the other end of the fibre being attached to the syphon. The contacts are mounted on an insulated platform, and their distance apart is adjusted by a right-handed and a left-handed screw.

Telephone Transmitters.

12918.—1909.—E. Egner & J. G. Holmstrom, Stockholm. In order that the vibrations of the diaphragm which are greatest at its centre may be made operative at all the contacts of the transmitter, a second diaphragm is provided. This is attached to the centre of the first diaphragm by an interposing hollow cylinder, so that the sounds are transmitted with as little delay as possible.

Apparatus for Controlling the Voltage of Dynamo Electric Machinery.

12704.—1908.—W. Stansfield & J. J. Hatt, Lowestoft. The apparatus has two generators, the armatures of which are coupled in series across the constant potential mains. These machines are provided with a number of exciting field coils connected in such a way that as the speed rises from zero, the two machines act together so as to build up their fields. Further increases of speed and further increases of voltage of the first machine results in consequence of the field winding connections in the field of the second machine being weakened. The field coils are so wound and connected that at and above the critical speed at which the apparatus is designed to become effective, the resultant voltage across the constant potential mains, due to the combined action of the two machines, remains constant.

Electrically-Driven Turret Clocks.

19458.—1908.—E. J. D. Newitt, A. B. Webber, and The Standard Time Co., London. The mechanism for operating the hands of the clock comprises an epicyclic train of non-reversible type. Its construction and operation is such as to overcome the action of the wind in causing the hands to vibrate and give irregular movement.

Electric Impulse Charges for the Purpose of Wireless Telegraphy.

17217.—1909.—S. Eisenstein, St. Petersburg. The hot or pointed electrode of the rectifying valve is connected with the negative pole, and the cooled electrode of large area with the positive pole of the course of current. The feeding tension of the charging current is selected in such manner that it is located at the limit of the penetrating force of the valve, so that in the first place current passes from the large to the pointed electrode, and thereupon a fresh passage of current in the opposite direction takes place, but a further passage of current and, consequently, a continuation of the oscillation process is prevented, because in the meantime the energy of the oscillation process has diminished, so that the passage of current in the direction of the first half period is impossible.

Dynamo Electric Machines for Operating Rolling Mills.

19485.—1908.—Allgemeine Electricitats Gesellschaft, F. Karl-Ufer, Berlin. An automatic regulator governed by the main current is provided for the purpose of weakening the excitation of the starting generator or strengthening the excitation of the working motor, or modifying the excitation of both machines simultaneously. The device is operative only when the current reaches a value just below a predetermined maximum current strength, and its action is to limit the current supplied to the driving motor.

Regulation of Dynamo Electric Machinery.

19921.—1908.—Aktiengesellschaft Brown Boveri & Co., Baden. In this automatic regulating device for electric machinery the regulating resistance is adjusted by means of a rolling sector, the point of which is mounted in a point bearing, and is moved by a relay controlled by the electrical system to be regulated. The circumference of the sector rolls over contacts of the regulating resistance arranged in an arc in order to produce an adjustment of the regulating resistance directly by means of the controlling apparatus and without intermediary members. By this means the system may be regulated with practically no expenditure of power and without much wear of the moving parts.

Incandescent Lamp Chains.

26287.—1908.—Allgemeine Electricitats Gesellschaft, F. Karl-Ufer, Berlin. The chain consists of the lamps and a series of insulated pieces of wire for connecting them together, and which carry on both ends holders for making the connections. The parts carrying current are completely insulated, and the linking up of the chain or the disconnection can be done rapidly without coming in contact with live portions.

Electrical Ignition Apparatus for Internal Combustion Engines.

11223.—1909.—R. F. Hall, Moseley. This is an improved construction of a combined coil and switch, in which the coil portion can be readily removed from the switch portion, and in which the making of the different wiring connections to the different parts of the circuits is greatly facilitated. Self-contained means are also provided in connection with the switch whereby the contact maker of the battery circuits can be temporarily cut out or short circuited for starting purposes, so that the trembler is at once brought into action and the circuit completed before the contact maker is rotated, thereby rendering the engine self-starting, the charge being ignited in one or other of the engine cylinders.

Converting an Ordinary Electric Lamp-Holder into a Switch Lamp-Holder.

3637.—1909.—E. B. Wright, Westcliff-on-Sea. An adapter consisting of a tube having a plug portion with pins for inserting into the bayonet socket of the lamp-holder, and a bayonet socket to take the lamp is provided. A cylinder of insulating material rotates within the plug portion, and is provided with spring contact plungers which lie within the socket and communicate with depressed contacts engaging spring plungers in the lamp-holder. A handle projects through slots in the barrel and permits rotation of the cylinder through 90°, thus breaking the circuit at four points. In the on position the switch is lightly held by the contact plungers being pressed into the depressed contact plates, while in the off position this is effected by providing blind depressions in the insulating cylinder.

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COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last prices. £
British Insulated and Helsby Cables, Ord. 1-100,000	5	7¼-7⅜
—— 6 p.c. Cum. Pref., 1-100,000	5	6⅛-6¼
—— 4½ p.c. Mortgage Debentures	100	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100	89-94
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 1-200,000 and 275,001-475,000	3	¼-⅜
—— 4 p.c. Mortgage Debenture Stock	100	40-43
Callender's Cable, Debentures	100	105-107
—— Ordinary	5	10½-11¼
—— 5 p.c. Pref.	5	5⅛-5¼
Consolidated Electrical Co., Ordinary, 1-110,000	1	⅛-¼
Dick, Kerr, and Co., Ordinary, 1,260,000	1	1-1⅛ xd
—— 6 p.c. Cum. Pref., 1-305,000	1	1-1⅛ xd
—— 4½ p.c. Debenture Stock.	100	100-103
Edison and Swan United, "A" Shares, 1-99,261	3	⅝-⅞
—— "A" Shares, 01-017,139	5	1-1⅛
—— 4 p.c. Deb. Stock, Red.	100	68-73
—— 5 p.c. 2nd Debentures	100	82-85
Electric Construction, Nos. 1 to 112,100	2	7/16-11/16
—— 7 p.c. Cumulative Pref.	2	1 3/16-1 7/16
—— 4 p.c. Perp. 1st Mort. Deb.	100	65-69
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100	68⅛-74⅛
General Electric Company (1900) 5 p.c. Cum. Pref.	10	8⅛-8⅜
—— 4 p.c. 1st Mort. Deb. Stock	100	83-87 xd
W. T. Henley's Telegraph Works, Ordinary	5	12⅛-13⅛
—— 4½ p.c. Preference	5	5⅛-5⅜
—— 4½ p.c. Debentures	100	106-108
National Electric Construction Co., 1-170,000	1	⅜-½
Telegraph Construction and Maintenance	12	34½-36
—— 4 p.c. Bonds	100	101-103

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Bournemouth and Poole, Ordinary	10	9¾-10¼
Brompton and Kensington, Ordinary	5	6¼-7⅛
—— 7 p.c. Preference	5	6¼-7⅛
Canadian General Electric Co., Common Shares	$100	120-125
—— 7 p.c. Cum. Pref. Stock	$100	120-122
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5	4-4⅛
—— 4½ p.c. Cum.. Pref., 1-80,000	5	4⅛-4⅜
—— 4 p.c. Debenture Stock, Red.	100	98-101
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5	3⅛-4¼
City of London, Ordinary	10	10⅛ 10⅜
—— 6 p.c. Cumulative Pref.	10	11⅛-12⅛
—— 5 p.c. Debenture Stock	100	121-124
—— 4½ p.c. 2nd Deb. Stk., Red.	100	100-103
County of Durham Electrical Power Distribution Co., Ordinary, 1-50,000	5	1⅛-2
—— 5 p.c. Preference, 1-50,000	5	2⅛-3⅛
County of London Elec. Supply, Ordinary	10	7⅛-8⅛
—— 6 p.c. Cum. Pref.	10	10⅜-11⅛
—— 4½ p.c. Debentures Prov. Certs. All pd., Rd.	100	104-107
—— 4½ p.c. 2nd Debentures, Red	100	100-103
Edmundson's Electricity Corporation, Ord., 1-80,000	5	⅛-5/16
—— 6 p.c. Cum. Pref.	5	⅛-¼
—— 4½ p.c. First Mort. Deb.	100	57-60
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100	91-94
Kalgoorlie Electric Power and Lighting, 6 p.c. Non. Cum. Pref., 1-150,000	1	⅜-27/32 xd
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000.	5	7-7⅛
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100	96½-99½
London Electric Ordinary	3	1⅜-2⅛
—— 6 p.c. Pref.	5	4⅜ 5⅛
—— 4 p.c. 1st Mortgage Debenture Stock, Red.	100	93-97
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	73½-77½ xd
Metropolitan Ordinary, 100,001-300,000	5	4⅛-4⅜
—— 4½ p.c. First Mortgage Debenture Stock	100	105-108
—— 4½ p.c. Cum. Pref.	5	4⅜-5
—— 3½ p.c. Mortgage Debenture, Red.	100	83½-86½
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-8,050 ($500) M 1-4,400 ($1,000)	—	82 84%
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb. Red	—	98-100
Newcastle-upon-Tyne Electric Supply, Ord., 1-50,000 and 57,010 to 137,500	5	4⅛-4⅜
—— do. 50,001 to 57,009	5	4⅛-4⅜
—— do., 5 p.c. Pref., 1-137,500 Non. Cum.	5	4⅜-5⅛
Notting Hill Electric Lighting	10	12½-13⅛
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	6-6⅛
—— 4 p.c. Debenture Stock	100	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1	1⅛-1⅜
—— 6 p.c. Non-Cum. Pref., 1-100,000	1	1⅞-1⅞
—— 5 p.c. Debenture Stock, Red.	100	103-106
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5	5⅞-5⅞
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5	6-6⅛
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	—	105½-107½%
Smithfield Markets Electric Supply, Ord., 1-12,000	5	⅜-½
South London, Ordinary	4	2⅛-3
South Metropolitan Electric Light and Power Ord.	1	5/16-9/16
—— 7 p.c. Cum. Pref.	1	1 1/16-1 3/16
—— 4½ p.c. 1st Mort. Deb.	100	100-103
St. James's and Pall Mall, Ordinary, 101-20,080 and 40,081 to 60,100	5	8⅛-9
—— 7 p.c. Pref. Non. Cum.	5	7-7⅛
—— 3½ p.c. Deb.	100	84-88
Urban Electric Supply Co., Ordinary	5	⅜-½
—— 5 p.c. Cumulative Preference, 50,001-100,000	5	1⅛-1⅜ xd
—— 4½ p.c. First Mort. Debenture Stock, Red.	100	77⅛-78½
Westminster, Ordinary	5	8⅛-9
—— 4½ p.c. Cum. Pref., 110,101-191,379	5	5-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 5 p.c. Cum. 1st Pref., 1-640,000	5	4⅛-4⅜
—— Debenture Stock, Red	100	92-93
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1	⅛-¼
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1	9/16-11/16
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	87-90
British Columbia Electric Railway Co., Ord. Def.	100	151-156
—— Ord. Pref.	100	121-126
—— 5 p.c. Cum. Perpetual Pref. Stock	100	109-112
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	100-102 xd
—— 4½ p.c. Vancouver Power Deb.	100	102-105
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10	⅛-1
—— 6 p.c. Cm. Pf., 30,001-60,000	10	2⅛-2⅜
—— 5 p.c. Perpetual Debenture Stock	100	82½-85½
—— 4½ p.c. 2nd Deb. Stock	100	62-66
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100	98½-100½
Calcutta Tramways, Ord., No. 1 137,610	5	4⅛-5⅛ xd
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5	4⅛-5
—— 4½ p.c. 1st Deb. Stock, Red.	100	101-104
Cape Electric Tramways, Nos. 1-491,222	1	3/16-7/16
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5	4⅛-5⅛
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100	96-100 xd
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5⅛-6
—— 4 p.c. Deb. Stock, Red. (1985)	100	98-101
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12⅛-13⅛
London United Trys (1901) 5 p.c. Cum. Pref.	10	2⅛-2⅜
—— 4 p.c. 1st Mt. Db. Stock, Red.	100	67-70
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	1/32-5/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1	3/32-7/32
—— 4½ p.c. Deb. Stock, Red.	100	94⅛-96⅛
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100	100½-103½
Provincial Tramways Co., Ordinary, 1-24,912	10	4-4⅛
—— 6 p.c. Cum. Pref., 1-10,000	10	9½-10⅛
San Paulo Tramway, Light, and Power Co.	$100	148½-151½
—— 5 p.c. 1st Mort Deb, Red. (1929) 1-12,000	$500	101-103%
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅜-½
—— 4 p.c. Deb. Stock, Red. (1940)	100	69-73
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5	⅛-¼
—— 6 p.c. Cum. Pref., 1-46,261	5	1⅛-2⅛
—— 4½ p.c. 1st Deb. Stock, Red.	100	81-85

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100	60-62
—— 4 p.c. Pref.	100	85-87
—— " " deferred	100	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	101-103
City and South London, Consolidated Ordinary	100	30-31
—— 4 p.c. Debenture Stock	100	100-102
—— 5 p.c. Pref. Stock '91	100	108-110
—— " " " '96	100	104-107
—— " " " '01	100	100-103
—— " " " '03	100	96-100
Underground Electric Railways of London, 5 p.c. Prior Ln. Bds.	—	102½-103⅛

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price £
Amazon Telegraph Co., 1-25,000	10	3-3⅛
—— 5 p.c. Debs., Red., within 1-1,609 Red	100	95-98
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000	96-98
Anglo-American Telegraph Co., Ordinary	100	61-63 xd
—— 6 p.c. Preferred Ordinary	100	102-103
—— Deferred Ordinary	100	21⅛-22
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100	88-90
Direct Spanish Telegraph Co., Ordinary	5	3-3⅛
—— 10 p.c. Cum. Preference	5	8-8⅛
—— 4½ p.c. Debs., 1-600	50	100½-102½
Direct United States Cable Co.	20	13⅛-13¾ xd
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 p.c. Mort. Debs., within 1-8,000 (1913),	25	100-102
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	—	—
Eastern Extension, Australasia and China, 1-300,000	10	11⅛-12⅛ xd
—— 4 p.c. Mort. Deb. Stock, Perp.	100	102-104
Eastern Telegraph Co., Ordinary Stock	100	127-130 xd
—— 3½ p.c. Preference Stock	100	84-86
—— 4 p.c. Mortgage Debenture Stock	100	104½-106½
Great Northern Telegraph Co. (of Copenhagen)	10	26'-27½
Marconi's Wireless Telegraph Co., Nos. 1-394,190	1	⅜-½
National Telephone, Preferred	100	107-108½
—— Deferred Stock	100	121-123
—— 6 p.c. Cum. First Pref.	10	10⅛-11
—— 6 p.c. Cum. Second Pref.	10	10⅛-10⅞
—— 5 p.c. Non. Cum. Third Pref.	5	5 7/16-5 11/16
—— 3½ p.c. Deb. Stock, Red.	100	98-100
—— 4 p.c. Deb. Stock, Red.	100	100-102
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100	100-102
West Coast of America, 1-30,000 and 53,001-53,008	2½	1⅞-1⅛
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	100-102
West India and Panama Telegraph Co., Ordinary	10	11/1613/16
—— 6 p.c. Cum. 1st Preference	10	8⅛-9⅛
—— 6 p.c. Cum. 2nd Preference	10	8⅜-9⅛
—— 5 p.c. Debs., Red., 1-800	100	101½-103½
Western Telegraph Co., 1-207,930	10	13⅛-14
—— 4 p.c. Debenture Stock, Red.	100	103-105 xd

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1909.	1908.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Oct. 13	1,322	1,331	— 9	— 607	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940.	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Sept.	6,538	7,241	— 703	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Oct. 10	1,080	1,071	+ 9	— 390	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Oct. 9	6,755	6,511	+ 244	—	56·702	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,273	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Oct. 9	4,889	4,888	+ 1	+ 3,568	98	98	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	Oct. 17	924	921	+ 3	+ 1,358	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Oct. 15	5,607	5,258	+ 349	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Oct. 16	1,292	1,185	+ 107	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Oct. 17	277	268	+ 9	— 193	10	10	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Oct. 16	5,509	8,262	—2,753	—37,272	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	Sept.	6,678	5,642	+ 1,036	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Oct. 17	3,016	2,933	+ 83	+ 1,498	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Oct. 14	505	477	+ 28	—	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Oct. 1	1,652	1,512	+ 140	+ 2,666	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Oct. 15	135	129	+ 6	+ 84	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Oct. 15	5,438	5,321	+ 117	+ 1,573	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Oct. 16	1,001	941	+ 60	+ 3,686	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Oct. 9	18,088	18,313	— 225	—4,723	189	179	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Sept.	9,693	9,264	+ 429	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Oct. 9	1,640	1,622	+ 18	+ 1,395	28½	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	Oct 16	3,928	3,370	+ 558	+ 2,463	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Oct. 9	477	464	+ 13	+ 902	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Oct. 13	135	139	— 4	— 243	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Oct. 13	1,303	1,313	— 10	— 744	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Oct. 2	11,158	11,443	— 285	—2,122	104	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Oct. 10	1,323	1,339	— 16	+ 39	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Oct. 2	38,768	38,562	+ 206	+36,151	124½	122½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	„ 17	216	258	— 42	— 743	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Oct. 9	195	202	— 7	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	—2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Oct. 16	10,168	10,114	+ 54	+ 5,731	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Oct. 10	16,455	1,4736	— 981	— 4,363	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,7·0	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Oct. 9	4,051	3,944	+ 107	— 1,463	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Oct 14	628	620	+ 8	— 119	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,596	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Oct. 10	5,935	5,667	+ 268	— 736	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Oct. 6	1,103	1,127	— 23	— 445	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug. 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	—7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Sept. 22	169	156	+ 13	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 17	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Oct. 16	918	891	+ 26	+ 700	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Sept. 30	2,304	2,289	+ 15	+ 3,896	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Sept. 22	879	804	+ 75	— 784	22½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train miles. h Half-year's figures.

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NOTES.

CENTRAL STATIONS AS SCHOOLS.

An instructive little episode has occurred at Swansea. It appears that two lads from the Technical College had had a three years' course of training at the Municipal Electricity Works, but the engineer reported that this training was inadequate as far as making them competent electricians was concerned, because they lacked the necessary workshop experience. The cheerful outlook before them, said somebody on the Electric Lighting Committee, was that they would remain switchboard attendants all their lives. Probably this was an exaggeration, for it does not reflect much credit on the intelligence of the pupils. In this particular case, the Education Committee is to enquire whether the lads should not be given scholarships to enable them to attend a workshop course. This is merely a detail of local concern; but the wider principle at stake is worthy of a moment's consideration. Have not the Education and the Electric Lighting Committees been making a grievous mistake, harmful alike to the unfortunate lads and to the Electrical undertaking? It seems clear that they were released from the Technical College too soon. They ought to have received their workshop training before being introduced to the Electricity Works. In that case, they would have been less trouble, more use to the Electrical Engineer, and more use to themselves. There is no objection to Municipal Departments, electrical or otherwise, being made a step in the educational ladder, provided common sense is used. Here common sense seems to have been conspicuously absent, so that the lads have partly mis-spent their own time and that of the Corporation's officials.

MUDDLED REPORTS.

Birmingham's Public Works Committee has distinguished itself by the issue of a muddle-headed report on street lighting. Sir James Smith, in presenting the Committee's report, stated that "after inspecting the experimental installation of electric lighting arranged by the Electric Supply Committee, they had caused the lamps in "seven of the leading streets" to be fitted with inverted incandescent gas-burners, which, by experiment, they found to be more efficient, and they purpose to slightly increase the height of the lanterns." To this categorical statement Mr. Ellanvy demurred, maintaining that no proper comparison was made between electric lighting and gas lighting. Very rightly he objected that it should go forth that proper investigations had been made, and the one system found more efficient than the other. Promptly the Lord Mayor made the fatuous remark that the words "more efficient" in the report meant that what was being done now was better than what obtained before! Then why not say so? That the Birmingham Public Works Committee plump for gas lighting against electric lighting without due consideration and proper examination is entirely a matter for local consideration, but that so misleading a report should be issued by a public body is a matter against which everyone interested in electricity and truth has a right to protest.

SEVENTY PER CENT. DROP.

Reporting to his Committee, Mr. Thomas Roles, City Electrical Engineer, Bradford, estimates the fall in revenue on the lighting side as a result of the introduction of metallic filament lamps as high as 70%. But he does not show himself inordinately perturbed at the prospect, realising that the economy thus made will prove the most convincing of advertisements, leading to further extensions. This, and the encouragement to be offered to power consumers, he feels, should enable the revenue to be kept up. This is the proper spirit in which to meet improvements. Nevertheless, it may be well for some kind of conference to be held on the whole subject of charging for current and general service.

IRRIGATION CANAL.

A very hopeful development of irrigation work is being put to practical test on the Upper Swat Valley, where a big irrigation scheme is being carried out. The water brought down in the canal is to be utilised for generating electricity, and a large station has been erected. For the present, and some time to come, all the power available will be utilised in pushing forward the irrigation scheme on both sides of the Malakand Ridge, which is to be pierced by a tunnel, work being commenced from each end. The tunnel, which is to accommodate a branch of the canal, will be over two miles long. It is probable that irrigation and electric power development might often go together, thus making both more feasible.

AUSTRALIA AND ELECTRICITY.

Australia has shown considerable enterprise both in the generation and utilisation of electricity and in the manufacture of electrical appliances. Obviously, however, there are limitations in the latter direction, seeing the scanty population of the island continent and the regrettable slowness of growth. Of late this has been brought before public notice rather conspicuously owing to the Postmaster-General of the Commonwealth deciding to make a lavish extension of slot telephone appliances, and desiring to obtain the machines from Australian manufacturers. Although two invitations have been made, not a single tender has been sent in. This is not altogether to be wondered at, when one considers the expensive equipment necessary for successful manufacture. Attempts are to be made to modify the design of machines and specifications in order to tempt the local manufacture. In a matter of this kind, populous countries are naturally in a better position to supply more efficient appliances at a lower price. In this instance it is probable that the Postmaster-General will ultimately have to seek what he wants in Europe or America, or ruthlessly cripple his service.

ELECTRIC LOCOMOTIVES IN PRUSSIA.

The Prussian State Railway Department already possess upwards of 70 electric-locomotives deriving their power from accumulators. These have answered so well that another 33 are on order, and are to be delivered for service early in the new year. The chief centre of activity is Worms, whence lines radiate to Oppenheim, Weinheim, and Bensheim. Experiments are also being carried out with a petrol-electric locomotive.

CENTRALISING SUPPLY IN FRANCE.

The Société Central Electrique du Nord's chief mission is to foster electric development in the most active of the industrial districts of France. One of its most promising offshoots is the Energie Electrique du Nord de la France, which is erecting a central station near Lille, with substations at Roubaix and Tourcoing. It will generate electricity in bulk, for other organizations to distribute, but will also act as a distributing agency. Within six miles of the Central Station steam power is used to the

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extent of over 150,000 h.p., and there is a population of 600,000. Another affiliated company is the Société Electrique Lille-Roubaix-Tourcoing, whose activity is devoted to locomotion. A considerable extent of tramway line at Lille has already been electrified.

STANDARDIZATION IN MINING.

Mr. F. C. Albrecht, of the Westinghouse Electric and Manufacturing Co., American branch, when lecturing on electricity in the coal mining industry, as reported in our last issue, had much to say on the question of standardisation. In the course of his remarks he roundly declared that :

" The sooner mining and electrical men get together and adopt a system of standards mutually agreeable and understood, the better it will be for all concerned. I am glad to say that some steps in this direction have already been taken. At the last meeting of the American Mining Congress in Pittsburg, a resolution was passed which authorized the appointment of a standing committee for the purpose of standardizing mining practice and making necessary recommendations for electrical work in the mines.

" This standardization can apply not only to the voltages employed in the mine, but can be followed out further, in, for instance, the gauges of the tracks in the mines. Likewise, a certain standard for horse-power per ton and speed in miles per hour for locomotives might be at least approximately arrived at."

STANDARDISATION OF CATALOGUES.

One of the minor, but by no means least irritating, worries of busy men is the difficulty of keeping track of manufacturers, catalogues, price lists and booklets, owing to their varied forms and sizes. It has occured to a number of practical engineers that something should be done to remedy the evil, and as a result the Engineers, Standardised Publications Association has been formed, with Mr. J. D. Barton Innes as the energetic Secretary, and Mr. John I. Hall as Technical Manager. The Advisory Committee consists of Messrs. A. H. Dykes, A.M.I.C.E., M.I.M.E., T. W. How, F.C.S., H. M. Savers, M.I.E.E., and W. H. Booth, M.Am.Soc.C.E. The object of the Association is to systematise the keeping of catalogues by the introduction of scientific classification, and by bringing influence to bear on manufacturers. The scheme is to get both engineers and manufacturers to become subscribers to the Association, and through its intermediary preventing waste, as members would apply only for lists relating to subjects in which they are interested. The Association should in time be able to confer a great boon on all concerned. It may be mentioned that about a score of electrical engineers, many of them being chiefs of Municipal Electrical Departments, are subscribers to the Association, whose address is Craven House, Kingsway, London, W.C.

ELECTRICAL STANDARDISATION IN CANADA.

A conference of municipal engineers has been held at the City Hall, Toronto, under the presidency of Mr. R. A. Ross, mainly to consider a system of standardising the equipment for municipal hydro-electric power schemes. It appears that excellent progress was made, among other matters, it being decided that no motor exceeding 10 h.p. shall be supplied with power from the lighting mains.

SWEDISH ELECTRIC SMELTING COSTS.

Sir Cecil Spring-Rice, writing from Stockholm to the Canadian Department of Mines, makes the following interesting statement regarding the development of electric smelting in Sweden :—Arrangements have been made with the Trollhatten Water Power Co. for the construction and working of three electric furnaces for the production of pig iron. Each furnace is to receive a current of 2,500 h.p. and to produce 7,500 tons per furnace per annum. Two are to be in working, while the third is in reserve. The price of the current per horse-power per annum is 27·60 kronors for the first 10 years, and 36·80 kronors the next 10. The ore is to be brought from Grängesberg, containing from 0·4 to 1·9% phosphorus. Westphalia coke will be used, costing about 21 kronors at Trollhatten. It is calculated that the cost of production will be 51 kronors per ton pig iron. The sale price is 58 kronors. With a production of 15,000 tons per year the cost is calculated as follows :

	Kronors.
Three furnaces	150,000
Tools, etc.	15,000
Crushing apparatus for 35,000 tons ore and 7,000 tons coke	9,000
Electric motors, lighting, etc.	6,000
Transport of ore, and coke from harbour	15,000
Transport of pig iron and slag	12,000
Houses and shelters	64,000
Harbour works, levelling, etc.	15,000
Laboratory, unforeseen, etc. (11%)	20,000
Licence	34,000
Working capital	25,000
Minimum capital	235,000
Totals	600,000

The kronor is worth a little over thirteenpence.

DEVELOPMENT OF THE MARINE STEAM ENGINE.*

By MR. A. T. BARBER.

The first actual experiments in the propulsion of ships by means of steam power were made in the early part of the eighteenth century. None of these early attempts led to any definite practical results, and it was not until 1801 that the *Charlotte Dundas* showed the practicability of employing the steam engine for propelling ships. The ordinary beam engine was the first type of engine generally used for driving the paddle-wheels, with which all the early steamships were fitted, and this arrangement is still in use on some American river steamers at the present date. A modified form of beam engine, known as the " side lever " engine, was very largely used from 1820 to 1860, and was very successful, being brought to great perfection by Robert Napier in the early Cunard liners. Direct-acting engines were introduced in 1837 in H.M.S. *Gorgon*, the cylinders being vertically below the paddle shaft, but these engines were objectionable on account of the short connecting rods, which were necessary. The " steeple " engine and " Siamese " engine, introduced a few years later by Maudslay and Field, were improvements on this, as they allowed longer connecting rods to be used. The oscillating cylinder engine, introduced in 1827, did not find much favour at first, but was improved and re-introduced by John Penn in 1838, and became very popular for paddle engines. The diagonal direct-acting engine was invented by Brunel, and is now the almost universal type of engine for paddle-wheel steamers.

On the introduction of the screw propellor in 1836, gearing was necessary in order to drive the screw by means of the slow-running engines then in use. On account of the trouble given by the gearing, screw propulsion was dropped, but revived later on with higher speed engines working direct on to the propellor shaft. The best types of the early direct-acting screw engines are : the " return connecting rod " engine, Penn's trunk engine, and the short-stroke horizontal engine. The universal type of piston engine for all screw steamers now is the inverted cylinder engine. The chief advantages of this type of engine are : adaptability to any class of boat, even distribution of power by using many cylinders acting on one shaft, and also economy in material and fuel.

The two chief points aimed at in the improvement of the marine engine have been : reduction in fuel consumption and reduction in weight of machinery. Early marine engines worked with absurdly low steam pressures, and used from 5 to 9 lbs. of coal per i.h.p. hour, but in the improved modern type of engine the coal consumption has been brought down to less than 1 lb. per i.h.p. hour. This has been effected by the use of high-pressure steam, multiple expansion, increase in crank revolutions and in piston speed, and improvement in design. Reduction in weight of engines is usually of first importance in war vessels, and has followed naturally with the improvements necessitated by a low fuel consumption. The weight of engines is reduced to a minimum in torpedo craft, the weight of machinery (including boilers) being about 30 lbs. per i.h.p. This light weight is brought about by running at very high speeds, using high-pressure steam and a very low factor of safety, with great care in design and careful balancing of parts.

* Abstract of paper to be read before Northampton Institute Engineering Society, London, Oct. 29.

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DEVELOPMENT OF ELECTRICAL UNDERTAKINGS.*

By S. J. WATSON (Borough Electrical Engineer, Bury).

It is, I believe, usual that a Chairman's address at the commencement of each session should deal with some particular subject, and I, therefore, propose to make a survey of various points of interest in connection with the development of electric supply undertakings during the past 15 years. I have personally been engaged with supply undertakings for about 17 years, and may fairly claim to have been closely in touch with the subject.

In looking backward, one cannot help but be impressed with the remarkable growth that has taken place during a comparatively short period of time, and the tremendous amount of work involved in the equipment and setting to work of the various power stations with their distributing systems.

Complete statistics are, unfortunately, not available, but, in order to illustrate the growth that has taken place, I have prepared a table, giving a summary of the records contained in issues of *Lightning* and the *Electrical Times* in 1894, 1899, 1904 and 1909, so that you will see, and, I hope, appreciate, the improvements which have taken place during three periods, each of five years.

It is no small thing to find that the amount of capital invested has increased from four to nearly 60 millions of money in 15 years, but such a fact does not necessarily imply that the capital is being employed to greater advantage from the engineering or even from the financial point of view, and in order to show that progress has, indeed, been made, I have also shown on the table what the increase has been during each period of five years, and the extra cost of dealing with such increase.

RECORDS OF SUPPLY UNDERTAKINGS.

Year.	1894.	1899.	1904.	1909.
Number of undertakings	30	100	225	290
Capital expenditure	£4,472,925	£11,895,993	£38,284,458	£57,818,142
Plant installed	32,108 kw.	112,631 kw.	454,565 kw.	795,036 kw.
Increase in capital	..	£7,423,068	£26,388,465	£19,533,684
Increase in plant	..	80,523 kw.	341,934 kw.	340,471 kw.
Capital outlay per kw.	£139	£105	£84	£72
Cost per additional kw.	..	£92	£77	£57
Maximum load	..	78,866 kw.	269,680 kw.	501,941 kw.
Per cent. to plant installed	..	70%	59%	63%
Units sold	15,231,181	76,432,250	349,003,935	824,819,503
Increase in output	..	61,201,069	272,571,685	475,815,568
Per cent. increase	..	401%	357%	156%
Units sold per £1 expenditure	3·4	6·4	9·1	14·2
Units per additional £1 expenditure	..	8·2	10·3	24·4
REVENUE	£392,077	£1,556,262	£4,763,111	£7,528,321
Per cent. to capital	8·7%	13·1%	12·4%	12·8%
Increase in revenue	..	£1,164,185	£3,206,849	£2,665,210
Revenue per unit	6·16d.	4·89d.	3·27d.	2·16d.
Revenue per additional unit	..	4·55d.	2·32d.	1·34d.
Working expenses	£243,021	£786,115	£2,334,088	£3,681,504
Per cent. to revenue	62%	51%	49%	49%
Cost per unit	3·82d.	2·47d.	1·60d.	1·07d.
Cost of additional units	..	£543,094	£1,547,973	£1,347,416
Cost per additional unit	..	2·13d.	1·36d.	0·68d.
GROSS PROFIT	£149,056	£770,147	£2,429,028	£3,846,817
Per cent. to capital	3·3%	6·4%	6·3%	6·6%
Increase in gross profit	..	£621,091	£1,658,876	£1,417,794
Per cent. to additional capital	..	8·3%	6·3%	7·2%
Load factor total output	..	11·0%	14·7%	18·7%
Load factor additional output	..	..	16·3%	23·3%

This method of ascertaining the cost of the extra units sold from year to year, and also the extra capital charges incurred in supplying the extra units, gives some very valuable assistance when working out the price to be charged to cover the cost of supplying large consumers. I have personally used this method for some years, and you may, perhaps, be interested to know that applying it to the past seven years' records of the undertaking with which I am connected, during which time the output has increased nearly tenfold, and large extensions have been carried out to plant and mains, I find that the extra generating costs amount to ·293d. per unit, the extra capital charges on plant to ·154d. per unit, the extra distributing costs, *i.e.*, repairs and capital charges on mains, etc., to ·234d. per unit, and the extra management charges to ·087d. per unit, so that the total additional cost of supplying the extra units amounts to ·768d. per unit. The load factor of the increased output has been 23·2%.

The figures given on the tables need little explanation, but I would particularly call your attention to the fact that the capital cost per kw. of plant and mains installed has decreased from £139 in 1894 to £72 in 1909, the number of units sold per £1 of capital invested has increased from 3·4 to 14·2, the average price charged has been reduced from 6·16d. to 2·16d. per unit, and the gross profit has gone up from 3·3% to 6·6%. It is also of interest to note that, whereas the cost of the plant and mains added during the period 1894 to 1899 was £92 per kw., the cost of the additions during the period 1904 to 1909 was only £57 per kw., and that the additional working expenses for the increase in the output between 1894 and 1899 was 2·13d. per unit, whereas the cost for the increase in output between 1904 and 1909 was only ·68d. per unit. A number of other contrasts might be made, but I will only mention that there is a difference of 293,095 kw. between the total capacity of the plant installed and the maximum load recorded, that is to say, that no less than 37% of the total plant is provided as spare. This represents a capital expenditure of over six millions, which is entirely unproductive, inasmuch as it does not earn one penny of income. In this connection I would remind you that Parliament has recently granted powers to the London supply undertakings to interconnect their power stations. It is evident from these figures that such permission was badly wanted. There is no doubt that where power stations are situated within a reasonable distance of each other, the cost of running interconnecting cables would be small compared with the saving of expendiure on plant.

I roughly estimate that within a distance of 8 or 10 miles of the Manchester Town Hall there are some 20 public generating stations, having between them a total capacity of 100,000 kw., which has probably cost over two million pounds. To construct a system of mains partly above and partly below ground so as to interconnect these generating staions would cost about £150,000, but by so doing it would be possible to reduce the quantity of spare plant from 37% to, say, 12%, and enable the existing stations to supply an increase in load of 25,000 kw. without any further expenditure, thus making use of existing plant, having a value of about £500,000 at a cost of £150,000 on mains. Some additional expenditure would be necessary to provide converters at some of the existing works, but against this might be put the saving in working expenses through running the plant at higher efficiencies.

It was about the year 1894 that the fight was taking place between the respective advocates of high-tension

* Chairman's address at opening meeting, Institution of Electrical Engineers' Manchester Section, Oct. 22.

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alternating and low-tension direct current systems. Judged in the light of later knowledge, it must be admitted that both sides had very good grounds for their arguments. The generation of high-tension alternating currents for for transmission over large areas has become the standard practice, although, by the way, such currents are not single, but multi-phase and low tension direct current is still very largely employed, and, in point of fact, absolutely essential for many purposes, although the pressure now used is mostly 220 or 440 volts instead of 100.

In the earlier years of their existence there is no doubt that much better results were obtained from the direct currents than from the alternating current stations owing to the assistance of storage batteries, which in nearly all cases formed part of the equipment, and also to the much higher efficiency of the distributing systems, but at the present time, principally owing to the increase in the outputs and in the supply area, and also to improvements in alternating current transformers, there is very little difference between the results obtained from either system.

Bearing in mind the rapidity with which power stations were constructed one after the other about 1894, it may be said that, with the knowledge and experience then available, the majority of the work was carried out on lines that have very well withstood the test of time. On carefully considering the matter, it appears to me that only one serious mistake was made, which has only become apparent as one extension after another has had to be carried out to meet the demands of a rapidly increasing business. I refer to the somewhat common practice originally adopted of erecting the generating stations in thickly populated districts in order to keep down the expenditure on mains, without taking into consideration either the facilities provided for obtaining delivery of fuel, the provision of an adequate supply of water for condensing purposes, or providing ample room for extensions.

The growth which has taken place was very much underestimated, and in consequence of this want of foresight, it has been necessary in many cases to construct new generating stations on more suitable sites, or to make good the deficiencies of the existing sites at considerable expense.

The reductions in the average cost per unit between 1894 and 1909 is, of course, appreciable, and has been brought about principally through the increase in the output and the better load factor conditions, but these influences, important as they undoubtedly are, would not appear to be sufficient to account for the reduction which has taken place in the fuel cost, and, speaking broadly, there has not been any considerable change in the design or arrangement of generating plants to account for this reduction. The steam consumption of engines in 1894, owing to the long experience on marine work, was very little greater than of engines obtainable to-day, and the efficiency of combined plants was much the same. Small improvements have, however, taken place, steam consumptions have been slightly reduced, particularly through the use of superheated steam, boiler pressures are higher, improved mechanical stokers have been designed and brought into service, steam and other piping arrangements have been simplified and greater attention has been given to the losses incurred in auxiliary plant. Not the least important factor has been the increase in the size of generating sets. The limit appeared to have been reached with the 500 kw. bi-polar machine, but with the advent of the multi-polar design, largely through being able to use carbon brushes, the sizes rapidly increased to about 1,500 kw., and to-day the Manchester turbine-alternators of 6,000 kw. are the largest in use in this country, although one hears of 10,000 and 15,000 kw. sets being used on the European and American continents.

In dealing with the changes that have taken place in connection with prime movers, one is bound to make some reference to the steam turbine, which, although obtainable in the smaller sizes as far back as 1894, was not generally accepted as a satisfactory article in the larger sizes until five or six years ago. For alternating currents, plants of 1,000 kw. and upwards, turbines have now, however, become standard practice.

In the early nineties a difference of opinion existed as to the relative advantages of single acting and double acting engines; a similar problem is with us to-day in regard to the principle of turbine construction. With the small plants of, say, 250 kw. used in the past, it would probably have been difficult to prove that any great difference existed between one type of engine and the other, although in the still larger sizes the double acting engine has been the most successful. At the present time equally good results are apparently being obtained from both the impulse and the reaction type of turbine, but if we accept as a sign of the times what is being done in other countries, it would appear that the impulse machine is being used to an increasing extent in the large sizes. The tendency of turbine construction is to increase the clearances, reduce the number of stages, and to shorten the length between bearings, and progress along these lines is likely to be more successful with the impulse rather than with the reaction machine.

A question of some importance to supply undertakings is to what extent the costs can be reduced by the employment of exhaust steam turbines. Many generating stations are wholly or partly equipped with reciprocating engines, and the advisability or otherwise of installing exhaust turbines to work in connection with such plants requires consideration.

The advantages to be derived are twofold :—1. The total capacity of the plant will be increased by an expenditure on the turbine sets only without any extensions of steam raising plants. 2. The fuel consumption will be appreciably reduced.

In order to illustrate the effect of installing exhaust turbines in an existing generating station, it will, perhaps, be of interest to work out an example, and I, therefore, assume a case where 4,000 kw. of reciprocating plant is installed, consisting of six compound sets having a capacity of 2,000 kw., and two triple expansion 1,000 kw. sets. With a moderate degree of superheat and a vacuum of 26 in., the steam consumption at full load, excluding condensers and other auxiliaries, will be about 24 lbs. per kw. hour for the compound sets,and 18·5 lbs. for the 1,000 kw. sets. Allowing for 1,000 kw. to be a standby, the total steam consumption will be 66,500 lbs. for an output of 3,000 kw. hours, an average of 22·2 lbs. per kw. hour.

To enable exhaust turbines to be used, the reciprocating plant would have to run under non-condensing conditions, that is to say, with the exhaust steam a few pounds above atmospheric pressure. The steam consumption at full load would then become about 31 lbs. per kw. hour for the small sets, and 24·5 lbs. for the large set, or a total consumption of 86,500 lbs. steam for the output of 3,000 kw. hours, an average of 28·8 lbs. per kw. hour.

The condensation and other losses between the engine exhaust outlet and the exhaust turbine inlet will probably amount to 10%, so that there would be 77,850 lbs. of exhaust steam to be utilised.

An exhaust turbine with a good vacuum will give 1 kw. hour for about 37·5 lbs. steam, and therefore the extra capacity obtainable would be 2,076 kw. hours,and the overall steam consumption of the plant on a load of 5,076 kw. would be 17·0 lbs. per kw. hour. The result of adding exhaust turbines is, therefore, an increase of 69% in the capacity of the generating plant under condensing conditions, and a reduction in the steam consumption of 23·4%.

In some cases the capacity of the reciprocating plant, if worked non-condensing, will be curtailed, but as the majority of the small plant in existing stations has been designed to give full outputs under such conditions, I do not make any allowance on this score.

It is as well to point out that, although the reduction on steam consumption on the prime movers works out at 23·4%, the actual saving in the fuel used per unit sold will be very much less, after making allowances for the constant losses in auxiliaries, condensation, and the extra power required to obtain the high vacuum, moreover, the probability is that some 70 to 80% of the total output is already being supplied by the 1,000 kw. sets, having a consumption of 18·5 lbs. per kw. hour, so that the saving on the steam consumption of the remainder of the output consisting, largely of peak loads, will only be a percentage of a percentage.

The cost of installing two or more sets of exhaust turbine plant having a total capacity of 2,076 kw., together with high vacuum pumps and condensers, will be £18,000 to £21,000. The same capacity of plant, including a single unit 2,076 kw. turbine set with its necessary complement of steam boilers, etc., could be provided for £22,000 to £25,000

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and the steam consumption on one set of plant of this size would certainly be less than 17·0 lbs. per kw. hour.

These figures would appear to show that for public generating stations the circumstances would have to be exceptional to result in any ultimate advantage from installing exhaust or mixed pressure turbines as compared with high pressure turbines of equal capacity. In the latter case the first cost would be slightly more, but the steam consumption would be less. A very wide field, however, exists for the application of exhaust turbines for other purposes, such as collieries, rolling mills, shipyards, and other industries, particularly where large non-condensing engines are used. In many such cases the output could be increased 100% with the same consumption of fuel and electrical motors supplied from the generator connected to the exhaust turbine could be substituted for the many small non-condensing engines usually required for other duties, and so effect a still further saving in the fuel consumption.

There is no doubt that the reciprocating engine has a very high thermal efficiency with moderate steam pressures, and it has been suggested that to obtain the highest possible efficiency from the use of highly superheated high pressure steam in large units of plant, a combination might be used consisting of a one or two stage impulse turbine at the high pressure end, a reciprocating engine for the intermediate pressure, and an exhaust turbine at the vacuum end. Such an arrangement possesses certain theoretical and practical advantages. There is apparently no difficulty in designing impulse machines to run with steam of the highest superheat and pressure, and the superheat and pressure can be very considerably reduced in one or two stages, whereas under similar conditions trouble is likely to arise in the cylinders or valves of reciprocating engines through distortion owing to changes of temperature in providing efficient internal lubrication, or in the maintenance of the steam glands. At the intermediate pressures the reciprocating engine is undoubtedly very economical and satisfactory. The equivalent of the large low pressure cylinders theoretically required for the reciprocating engine working on high vacuum can be much better provided in a turbine. As two-thirds of such a combination would, however, consist of turbines, there would have to be a very considerable advantage in the economy of the reciprocating engine at the intermediate pressures compared with the corresponding portion of a turbine to warrant the additional cost and complication of such a combination, and as yet no figures are available to show that such a marked improvement would be forthcoming.

So much has been written and said recently concerning large gas engines for power stations that I hesitate to say very much on the matter. The whole question is really one of load factor, and, unfortunately, the load factor of the most public supply undertakings is so low, it is impossible to say or to estimate with any degree of certainty that the extra cost of the gas engine plant will be counterbalanced by the reduced fuel costs. Inasmuch as the load factor, however, is slowly but surely improving, it is not unlikely that in the near future it will be found economical to install gas engines to deal with at least that portion of the load having the highest load factor.

For a direct current station situated in a good position for obtaining coal supplies a combination of gas engines as the prime movers with large storage battery capacity appears to be an excellent arrangement. The higher capital cost of gas engines as compared with steam plant is only warranted when the running load factor is high, and the cost of storage batteries as compared with steam plant only appears advantageous when the output capacity is taken at the one hour discharge rate. If, therefore, the capital cost of a gas engine with battery station is compared with a steam station without batteries not on the basis of the capacity per kw. of generating plant installed, but on the maximum demand it is possible to supply, there is very little difference between the two. Exception has often been taken to comparing the capital cost per kw. of batteries at their one hour rate with generating plant capable of giving the rated output continuously for 24 hours because the one is strictly speaking unproductive, while the other is productive plant, but so long as peak loads are obtained which only necessitate the employment of plant for about one hour per day, the comparison is quite fair, as the additional 23 hours capacity of the steam plant is quite useless, and yet has had to be provided and paid for as part of the equipment. The combination, then, of gas engines with batteries would not much exceed in cost the steam plant capable of dealing with the same maximum demand, and as the working load factor of the gas engine would probably reach, if not exceed, 60%, there is little doubt that the fuel costs and the working expenses generally would be lower than the steam station.

Before leaving the subject of gas engines, it may be as well to note, in passing, that the coming of the gas turbine still seems a long way off. In conversation with a gas engine manufacturer a short time ago, I was assured that gas turbines can be designed; they cannot, however, be constructed, because at the present time there is not a metal on the market suitable to meet the difficult conditions in regard to high temperatures and high pressures under which turbines must work successfully when internal combustion is employed.

Power station engineers are evidently appreciating the many advantages incidental to the use of storage batteries on a comprehensive scale. The load can be levelled out so as to improve the load factor of the main plant, the supply pressure can be kept constant even with sudden and violent changes of load and greater security is provided against a total shut down. During the last few years batteries many sizes larger than previously contemplated have been put into use, and the ideal conditions of supply of our gas and water undertakings in regard to storage may even be realised in the near future.

Much less attention is given nowadays to the old idea of grading the size of plant so that whatever the demand it should be possible to work with approximately full load on each set. The best all-round results are now obtained from large plants, although they do sometimes have to be worked on light loads. The sub-division of plant reminds me that the original contract for one of our supply undertakings provided for the erection of two 35 kw. and eight 66 kw. sets, and before they were all set to work it was decided to sell two of the 66 kw. sets and obtain one or more of 250 kw. size, which in turn have since been superseded by plants of still larger capacity. To a less extent, perhaps, the same course has already been, or will eventually have to be, taken by all undertakings, and for this reason, if for no other, those responsible for the management should use every opportunity to provide funds, whether under the heading of reserve or depreciation, to enable the value of such obsolescent plant to be entirely written off from time to time, so that the nett capital expenditure shall only represent the value of the plant capable of being usefully and economically employed under modern conditions.

One of the greatest changes that has taken place in recent years has been in the extended usage of multi-phase current, brought about principally through the necessity of generating and transmitting high pressure currents which could be reduced to a lower pressure by means of static transformers and then used for power purposes.

As it has become the common practice to generate multi-phase currents, it is somewhat remarkable that so little has been done in the distribution of such supply direct to consumers without conversion. A three-phase system of generation and distribution at high or extra high pressure to static transformers, and thence through a three or four wire low tension network to consumers, appears to offer the highest efficiency with a minimum cost for attendance and for capital outlay, and in the future I feel sure that progress along these lines will be recorded. On the other hand, without wishing to raise a heated discussion on the respective merits of direct *versus* alternating current motors, there is no doubt that many manufacturers appreciate and have taken full advantage of the improved results obtained by using direct current motors with efficient long range speed regulating devices, and would not have a constant speed motor even if it was given to them. For other classes of work the alternating current motor, with the speed depending on the periodicity and practically unaffected by changes of pressure or load, has undoubtedly given good results, but with the exception of the fine spinner and a few other special trades, and then only when they are always engaged in the production of materials of exactly the same kind, I am not altogether convinced that a direct current motor with speed regulation will not be equally satisfactory. It naturally follows, I think, that what may be the best

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speed for a given machine, be it a lathe, a rolling mill, a spinning mule or frame, or a loom when in use on the particular class of work will not be the best speed when in use for a different class of work, and, therefore, some range of speed is a very desirable thing to have. I have been led to this conclusion through remarks made to me recently by two different textile manufacturers in my town. Both of them installed a few direct current motors with shunt regulators to drive a portion of their premises. These worked very well, and I was subsequently approached in regard to the driving the remainder of the mills. A question then arose as to whether they should continue to use the existing direct current supply or wait a few months until alternating current is available. In each case, much to my surprise, on pointing out how much better it would be to use constant speed alternating current motors with no brush or commutator troubles, I was told that they did not want constant speed, as they had found it exceedingly convenient to alter the speed slightly to suit the work they might happen to be engaged on, and in regard to commutator troubles, they had not experienced any, and so would not benefit by the change. Some amongst you have probably had experience exactly opposite to the above, but I am inclined to think that the failure of direct current motors in many instances has been due to the fact that the supply was given from private plants, and probably had considerable variation in voltage with consequent variation in the speed of the motors, or that the motors were over-rated and varied widely in speed with changes in load. Where such a condition of affairs existed, obviously much better results would be obtained by using alternating current supply from the public mains. Most supply undertakings having alternating current generators naturally enough wish to sell their supply without conversion, and they may be inclined to overlook the advantages their consumers might obtain if such supply was converted to direct current.

In regard to distributing and feeder cable systems, it is extraordinary what little alteration in methods obtain to-day as compared with 1894. The only changes of importance to be chronicled are that vulcanised rubber insulated cables have ceased to be laid for underground work, and the same remarks must also be made concerning the various systems with bare copper conductors. Otherwise the practice to-day is almost identical with that of 1894. Cables were then laid solid in wood or iron troughs and filled up with bitumen or were drawn into stoneware conduits very much in the same way as they are to-day, and advocates for one system or the other were equally strong in their approbation or condemnation then as now, but I think that on the whole the tendency is more towards the use of cables having an insulated outer covering such as bitumen than a conducting covering such as lead. One important improvement has been carried out, as it is now common practice to divide up the distributing network into sections corresponding roughly to each feeder, and to provide fuses for each set of distributors so that a fault or a short circuit on one set of cables shall not interfere with the maintenance of the supply to the others.

Integrating meters both for direct and alternating current have been much improved in recent years both in accuracy over a long range, in the smallness of the starting current, and in general reliability. Considerable ingenuity has also been shown in the design of "money in the slot," two-rate and time meters. Manufacturers will, I hope, strive to maintain the high degree of excellence of workmanship in all their meters, as such appliances, although not of so much importance as other plant so far as the intrinsic value is concerned, are, nevertheless, if defective, a constant source of trouble and irritation to supply undertakings.

It is hardly necessary to say much about the many improvements in small electrical appliances during recent years. The old open type arc lamp had to give way to the enclosed arc, which in turn has been largely superseded by the modern magazine flame lamp. Incandescent lamps having filaments of metal of one kind or another are readily displacing other lamps having carbon filaments. Small motors are now of much better design and more reliable. All these changes and improvements have enabled supply undertakings to obtain additional consumers and the public generally to more fully understand and appreciate the many uses and advantages of the public supply of electricity.

The development of our public supply undertakings has been very materially assisted by the hiring out of different kinds of apparatus, particularly of motors, and I venture to say that had our undertakings not been in a position to carry out such work, there would have been much slower growth in power work generally than has actually been the case. It is, therefore, much to be regretted that steps should have been recently taken to seriously hamper the work carried on by municipalities in this direction. I do not remember having heard of serious opposition by manufacturers of gas stoves or by gas fitters or plumbers to the hiring out of apparatus by authorised gas undertakings, whether established by municipalities or by private enterprise: in fact, it is recognised that through being in a position to carry out such work, gas undertakings have not only been able to obtain an outlet for their commodity not otherwise obtainable, but have also satisfied a public demand.

I have no desire in an address such as this to raise any controversy regarding municipal trading, as this is neither the time nor place, and I would, therefore, only point out that, inasmuch as Parliament in its wisdom has seemed fit to grant powers both to municipalities and to companies to establish and to work electrical supply undertakings, the same treatment should be meted out to both alike. If an undertaking established by a company in one district is allowed to supply its consumers direct with hired apparatus, it would be very unfair to debar a similar undertaking established by a local authority in a neighbouring district from doing the same thing.

The principle involved is not of the employment of public or of private capital, because, as already mentioned, Parliament settled that point many years ago, but whether it is in the interests of the public that such appliances should be provided by supply undertakings. If it is in the public interests that the work should be carried out by undertakings, then both companies and municipalities should be permitted to exercise similar rights and privileges. The majority of municipal undertakings are directed and managed at least as well as those financed by private enterprise. There are, of course, bad examples of both kinds; you will easily recall some to mind, but whereas any mistake or want of foresight on the part of the municipal undertaking is made the most of in the public press, similar mistakes on the part of companies are not of interest to the man in the street, and are known only to shareholders, who, for obvious reasons, do not usually shout the news in public places.

I have personally spent several years in the employment of both company and municipal authorities, and, although, owing to present circumstances, my opinion may be considered to be biassed, I have no hesitation in saying that a careful investigation of the records of both, whether compared on the basis of the capital expenditure per kw. of plant installed, of the percentage of gross profit to capital, of costs and charges and of the amount set aside out of the profits for the reduction of capital, or for the building up of reserve or depreciation funds, that is to say, the amount actually paid off or in hand as a credit to the gross capital expenditure, will show that the majority of municipal undertakings stand in as strong a position financially as the majority of the companise.

Although a great deal has been said and written at different times in regard to the charges for electricity supply, I am tempted to say a few words on the matter. The fundamental groundwork on which the charges are based is very well known and need not here be referred to, but it is in the application of these principles that there exists so much difference of opinion. Some discrimination must be shown between the long and the short hour user, between the large and the small consumer, between those using the supply intermittently and those using it continuously, between those who are prepared to use it for a short time after sunset, and those who will agree not to do so during this period, and so on. No tariff has yet been devised that will take into consideration all these different elements, nor would it appear possible to work out a tariff that will deal in a fair and comprehensive manner with the great diversity of conditions which must always prevail.

It is probably less difficult to ascertain the amount to be charged to individual consumers on account of the working

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expenses of the generating plant than to arrive at a fair figure for the cost of distribution. Apart from other factors, an appreciable difference in price should be quoted to a consumer who only necessitates an expenditure of £100 on mains as compared with another at a distance on whose behalf £5,000 has to be spent, The capital charges in the one case at 10% per annum will be £10, and in the other £500. If the revenue received from each consumer at the same price per unit is £5,000 a year, it is clear that one is being charged 5% too much and the other 5% too little for the services rendered.

Another point which is often lost sight of is that the cost of meter reading and repairs, office expenses in making out and collecting accounts, depends entirely on the number of consumers supplied or on the number of meters fixed, and is independent of the consumption of each consumer or on the amount of the annual account. Assuming that 500 consumers are supplied using between them 1,000,000 units a year, and that the cost of the above items come to £500 a year, equal to £1 per consumer per annum, or an average cost of ·12d. per unit on the total consumption. If one additional large consumer is connected using another 1,000,000 units a year, which at a power rate of a halfpenny per unit would give an income of rather more than £2,000 a year, the extra cost of the items mentioned will only be £1 per annum instead of another £500, and it would be grossly unfair to reduce the charges to the other 500 consumers by ·06d. per unit and to charge the large consumer ·56d. instead of ·5d. per unit when the actual cost of supplying him is only quite an insignificant sum. Moreover, the difference between the price of ·56d. and ·50d. per unit on the output supplied to the large consumer is 12%, and represents in cash nearly £250 a year, surely no small matter in these days of competition.

I have only mentioned these two aspects of the problem to illustrate the difference which must be made in the charges as between one consumer and another if the business is to be carried out on sound commercial lines, and how unjustified is the contention so often put forward by those insufficiently acquainted with the subject that all consumers should be charged alike without taking into consideration all the circumstances of the case.

There is just one other point in connection with charges for power supply on which I should like to say a few words here in Manchester, the busy industrial centre of Lancashire. When the question of power supply has been under discussion at engineering meetings in this and other districts, I have heard the remark made time after time, that if any great progress is to be made in the application of motor power supply from public mains, the price will have to be brought down to about ·30d. per unit, because that is the total inclusive price (usually stated as rather on the high side) it is costing large consumers to work their own plant. Well, gentlemen, figures speak for themselves, and if there is one fact more than another which stands out prominently in connection with the most of the supply undertakings in Lancashire it is in the tremendous growth in the demand for power supply during the last few years. At first only comparatively small users were connected with 10 to 20 h.p., then, with slight concessions in price, applications came in from those having 50 h.p., and with further slight concessions in price from 100 h.p., and so the demand has increased by leaps and bounds, until to-day there are quite a number of consumers connected with demands of 1,000 h.p. and upwards.

To demonstrate the many advantages incidental to electrical driving, it has doubtless been necessary forundertakings in some cases to enter into a contract to supply at ·30d. per unit, but I feel quite sure it is unnecessary to quote so low a figure nowadays. Many large manufacturing concerns have found it remunerative in the long run to purchase from outside sources at prices varying between ·75d. and ·50d. per unit, depending on the conditions; but, unfortunately, it is difficult to get those who have made the change to come forward and give facts and figures to show what electrical driving has done for them. We are mostly left to assume that they are entirely satisfied through the way motor installations are extended as the opportunity occurs. There is not the slightest doubt also that a price between ·75d. and ·50d. per unit is quite sufficient to enable the most of the larger undertakings to maintain andeven improve their financial position, as their accounts show that with the access of the power load at these low prices the working expenses per unit have been very largely reduced and improved financial results attained. These prices are only intended to refer to mills or workshops using the supply during ordinary factory hours and where fuel can be obtained at about 8s. per ton. For longer hours the price can be appreciably reduced. If the demand can be used 24 hours a day all the year round it would be possible to quote a works situated near the power station a price of ·20d. per unit, equal to an annual charge of £7 per kw. per annum. The load factor in such a case would, of course, be 100%. As a better load factor than this cannot be obtained, the working expenses could not be further reduced, but a slightly lower price might still be quoted if a consumer was able to appreciably reduce or entirely cut out his consuming device during certain hours in the winter months as a portion of the capital charges on the generating plant would then be allocated elsewhere. It does not appear likely that many large consumers of this kind will be forthcoming in the immediate future, and if they do arrive there will be very keen competition on the part of supply undertakings to obtain their custom, but an outlet for the supply under such conditions may eventually be found if investigation into one or another of the chemical or metallurgical processes are brought to a successful conclusion.

I have endeavoured to show that progress has, indeed, been made by electrical supply undertakings during the past 15 years, and to define some of the means whereby such progress has been possible. In this case it is, however, somewhat difficult to discriminate between the cause and the effect, but I consider that probably the most important influence has been the gradual reduction in the price of electrical plant and appliances Large generators which cost £6 per kw. can now be obtained for £1 12s. 6d. Motors which cost £120 can now be obtained for £30. It may, in fact, be said that the price of all standard electrical apparatus has been reduced 50% to 75%. The use of electricity has in consequence steadily grown in popularity, and with the increase in outputs supply authorities have also been able to grant large reductions in the price per unit.

The only matter for regret is that many of the old-established manufacturing concerns, who have contributed so largely to the success of the industry, have not themselves received the financial reward their services deserve. The difference between a successful and an unsuccessful business is, after all, only a question of the addition or deduction of a few per cent. to or from the manufacturing cost of the article produced. The annual value of appliances made and sold in this country has immensely increased during recent years, but coincident with this there has been no improvement, but rather a falling off in their financial position.

In the earlier years of any industry changes and improvement take place at more frequent intervals of time than is subsequently the case, due in no small measure to the keenness and perseverance with which the young and vigorous brains and bodies of those always associated with new industries in the early days, are applied to the solving of the different problems as they arise. The electrical supply business will doubtless in time tend to remain stationary rather than to make further advancement. It does not appear possible, for instance, that manufacturers can reduce the cost of appliances by another 50% or 75%, or for the costs and charges of some of our larger supply undertakings to be reduced by a similar amount.

It has often been remarked that electrical engineers appear to be all young men. This reproach, if such it be, is slowly being removed, for there are quite a number of us present who are beginning to show the marks of time, and, in bringing this address to a close, I would express the hope that the industry as a whole will continue to attract to it young men having the same earnestness of purpose to perceive and to carry out improvements in the future as they have done in the past, and that through the work carried out by our members, associate members, associates and students, still further progress may be made in the direction so well expressed in the Charter of the Institution of Civil Engineers, viz. :—" The Art of directing the great sources of power in nature for the use and convenience of man."

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THE ELECTRIC FURNACE AT DOMNARFVET, SWEDEN.*

By EUGENE HAANEL, Ph.D. (Director of Mines for Canada).

In the winter of 1905–6, a series of experiments in electric smelting were conducted at Sault Ste. Marie, Ont., under the auspices of the Dominion Government, with the object of establishing the feasibility of economically smelting Canadian magnetic iron ores comparatively high in sulphur, but free from manganese; and using charcoal as the reducing agent.

As a result of these experiments, the electro-metallurgy of the reduction of refractory iron ores without the use of coal or coke fuel was established; and—as far as could be expected from a small, experimental furnace—the output of pig iron per electrical horse-power-year, determined. Moreover, based upon the experience thus gained, certain fundamental changes and improvements necessary in the construction of an economic electric furnace in the future

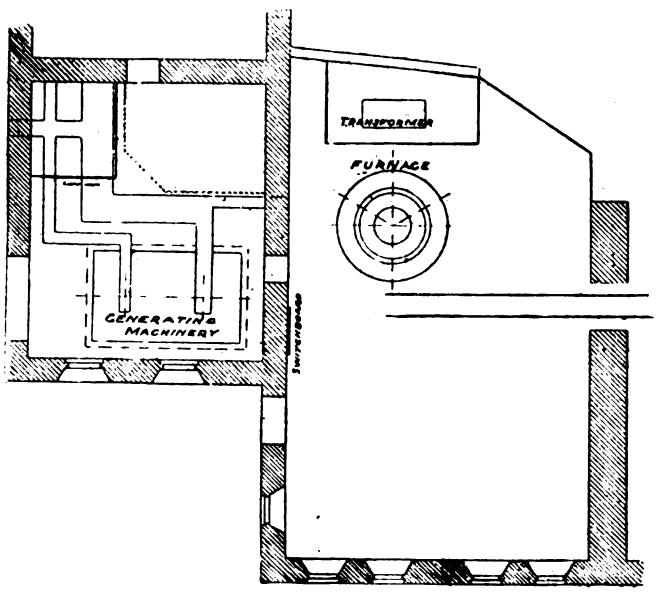

Fig. 1.—Plan of Electric Smelting Plant.

were suggested, in order to render it suitable for the production of pig iron on a commercial scale.

Although the Canadian experiments of 1905–6, proved entirely successful as regards the special objects aimed at, and while considerable interest in the reduction of iron ores by the electro-thermic process was manifested at the time, no additional experimentation of any significance has been undertaken in Canada, along the line suggested in the Mines Branch report, to ensure the commercial success of electric smelting. In Sweden, however, where the conditions governing the economical use of the raw materials necessary for an iron industry are very similar to, and in many respects identical with, those existing in several of the provinces of the Dominion of Canada, the importance of an economic, commercial, electric smelting process was fully realised by three young Swedish engineers some two years ago. These engineers, viz., Assar Grönwall, Axel Lindblad, and Otto Stalhane—stimulated by the successful results of the work done at Sault Ste. Marie—undertook to solve the problem of designing and constructing a commercial electric furnace.

Inasmuch as the electro-metallurgy of the reduction of iron ores had been established by the Canadian experiments, these Swedish inventors concentrated their entire efforts in an attempt to solve the practical, commercial problem, along the lines suggested in the official report. In carrying out their plans to a successful issue, they were ably assisted by the ironmasters of Sweden, who manifested great interest in this question. Special assistance was rendered by the able, and far-sighted director, E. J. Ljungberg, and the vice-director, Lars Yngström, of the largest and most influential industrial company in Sweden, the Stora Kopparbergs Bergslags Aktiebolag. The inventors made an agreement with this company, and the Trafikaktiebolaget Grangesberg-Oxelösund (owners of the largest iron ore deposits in Sweden), to carry on smelting experiments on a large scale at the Domnarfvet Ironworks.

* Report to the Department of Mines, Canada.

In order to concentrate their individual attention on this problem, the inventors formed a company called the Aktiebolaget Electrometall, to which the patent rights were assigned.

Evolution of the Electric Shaft Furnace.

The construction of the specially designed electrical machinery, and the preliminary work necessary for the construction of the furnace, were commenced in April, 1906;

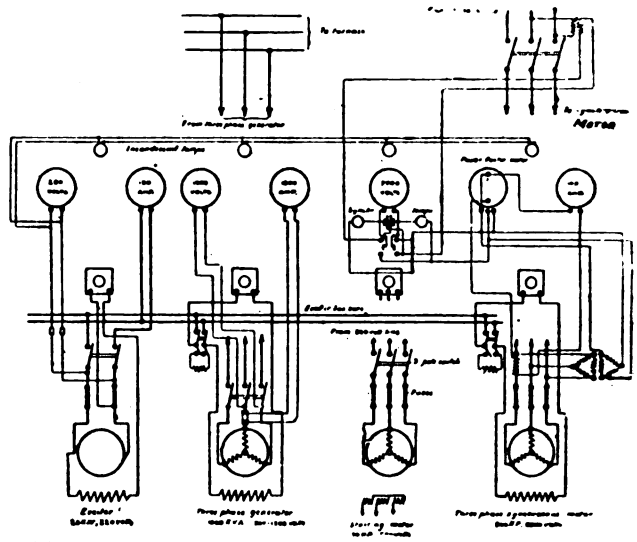

Fig. 2.—Diagram of Switchboard Connections in Generating Station.

and towards the end of that year—when the installation of the electrical machinery and high-tension cables, etc., was completed the construction of the first electric shaft furnace was begun.

This furnace was put in operation April, 1907, and from that time experiments were continuously carried on and improvements made; the daily experience thus gained being utilised in successive changes in design and reconstruction towards perfection. All experimentation was conducted along scientfic lines, and has yielded a rich fund of usable knowledge and instructive data as follows:—(1) On the construction and operation of electrical furnaces; (2) on the conductivity and other characteristics exhibited by materials when subjected to high temperature; (3) on the qualities of the refractory lining materials; and (4) on the most suitable manner of designing and constructing the masonry of the furnaces. In addition to this, different methods of supplying the current and of various contact devices, etc., were tried and tested. In these initial steps the experimenters did not confine their entire attention to the practical side of electric smelting, but carried on laborious researches and investigations concerning the solution of purely theoretical problems; and the determinations made and data gathered will doubtless form an important contribution to the electro-metallurgy of iron and steel.

Taking into consideration the fact that the inventors have signified their intention of writing a detailed account of all the experiments conducted by them during the past three years, it will be unnecessary for me to enter into minute details; but to set forth only such facts as have a direct bearing on the experimental trials witnessed at Domnarfvet.

With a view of elucidating a number of disputed technical points involved in the smelting process itself, initial experiments were conducted at Ludvika during the summer of 1907, with a small furnace of 300 h.p. capacity. During these preliminary experiments many difficulties were encountered which had to be overcome; and it was not until the summer of 1908 that they succeeded in designing and constructing a furnace which, in their opinion, could be economically used in practice. Towards the end of the summer a number of experiments were made with this furnace, which demonstrated that the type evolved was durable, and that a good output could be obtained therefrom, notwithstanding the fact that the furnace was constructed with a relatively low shaft in order to reduce the building expense. On account of this low shaft, which was open at the top—as in the case of the furnace employed at Sault Ste. Marie—the consumption of charcoal was large,

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viz., 9 cwt. 6 lb. per metric ton of pig iron produced. A considerable portion of this charcoal was consumed at the top of the open shaft, and the gas escaping from the furnace consisted almost wholly of carbon monoxide. Hence, notwithstanding the excellent results obtained with this furnace, the inventors conceived that by utilising the waste gases, even more economic results could be attained; they consequently decided to construct a new one of larger capacity, with a higher and more rationally designed shaft.

The new furnace was completed early in December, 1908, and the intention was to at once begin an extended trial run; but owing to a severe drought this extended trial had to be postponed. Some time previous to the completion of this furnace the inventors tendered the writer an invitation to witness a short trial test to take place early in December. Although little rain had fallen up to this time, hopes were entertained that by the middle of December there would be sufficient water to carry on the contemplated experimental trials.

Soon after receiving the invitation, I received official instructions to proceed to Sweden to investigate and report upon this new electric shaft furnace, and sailed for Europe *via* New York, on November 25, 1908. Immediately on my arrival in Stockholm, where I met Mr. Grönwall—one of the inventors of the furnace—it was arranged that we should go to Falun for the purpose of placing before Mr. Ljungberg, the general director of Stora Kopperbergs Bergslags Aktiebolaget—at whose works the furnace was erected—the great importance to Sweden, as well as other countries, of making, if possible, the contemplated special trials. As a result of this conference, he very generously allowed the use of power to operate the furnace for 12 days. The inventors informed me, however, that they did not expect entirely satisfactory results as regards the output of pig iron per electrical h.p. year, since a furnace of this size could not possibly arrive at its normal working condition in the short time allowed for the test inasmuch as the walls are so thick that it takes a comparatively long time to heat them entirely through; and acceleration of the heating could only be accomplished at the risk of damaging the furnace walls. In addition to this, the shaft should not be filled to the top until after several days' working.

In concluding this preface, it may be mentioned that the experimental trials witnessed were not conducted for the purpose of determining the output of pig iron per electrical h.p. year—this had been satisfactorily determined by the experiments at Sault Ste. Marie, as well as by the Swedish inventors in their experiments with the furnace preceding the one investigated at Domnarfvet—but to demonstrate the commercial feasibility of the furnace, and to prove whether uniform working without disturbance could be expected.

Description of the Plant.

The experimental plant (Fig. 1) was installed in an old building adjoining the basic-Bessemer converter house. The machinery, which was specially designed and constructed

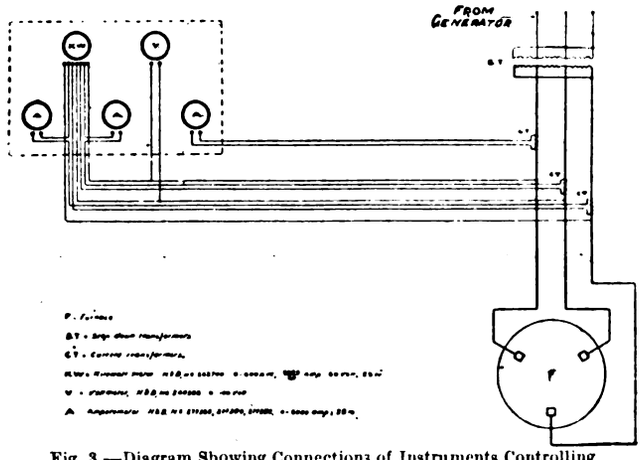

Fig. 3.—Diagram Showing Connections of Instruments Controlling the Furnace.

for the experimental trials, consists of a three-phase synchronous motor of about 900 h.p., supplied with a current of 7,000 volts, and 60 periods, from a three-phase cable line in the ironworks. This motor is directly coupled to a three-phase generator, which supplies current of 25 periods, adjustable to between 300 and 1,200 volts, through small intervals to the transformers erected in the immediate vicinity of the furnace. By means of this extensive regulation it is possible to determine the most suitable voltage to be employed with furnaces of different construction, and operating under various conditions.

The fields of both the synchronous motor and the generator are fed with current at a tension of 220 volts, from a direct-current generator of 20 k.w. capacity, directly coupled to the system. For starting the system a three-phase synchronous motors, directly coupled is employed. This is fed with a current stepped down to 500 volts. The arrangement for controlling the machines may be seen from the coupling scheme shown in Fig. 3.

From the switchboard the current is conducted through copper bars, laid in cement channels, to the three-phase transformers. The capacity of these transformers is 1,500 k.v.a., and their ratio of transformation 14 : 1. By regulating the tension of the generator, the low tension sides of the transformers can be altered, through small intervals, from 20 to 85 volts. The ratio of transformation can be altered to 7 : 1 by means of certain easily performed changes of coupling in the transformers; in which case the low tension can be varied between 40 and 170 volts. The transformers are cooled with air supplied under pressure by two electric blowers. A switchboard is situated conveniently near the furnace for controlling its operation. On it are mounted the following instruments:—One three-phase precision wattmeter for differently loaded phases: three ampere meters—one for each phase, and one voltmeter. The ampere meters, and the wattmeter, are connected to the current system by means of transformers. The voltmeter and tension terminals of the wattmeter are directly connected to two of the conducting bars.

To protect these instruments from heat when tapping, an iron curtain, which may be lowered or raised, is placed in front of the switchboard. The connection of the instruments is shown by the connection-diagram, Fig. 3; while the external appearance of the arrangement is shown by the photograph, Fig. 4. It will be seen that the wheels—by which the electrodes are adjusted—are placed under the instruments in such a manner that the wheel and ampere meter opposite to each other belong to the same phase.

Description of Electric Furnace.

In general appearance this electric shaft furnace is unlike any hitherto constructed, being very similar in design to an ordinary blast furnace, in which the tuyeres are replaced by electrodes.

A vertical section of the furnace is represented by Fig. 5; and Fig. 6 shows a plan with the shaft and electrodes removed. The height of the furnace above ground level is about 25 ft. The melting chamber or crucible containing the electrodes is about 7 ft. high, and is of greater diameter than any other part. The shaft is about 18 ft. high, the lower end of which—for about 4 ft.—has the form of a truncated cone; for the purpose of directing the charge into the crucible in such a manner that the electrodes, lining, and descending charge, could not come in contact. This special feature in the design was introduced by the inventors after repeated experiments, which demonstrated that the upper surface of the column formed by the materials charged into the furnace assumes a definite angle, viz., 50° to 55° to the vertical, when the materials—crushed to normal size, and at the same temperature as that existing in the melting chamber—are allowed to fall through a circular aperture into a free space. In Fig. 5 the slope is indicated by dotted lines.

It is this isolation of the descending charge from the lining at the point where the electrode enters the furnace that constitutes the particular economic advantage of the construction, since it prevents the destruction of the lining, which occurred in all previous furnaces where the electrode came directly in contact with the melting charge and the lining; for the temperature of the brickwork in close proximity to the electrodes becomes so great that the most refractory lining materials are rapidly destroyed—even when the electrodes are cooled by the water jackets.

The contracted neck of the shaft immediately over the central opening into the melting chamber is not supported by the arched roof, but the entire weight of the shaft is carried by six cast-iron columns arranged symmetrically around the furnace hearth.

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The melting chamber is made in the form of a crucible, and is covered with an arched roof provided with openings for the reception of the electrodes and descending charge. The roof and walls of the crucible are lined with magnesite.

For the purpose of cooling the brickwork composing the lining of the roof of the melting chamber, and thereby increasing its life, three tuyeres are introduced into the crucible—just above the melting zone—through which the comparatively cool, tunnel-head gases* are forced against the lining of the roof into the free spaces. This gas absorbs heat from the exposed lining of the roof and walls, and the free surface of the spreading charge, thus effectively lowering the temperature of the roof and exposed walls.

With the exception, however, of radiation from the tuyeres, no heat is lost by this method of cooling or lowering of temperature, since the heat given up by the lining of roof and wall to the comparatively cool gas introduced through the tuyeres, is imparted in passing upward through the shaft to the cooler portions of the descending charge. This effects not only a better utilisation of the reducing power of the CO, but in addition, produces a better distribution of heat throughout the charge in the shaft than in any electric furnaces previously constructed.

The tuyeres are provided with sight holes, covered with mica, through which the interior surface of the arched roof can be observed. By means of this device it is possible to determine approximately the necessary quantity of gas required to effectively cool the roof lining at the mouth of the melting chamber.

Each electrode was built up from two carbons 11 in. square × 63 in. long, making the total cross section of the built-up electrode 11 in. × 22 in. The electrode holder is made of a strong steel frame, forming a support for the wedges by means of which the copper plates conducting the current from the copper cables are pressed against the faces of the electrode. The electrode is clamped in the steel frame mentioned above, and slides on two guides, which serve the two-fold purpose of keeping the angle of inclination to the vertical constant and relieving the arched roof of any undue strain which would arise from the weight of the electrode—if insufficiently supported. A steel cable, secured to the top of the electrode holder and passing over a system of guide wheels or pulleys to the drum operated by the hand-wheel on the switchboard, serves to lower and raise the electrode, by winding or unwinding the drum. In order to protect the parts of the electrodes outside the furnace from the oxidising action of the air, a suitable covering is provided.

The water-cooled stuffing boxes, through which the electrodes enter the melting chamber, are provided with special devices (not shown on the drawing) for preventing the gas under pressure within the melting chamber from leaking out around the electrodes.

The shaft—as previously mentioned—is supported by an iron plate, resting on six cast-iron pillars arranged symmetrically around the furnace hearth. To prevent the pillars from being cut off in the event of the molten iro accidentally finding its way to them, the lower parts are protected by sand enclosed in a sheet-iron casing. This mode of construction enables the operator to repair or replace—without removing the shaft—those parts of the furnace needing the most frequent repairs, viz., the lower part of the shaft, and the melting chamber.

In order to collect the waste gases at the throat of the furnace—with the object of utilising them economically for the purposes specified, and at the same time to protect the charcoal fuel from premature combustion—the top of the shaft is closed by an iron cover fitted with a charging bell and hopper, covered in by means of a specially constructed sheet-iron hood, designed to prevent gas explosions caused by the intrusion of atmospheric air into the shaft when a charge is being introduced.

The collected gases at the throat of the furnace are discharged into a downcomer pipe, provided with a dust-catcher, from which the gases—largely denuded of dust—are drawn by means of a fan, and forced down into the smelting chamber through the tuyeres. With a view of preventing excessive pressure in the interior of the furnace, an uptake pipe—provided with loaded, self-closing valve—is placed at the junction of the outlet pipe and top of downcomer, for conducting the gases generated in the furnace (when the pressure reaches a certain point) to apparatus designed for the utilisation of the waste gases, or to the atmosphere.

Raw Materials Used.—The iron ore placed at the disposal of the inventors for the trail run was magnetite from Grängesberg, and had the following composition :—Fe_3O_4, 66·46% ; Fe_2O_3, 21·21% ; MnO, 0·30% ; MgO, 0·98% ; CaO, 3·84% ; Al_2O_3, 1·07% ; SiO_2, 3·16% ; P_2O_5, 2·34% ; S, undetermined ; metallic iron, 62·96%.

During the first part of the trial run, coke containing 85% C and 0·55% S was used. This, however, had been exposed for a long time to the open air and rain, which made its percentage of moisture unusually high. Lime was used as a flux. The raw material—crushed to pieces of about 1 in. diameter—was conveyed to the charging floor of the furnace, where it was weighed, and charged by hand. The instruments were read every half-hour, the product of each tapping carefully weighed, and samples of both the iron and slag taken for analysis. The iron and slag were tapped through the same hole, but no difficulty was encountered in separating the iron from the slag after cooling. The men operating the furnace were divided into two shifts, each shift being of 12 hours duration, and consisting of four labourers and a foreman.

Heating of the Furnace.—Notwithstanding the fact that the furnace was new in every respect, only one week was allowed for heating from the time the first coke fire was lighted in the melting chamber to the time of the first tapping. Experience with blast furnaces has proved that at least three weeks should be devoted to the drying of the linings in furnaces of this size, prior to charging, otherwise, the heat energy which should be utilised in the reduction and dissociation of the ores will be expended in converting the moisture in the brickwork into steam, resulting in the chilling of the iron, and consequent reduction of the output. The unavoidable neglect of this precaution in the present instance interfered materially with the normal thermal working condition of the furnace throughout the entire trial—especially at the beginning—as the output tables clearly show.

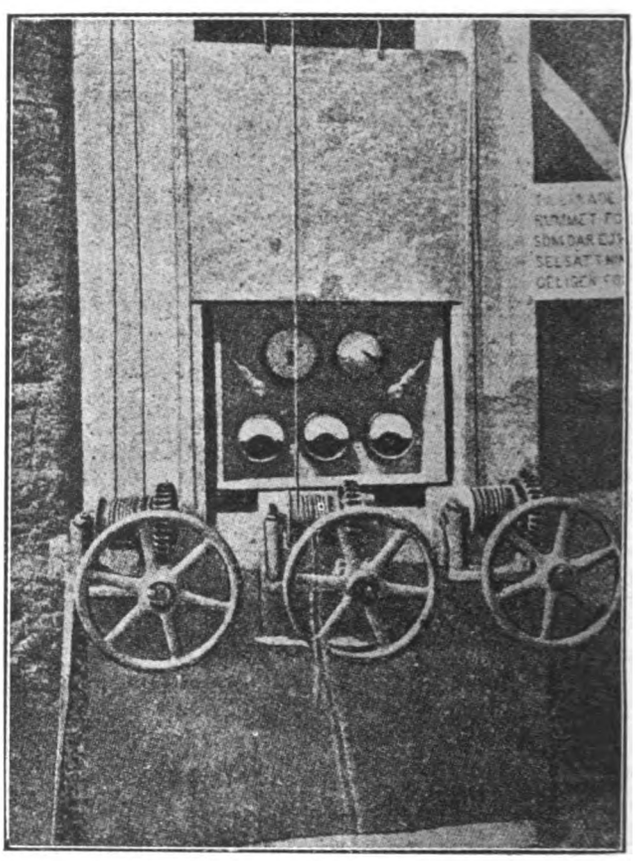

Fig. 4.—Wheels and Instruments for Controlling the Electrodes.

* During the run of the furnace now in progress (July 7) an examination of the tunnel-head gases was made, resulting as follows :—The escaping gases were kept (by regulating the circulation) at a temperature of 200° to 300° ; and the following is an analysis when using :—

Hematite :	Per Cent.	Magnetite :	Per Cent.
CO_2	40	CO_2	25
CO	50	CO	65
H	10	H	10

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Power Supplied to the Furnace.—Although the furnace was designed for a much larger capacity, the power available at the time was only 400 to 450 kw. The tension was kept at between 40 and 50 volts, and the power factor—which, with the lower tension during the first part of the run was 0·85—rose to 0·90 with the higher tension.

A point in the construction of the furnace deserving of special attention is the almost complete absence of fluctuation in the instruments for recording the current and tension delivered. This, in former electric furnaces, occasioned a serious difficulty, and necessitated either the installation of automatic electrode regulators, or the constant presence of a man at the switchboard for adjustment and regulation. In this case, however, the only regulation required is that corresponding to the consumption of the electrodes, which requires to be done once a day, and sometimes for slightly longer periods. The cost of the electric installation for this furnace, compared with that of other types, is therefore cheaper, inasmuch as the costly apparatus for controlling the electrodes is dispensed with. Since the fluctuation of power is almost negligible, and current shocks do not have to be taken into consideration, this type of electric furnace constitutes an ideal load for a power station.

The Trial Run.

The trial run was started at 6.30 a.m., December 27, when the readings of the different measuring instruments were taken and recorded every half hour. Samples of the pig iron and slag were taken for analysis, and the iron—after the slag had been entirely removed—carefully weighed. During the first part of the trial the composition of the charge was: Ore, 209·0 lbs.; coke, 48·4 lbs.; lime, 11·0 lbs. The coke used in this charge corresponds to a consumption of about 810 lbs. per ton (2,240 lbs.) of pig iron. During tapping, however, carbon was observed to escape through the tap-hole with the slag, which, in addition, contained a considerable amount of carbide. This indicated an excess of carbon. The charge was, therefore, altered the next morning to the following composition: Ore, 209·0 lbs.; coke, 42·0 lbs.; lime, 4·4 lbs.; corresponding to a consumption of carbon of about 704 lbs. per ton of pig iron. On the evening of the same day the charge was again changed to: Ore, 220·0 lbs.; coke, 41·8 lbs.; lime, 4·4 lbs.; which corresponds to a consumption of carbon of about 671 lbs. per ton of pig iron.

The coke used up to this time was very wet, having been exposed to rain and snow. As, however, dry coke, which consequently contained a higher percentage of carbon per unit weight, was now available, the charge was again changed to: Ore, 220·0 lbs.; coke, 37·4 lbs.; lime, 4·4 lbs.; which corresponds to a consumption of coke of about 605 lbs. per ton of pig iron. This might be further reduced when the furnace is working normally, and the gases circulated as previously described. However, this consumption of carbon must be considered as extremely satisfactory.

Analyses of the pig iron from six different tappings, and of the slag from tapping No. 4, are given below. From an inspection of these analyses it will be seen that the sulphur content, especially in the last one, is exceedingly low. During the last tapping the temperature of the furnace was higher than in the former tappings, which accounts for the low sulphur content.

Analyses of Pig Iron Produced.

Cast No.	C	Si	Mn	P	S
2	3·20	0·056	0·32	1·80	0·015
3	3·20	0·103	0·37	1·50	*—
4	3·40	0·065	0·34	1·64	0·015
5	3·20	0·075	0·32	1·80	*—
9	3·20	0·075	0·39	1·90	0·015
13	3·15	0·070	0·24	2·06	0·005

In the following table is given the number of tons of pig iron produced per electrical h.p.-year, in casts Nos. 2 to 10, inclusive:—

Cast No.	Tons of pig iron per E.H.P. year.
2	0·744
3	1·870
4	2·180
5	2·360
6	2·440
7	1·120†
8	3·160
9	1·950
10	1·030

From the foregoing table it will be seen that the output before the leakage of water into the furnace became serious was 2·44 metric tons per electrical h.p.-year. This figure—considering the disadvantages‡ under which the trial was made—may be deemed very satisfactory. Owing to the short duration of the trial, it was impossible to determine the consumption of electrodes per ton of pig iron produced. According to former tests, however, this may be placed at about 11 lbs. per metric ton (2,204 lbs.) of pig iron produced.

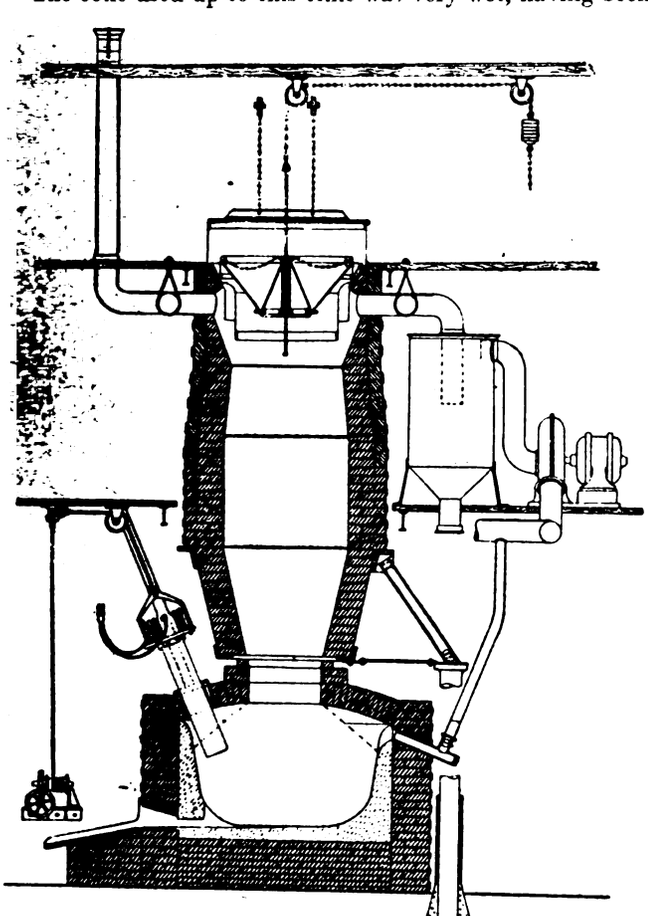

Fig. 5.—Sectional Elevation of Electric Shaft Furnace.

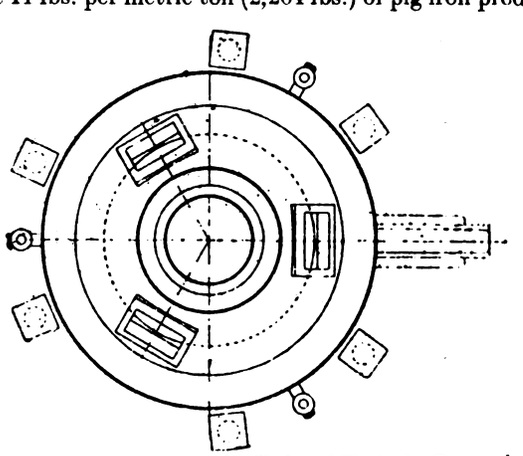

Fig. 6—Plan of Furnace with Shaft and Electrodes Removed.

The trial run was intended to elucidate the following points: (1) Whether undisturbed and uniform working without troublesome regulation of the electrodes could be obtained. (2) Whether great variations in the consumption of energy would occur. (3) Whether the free spaces within the melting chamber would be maintained with a shaft considerably higher than in the furnaces of earlier design and construction. (4) Whether the contraction of the shaft would prevent the charge from sinking uniformly, or cause hanging. (5) The durability of the arched roof, and the possibility of cooling it by means of the circulating gas.

* Undetermined.

† Electrode holder began to leak badly.

‡ Water leaked into the furnace in small quantities from the beginning of the trial, but was not so noticeable until after the seventh cast.

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Deductions from Observations.

The following is a summarised statement of practical deductions drawn from observations made during the trial run, having regard to the objective points specified above :—

(*a*) It was observed that the furnace operated uniformly and without trouble of any kind, and that the electrodes required absolutely no regulation, in one case, for five consecutive days. In any case, the only regulation required is that corresponding to the consumption of the electrodes, and is necessary only once a day, and sometimes not for much longer periods. On account of this expensive regulation can be dispensed with.

(*b*) During the short trial, even though the furnace did not approach its normal working condition until towards the end, it was observed that the consumption of energy was remarkably uniform. This can readily be seen from an inspection of the readings of the different instruments.

(*c*) Free spaces were maintained between the linings of the roof and walls, and the electrodes and charge at the openings where the electrodes enter the melting chamber.

(*d*) It was found that the charge did not jam in the lower contracted neck of the shaft, as had been feared, but moved with regularity into the melting chamber.

(*e*) Although the gases generated by the reduction of the ore were not circulated through the cooling tuyeres until near the end of the trial run, it was demonstrated that the lining of the roof of the melting chamber was effectively cooled by this means.

TRANSFORMER NOTES AND CALCULATIONS.—II.

BY "ELECTRON."

(6) Determine the value of the magnetising current of a transformer with closed iron circuit, of which the data are as follows :—

Primary voltage,	2,200.
Primary turns,	320.
Area of core,	130 sq. in.
Mean magnetic length of core,	40 in.
Permeability of iron,	2,000.
Frequency of supply,	50 periods per sec.

As a converting appliance, the static transformer must necessarily receive more power than corresponds to the load on the secondary, and, neglecting magnetic leakage, it is clear that the power supplied to the primary winding must include the power lost in the two copper circuits and in the core, as well as the power usefully transformed. When the transformer, however, is on open circuit, the copper losses are a minimum, since the power taken from the primary mains is automatically restricted to that required to balance the core or iron losses, which are practically constant at all loads. Assuming that the primary copper loss is negligible, which is quite permissible when the secondary circuit is open, we have

$$P_o = E_1 I_o \cos \theta$$

where I_o is the primary open-circuit current, E_1 the primary pressure applied to the transformer, and P_o in watts is the power absorbed. Now, a transformer on open circuit acts as a choking coil, and the current I_o lags θ behind the pressure E_1 ; and, as in all inductive circuits, the current is made up of two components : (1) a power component, I_p, such that $P_o = E_1 I_p$, I_p being, in phase with the

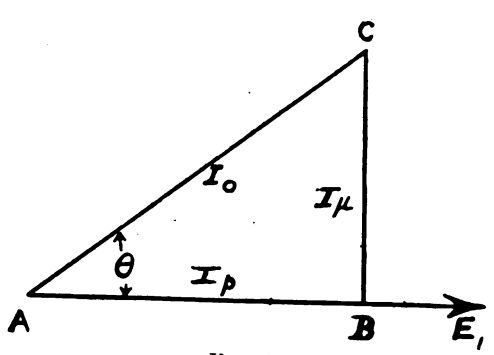

Fig. 1.

pressure E_1, directly proportional to the iron losses ; and (2) an idle or wattless component, I_μ, which maintains the magnetic flux, and is known as the *magnetising current* of the transformer. This component, I_μ, is in quadrature with I_p and E_1, consequently I_o, I_p, and I_μ may be represented in magnitude and phase by the three sides of a right-angled triangle, as shown in Fig. 1, in which the hypotenuse A C denotes the open circuit current I_o, and makes an angle θ with I_p and E_1 ; obviously

$$I_\mu = \sqrt{I_o^2 - I_p^2}$$

The magnitude of I_μ may be determined from the laws of the magnetic circuit, if the magnetic leakage be negligible, since from first principles we have

$$B = \frac{\frac{4\pi}{10} I_\mu S_1 \mu}{l}$$

where l is the length of the closed magnetic circuit, μ is the permeability of the iron, I_μ and B being expressed as virtual values of the magnetising current and flux-density respectively. As the maximum value of the flux-density is used universally in transformer culculations, we have

$$B_{max} = \frac{\frac{4\pi}{10} (I_{\mu max}) S_1 \mu}{l} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

We also have from first principles

$$E_1 = \sqrt{2}\,\pi f S_1 A B_{max} \times 10^{-8} \text{ volts}$$

and since $E_1 = \frac{1}{\sqrt{2}} E_{1\,max}$, we have

$$B_{max} = \frac{E_{1\,max} \times 10^8}{\sqrt{2}\sqrt{2}\,\pi f S_1 A} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Equating (1) and (2), we have

$$\frac{\frac{4\pi}{10} (I_{\mu\,max}) S_1 \mu}{l} = \frac{E_{1\,max} \times 10^8}{2\pi f S_1 A}$$

and

$$I_{\mu\,max} = \frac{E_{1\,max} \times l \times 10^8}{2 \times 4\pi^2 f S_1 \mu A}{10}$$

Therefore, the virtual value of the magnetising current is given by

$$I_\mu = \frac{E_1 l \times 10^8}{0{\cdot}8\,\pi^2 f S_1{}^2 \mu A}$$

and by substitution, using C. G. S. units, we have

$$I_\mu = \frac{2{,}200 \times (40 \times 2{\cdot}54) \times 10^8}{0{\cdot}8\,\pi^2 \times 50 \times 320^2 \times 2{,}000 \times 130 \times (2{\cdot}54)^2}$$

$$= 0{\cdot}33 \text{ ampere.}$$

(7) A 20 kw. transformer, with primary at normal pressure of 2,000 volts, takes on open circuit a current of 0·25 ampere at a power-factor of 0·7. When 120 volts are applied to the primary, and the secondary terminals are short-circuited, the former takes a current of 10 amperes at a power-factor of 0·3. Calculate the efficiency and percentage drop of volts at the seconardy terminals, when the full load non-inductive current is taken from the transformer under normal working conditions. How would the answer be affected if the load, instead of being non-inductive, had a power-factor of 0·6 ?

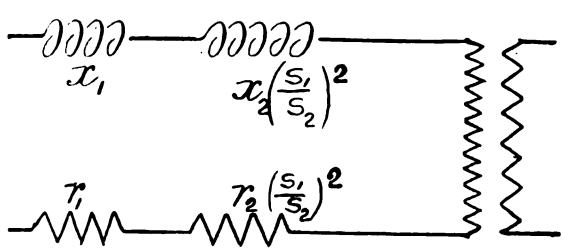

Fig. 2.

The question of the regulation of a transformer is a matter of much importance in practice, and as the voltage drop is influenced much more by the inductances of the windings than by their resistances, it is a convenience to be able to imagine that the same result would be produced if the transformer were replaced by an ideal transformer (one without any drop of pressure), with a definite amount of impedance connected in series with it, as indicated in Fig. 2. In this method it is assumed that the reactance x_2 and resistance R_2 of the secondary winding have been transferred to the primary side, and their magnitudes changed so as to be of the same order of magnitude as those on the primary side, as if the ratio of transformation were unity. The resistances of the windings are readily determined, but the inductances are difficult to measure

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and separate; for this reason the equivalent values are used, and in the case shown in Fig. 2 we have

Equivalent primary resistance $= R_1 + R_2 \frac{S_1^2}{S_2^2} = R$

Equivalent primary reactance $= x_1 + x_2 \frac{S_1^2}{S_2^2} = x$

and equivalent primary impedance $= \sqrt{R^2 + x^2}$

Consequently, the value of the secondary pressure is given by

$$E_2 = \frac{1}{K} [E_1 - I_1 (\sqrt{R^2 + x^2})]$$
$$= \frac{1}{K} E_1^1$$

where $E^1_1 = E_1 - I_1 \sqrt{R^2 + x^2}$ is the theoretical value of the pressure transformed. In applying this idea in the

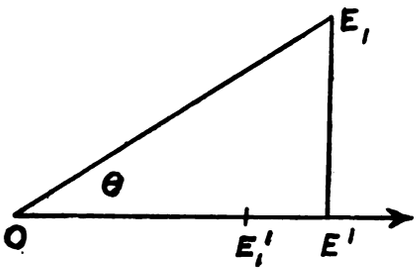

FIG. 3.

example under consideration, the problem is simplified by the fact that sufficient data is given to obtain the measure of the efficiency and the regulation. Thus, the power absorbed on open circuit gives the iron losses, since

iron losses $= P_i = E_1 I_o \cos\theta$ and $\cos\theta = 0{\cdot}7$
$= 2{,}000 \times 0{\cdot}25 \times 0{\cdot}7$
$= 350$ watts.

The copper losses are also readily obtained by short-circuiting its secondary through a low resistance, non-inductive ammeter, and gradually adjusting the supply pressure to the primary until the ammeter registers the rated full-load current, and a wattmeter inserted in the supply circuit gives the power absorbed by the primary and secondary windings. Thus, when 120 volts are applied to the primary terminals, and the short-circuited secondary carries the full load current, the primary current is 10 amperes at a power-factor of 0·3, consequently the copper losses at full load will be

copper losses $= P_c = E_s I_s \cos\theta_1$ and $\cos\theta_1 = 0{\cdot}3$
$= 120 \times 10 \times 0{\cdot}3 = 360$ watts.

With the full-load, non-inductive current on the secondary the efficiency is

$$\eta = \frac{20{,}000}{20{,}000 + 350 + 360}$$
$$= \frac{20{,}000}{20{,}710}$$
$$= 0{\cdot}965 \text{ or } 96{\cdot}5\%$$

The distribution of voltage introducing the idea of equivalent impedance is shown graphically in Fig. 3, in which O E_1^1 is the E.M.F. transformed (2,000 volts), $E_1^1 E^1$ is the primary equivalent resistance drop, and $E^1 E_1$ is the primary equivalent reactance drop. Obviously the equivalent resistance drop is

$$e_r = \frac{P_i}{I_o} = \frac{360}{10}$$
$$= 36 \text{ volts},$$

and the equivalent reactance drop is

$$e_s = \sqrt{E_s^2 - e_r^2} = \sqrt{120^2 - 36^2}$$
$$= 114{\cdot}4 \text{ volts},$$

and equivalent reactance $= x = \frac{e_s}{I_s} = \frac{114{\cdot}4}{10}$
$= 11{\cdot}44$ ohms.

And from the geometry of Fig. 3, we have

$$(O E_1)^2 = (O E_1^1 + E_1^1 E^1)^2 + (E^1 E_1)^2$$
$$= (2{,}000 + 36)^2 + (114{\cdot}4)^2$$
$$\therefore O E_1 = 2{,}039 \text{ volts}$$

and with a pressure of 2,039 volts applied to the primary, a pressure of 2,000 volts is actually transformed, therefore

$$\text{percentage regulation} = \frac{2{,}039 - 2{,}000}{2{,}000} \times 100$$
$$= 1{\cdot}95\%$$

In the case of an inductive load of power-factor 0·6, the current required will be $(\frac{1}{6}^0)$ times as great, therefore the copper losses will be

$$P_c = (\tfrac{1}{6}^0)^2 \times 360 = 1{,}000 \text{ watts},$$

whilst the iron losses will be 350 as before, consequently the efficiency will be

$$\eta = \frac{20{,}000}{20{,}000 + 1{,}000 + 350} = 0{\cdot}936$$
$$= 93{\cdot}6\%$$

The equivalent resistance-drop will be

$$e_r = \tfrac{1}{6}^0 \times 36 = 60 \text{ volts}$$

whilst the equivalent reactance drop will be

$$e_s = \tfrac{1}{6}^0 \times 114{\cdot}4 = 190{\cdot}6 \text{ volts}.$$

And from the geometry of Fig. 4, the required primary pressure will be

$$(OE_1)^2 = (OE_1^1 \cos\theta_1 + E_1^1 E^1)^2 + (OE_1^1 \sin\theta_1 + E^1 E_1)^2$$
$$\therefore OE_1 = \sqrt{[2{,}000 \times 0{\cdot}6 + 60]^2 + [2{,}000 \times 0{\cdot}8 + 190{\cdot}6]^2}$$
$$= 2189{\cdot}5 \text{ volts},$$

and the percentage regulation will be

$$\text{percentage regulation} = \frac{2{,}189{\cdot}5 - 2{,}000}{2{,}000} \times 100$$
$$= 9{\cdot}475\%$$

(8) A single-phase static transformer is designed for a primary pressure of 2,000 volts. The primary and secondary windings have resistances of 2 and 0·02 ohms. respectively, and the current taken by the primary with the secondary on open circuit is 0·3 ampere, lagging by 45° behind the primary E.M.F. Calculate the all-day efficiency of the transformer with a load of 300, 16 c.p. 4 watts per c.p. glow lamps on the secondary for 4 hours each day. Secondary pressure = 200 volts.

Non-inductive load $= 300 \times 16 \times 4$
$= 19{,}200$ watts,

and secondary current $I_2 = \frac{P}{E_2} = \frac{19{,}200}{200}$
$= 96$ amperes.

The secondary equivalent resistance is

$$\left(\frac{S_2}{S_1}\right)^2 \times 2 + 0{\cdot}02, \text{ or}$$
$$R = \frac{1}{100} \times 2 + 0{\cdot}02 = 0{\cdot}04 \text{ ohm}.$$

therefore the copper loss at full load is

$$P_c = I_2^2 R = 96^2 \times 0{\cdot}04$$
$$= 368{\cdot}64 \text{ watts}.$$

The iron loss is

$$P_i = E_1 I_o \cos\theta$$
$$= 2{,}000 \times 0{\cdot}3 \times 0{\cdot}707$$
$$= 424{\cdot}2 \text{ watts}.$$

And iron loss per day is $24 P_i = 24 \times 424{\cdot}2$
$= 10{,}180{\cdot}8$ watt-hours

whilst copper loss per day is $4 P_c = 4 \times 368{\cdot}64$
$= 1{,}474{\cdot}56$ watt-hours

$\therefore$ Total loss per day $= 10{,}180{\cdot}8 + 1{,}474{\cdot}56$
$= 11{,}655{\cdot}36$ watt-hours.

Output per day $= 19{,}200 \times 4$
$= 76{,}800$ watt hours

and all-day efficiency $= \frac{76{,}800}{76{,}800 + 11{,}655{\cdot}36} \times 100$
$= 86{\cdot}8\%$

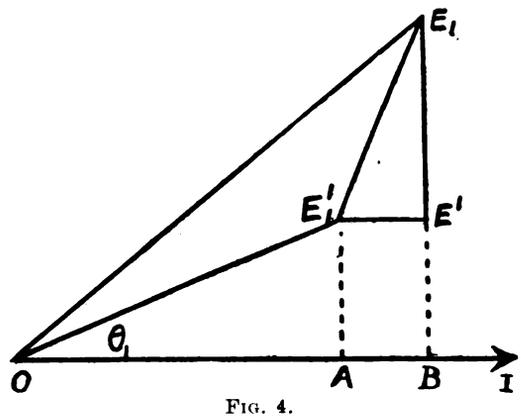

FIG. 4.

ERRATA.—TRANSFORMER NOTES AND CALCULATIONS.

Last line but one, page 574, $\frac{9}{0}$A should be $\frac{9}{10}$A. In the formula for hysteresis loss the symbol for the coefficient of molecular magnetic friction should be η (Greek letter) and not *nor* π. In the eddy current loss formula

$W_e = V (f t B_{max}^2 \times 10^{-8})^2$ watts.

should be $W_e = V (f t B_{max} \times 10^{-8})^2$ watts.

In last line first column, page 575, 300−21 should be 300−210.

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CADMIUM AMALGAMS AND THE WESTON NORMAL CELL.*

By F. E. SMITH, A.R.C.Sc. (From the National Physical Laboratory).

Within the past few years a number of researches have been made on the electromotive properties of mercurous sulphate, and as a result the standard cell is now reproducible with a very high degree of accuracy. However, there are many instances of abnormal behaviour of such cells both with regard to constancy of E.M.F. and with respect to change of E.M.F. with varying temperature. The want of constancy has been attributed by Hulett to slow hydrolysis of the mercurous sulphate, and by Steinwehr [9] to a change in the size of the mercurous sulphate crystals. Irregular behaviour with changing temperature has been observed by Tinsley [13], by Janet [15] and Jouast [15 16] and more recently by Cohen and Kruyt [17], and all of these attribute the observed differences to the cadmium amalgam. While the exact constitution of cadmium amalgams is doubtful and is not discussed in the present paper, there is no doubt that the electromotive properties of the amalgams depend largely on whether one or two phases are present. When, by increasing the temperature a solid amalgam is converted into a mixture of liquid and solid phases, there is an immediate change in the electromotive temperature co-efficient of the amalgam, and a similar change results when the co-existing phases are changed entirely into the liquid state. If the temperature of an amalgam, containing the mixed phases, is raised, the liquid phase is increased and the solid phase diminished; it is probable, however, that the E.M.F. of an amalgam towards a solution of cadmium sulphate does not depend on the relative amounts of the two phases. Hence, amalgams containing different percentages of cadmium, but possessing the two phases, may have the same E.M.F. towards a cadmium sulphate solution. With amalgams all solid or all liquid, the E.M.F. varies with the cadmium content.

The present investigation was commenced in October 1908. The objects in view were:—(1) To trace the cause of the electromotive difference, which sometimes existed, and which was sometimes absent, between 10 and 12½ per cent. amalgams. (2) To determine the limits of temperature between which amalgams of various concentrations could be usefully employed. (Requests for information on this point had on several occasions been received from India.) (3) To explain the abnormal E.M.F.'s of cells made by various observers, when the amalgams contained from 12½ to 14 per cent. of cadmium. (4) As the recent International Conference on Electrical Units and Standards specify a 12½ per cent. amalgam, it was important to decide whether the limits of temperature (0°—40° C.) specified, required amending or not.

The author's conclusions are as follow:—

1. Cadmium amalgams of such a composition that if homogeneous—the term is used in a relative sense—they would be completely solid below certain temperatures, may not in a Weston normal cell have that E.M.F. towards a cadmium sulphate solution corresponding to such a solid. The general result is a lowering of the E.M.F. of the cell and is due to lack of homogeneity of the amalgam, the outer skin of which is of low cadmium concentration and the centre of the mass of high cadmium concentration. Diffusion tends to restore uniformity, and in consequence the cell is unstable for a very considerable time—the E.M.F. rising.

2. When the amalgam is at a temperature near to, but below, the first transition point, the difference of concentration between the inner and outer parts of the amalgam need be only small to enable the outer skin to be a two-phase system. Owing to the small difference of cadmium concentration throughout the mass the diffusion process will be slow and the E.M.F. of the cell may remain constant for a very long time. There is, however, in general, a small difference in E.M.F. between such a cell and one containing a normal two-phase system.

3. Cadmium amalgams of such a composition that, if homogeneous, they would be all liquid above certain temperatures, may not in a standard cell have that E.M.F. towards the solution corresponding to a homogeneous amalgam. In such a case the E.M.F. of the cell is higher than usual. The effect is due to the upper part of the amalgam being a two-phase system and the lower part an all liquid system of less cadmium concentration than the upper part. Diffusion quickly equalises the concentration and the E.M.F. falls to a normal value.

4. The 12½ per cent. cadmium amalgam at present used in the Weston normal cell may be completely solid at temperatures below 12°, and cells containing it may have a higher E.M.F. than normal if used below that temperature. Fortunately, even at temperatures such as 0° C. the amalgam is comparatively near to its first transition point, and the conditions are similar to those noted in (2). In consequence, except in rare cases, cells containing the 12½ per cent. amalgam will behave at 0° as though they contained an amalgam which was always in a two-phase system at that temperature.

5. As a 10 per cent. amalgam at 0° is above its first transition temperature this may be used in standard cells at low temperatures. Such cells may also be used at temperatures as high as 51°. We suggest that the 12½ per cent. amalgam in the Weston normal cell be replaced by a 10 per cent. amalgam.

* Abstract of paper submitted before Physical Society of London, Oct. 22.

THREADS OF SPARKING PLUGS: THEIR STANDARD DIMENSIONS.

The consideration of standard dimensions for sparking plugs in this country was the direct outcome of a conference held by the Sectional Committee on screw threads and limit gauges on October 24, 1907, at which representatives of the automobile industry were present. At this conference the representatives of the Royal Automobile Club of Great Britain and Ireland and the Institution of Automobile Engineers called attention to the necessity of standardising the thread on sparking plugs of internal combustion engines of the types used in automobile and motor-launch work. It was hoped in the early stages that one or other of the Committee's existing standard threads might have been employed in this direction, but after consultation with the representatives of the above two bodies, it became apparent that the general practice was to employ a thread similar to that originated by Messrs. de Dion-Bouton, Puteaux, near Paris, and having 17 threads to the inch (corresponding to a pitch of 1·5 mm.).

This particular thread is now so extensively used in this country for sparking plugs that the Committee were led to the conclusion that considerable difficulty would be experienced by manufacturers in adopting any other standard than that included in the present report.

The report, after giving the standard definitions for the terms employed, deals with the dimensions of the thread on the plug itself, the tap for cutting the thread to receive it, and the gauges for both the plug and female thread.

One of the disadvantages possessed by the present standard is its small diameter, which being under ¾ inch does not give sufficient space for the internal portions of the plug without rendering the walls unduly thin and somewhat hampering the design of a satisfactory sparking gap. This has led to the employment of adapters, which is at present a common practice, but which the Committee feel is somewhat unsatisfactory. It is, therefore, the Committee's intention to hold a conference in the near future with the Institution of Automobile Engineers and the Royal Automobile Club in order to draw up an alternative standard, which shall have a larger diameter and will, therefore, permit of a more satisfactory design.

The price of the specification is 2s. 8d. post free, and it may be procured from any bookseller or direct from the Offices of the Committee, 28, Victoria-street, Westminster. It is published for the Committee by Messrs. Crosby Lockwood & Son, 7, Stationer's Hall-court, Ludgate Hill, E.C., and 121a, Victoria-street, S.W.

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CONTENTS.

	PAGE
Notes	605
Swedish Electric Smelting Costs	606
Development of the Marine Steam Engine	606
Development of Electrical Undertakings	607
The Electric Furnace at Domnarfvet, Sweden	612
Transformer Notes and Calculations	616
Cadmium Amalgams and the Weston Normal Cell	618
Threads of Sparking Plugs: Their Standard Dimensions	618
A Good Servant	619
Correspondence	620
The Stannos System of Wiring	621
Social and Recreative	622
The Foster Transformer	622
Civil Engineers' Reward	622
The Electricity Bill	622
An Up-to-date Installation	627
Catalogues Received	627
Electric Supply in Stepney	628
Educational	629
Technical Problems, with Solutions by Practical Men	631
Reviews	633
Tyneside Notes	634
Lancashire Notes	634
Midland Notes	635
American Notes	635
Companies' Meetings and Reports	636
Companies Registered	637
Contracts Open	637
Some Contracts	638
Tenders Accepted	638
Lighting and General Notes	638
Traction Notes	639
Personal	640
Sheffield Electrical Exhibition	640
Diary	640
New York Electrical Show	640
Metallic Filament Lamp Prosecution	640
Patents	641

A GOOD SERVANT.

Those who systematically decry municipal activity in the field of electrical enterprise, must at least acknowledge that the Corporations are doing excellent work in popularising electricity, and demonstrating what a splendid servant it is to the community at large and citizens individually. We have recently had to record the holding of Electricity Exhibitions both in London and the provinces, promoted and organised by municipal authorities. These are merely glorified forms of advertisements for the local Electricity Departments; even so, the work of popularising has a wide-spread influence, even far beyond the borders of the particular Corporation. Moreover, if we take a broad view of matters, it is good to see the Municipalities taking their duties seriously and running commercial departments on business lines, and, as we know, advertising is the soul of business. These exhibitions are certainly useful to the Electricity Departments and to the ratepayers, both as co-proprietors in the undertakings and as actual or potential customers. Another commendable side of this popularising campaign is the delivery of lectures by the Municipal Electrical Engineers, a method of taking the townspeople into the administrators' confidence first adopted, we believe, by Glasgow. One of the most recent emulators in this direction is Mr. J. W. Hame, the esteemed City Electrical Engineer and Tramway Manager of York. As one who has fearlessly grappled with the many difficulties of municipalisation, and has converted his department into a remunerative concern, he was well qualified to tell the people of the ancient city of York all about "Electricity as the Servant of the Municipality," taking the last-mentioned term as the representative of the community. Mr. Hame pointed out that Electricity in this aspect is a thing of yesterday. When the British Association first met in York (in the year 1831, its inaugurative meeting), nothing was known of electricity of any practical value, but within a brief two months of

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that momentous gathering, Michael Farady had made his great discovery in static electricity, and therefrom flowed all the wonderful results of which we are reaping the benefits to-day. Thirty-five years after the great meeting of British scientific men, York was the seat of another progressive movement, the holding of Fine Arts and Industrial Exhibition, opened in July, 1866, and visited by the then Prince and Princess of Wales. In honour of this event certain commercial men were able to offer the Corporation to light the streets and the exhibition buildings by means of electricity, an offer which was accepted, and then for the first time the citizens were introduced to the Swann lamp. Locally, progress was somewhat slow after this, and of recent years there has been a great conflict of opinion as to the policy of municipalising the electric works. But the development took part, and assuredly the city has had no reason to regret the step taken, for Mr. Hame has made the department pay, while supplying electricity for light and power so as to bring it within the reach of all. In the course of his lecture he said the poor man could light his cottage with three 16 c.p. lamps at an expenditure of under 8½d. per week. This is bringing it within the reach of everybody. Next the lecturer dwelt on the use of electricity for heating and cooking purposes. Here, as Mr. Hame rightly said, there is still much room for improvement, but considerable advance has been made when we consider that tens of gallons of boiling water may be obtained in a few minutes at a very small expenditure. Then there is the industrial side, the use of small and large electric motors. For locomotive purposes, the uses of electricity is apparent to everybody, for it has enabled vast improvements to be made in tramway systems, both by way of giving better and cheaper service. Here, indeed, electricity has proved a superlatively good servant to the municipalities and the communities. Other examples Mr. Hame might well have cited. Electricity is being largely enlisted in promoting sanitation; for instance, in the matter of ventilation, where we have electrically-driven fans, and also the supply of ozone to purify the atmosphere of schools and public buildings. Poplar is well pleased with its municipal service of so-called electrolytic disinfecting fluid; and we have many promising experiments in the electrolytic purification of both water and sewage by means of ozone. Municipal telephone systems are not unknown, both here and abroad, to which we may add synchronisation of timepieces, signalling systems in case of fire, accidents or other mishaps. In fact, electricity is ubiquitous as a servant of the public. It has invaded well nigh every department of activity, even the public libraries, where it not only sheds light on our darkness, but gives us volumes of fresh, ozonised air; it may give us ozonised books, freed from the possible contaminating influences of bacteria; and, in Germany, it is already used to save the librarians' and students' time, books being brought from the remotest parts of the establishment to the reading desks by means of electrically-worked lifts and miniature trolley cars. Truly, Electricity is a very good servant, and our municipalities do well to make its virtues known as widely as possible.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

LOCATING FAULT IN ARMATURE.

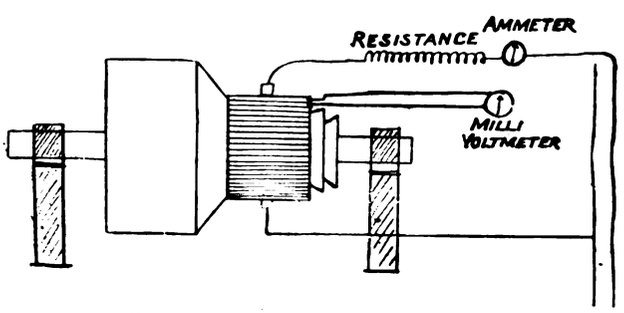
Sir,—Having read the above in your issue of September 24, I should like to give a very useful test which may not be known to all of your readers, so therefore, it may be of service to some of them. For a broken circuit, short or partial short circuit, the following test is all that is necessary to find the coil that is concerned. Sketch No. 1 gives all the necessary connections.

Send sufficient current through the armature to give a deflection on the milli-voltmeter when connected to two segments as shown, then test armature all round getting about the same deflection between any two segments.

Now in the case of a fault.

Short or partial short circuit :—

If a coil is shorted there will be no deflection; if a partial short there will be a small deflection.



Broken Coil :—

In the case of a broken coil the ammeter in circuit, of course, will not read, and the full voltage of the supply will be found between the segments to which the broken coil is connected; therefore, it is advisable to use a high reading voltmeter first, otherwise the milli-voltmeter stands a good chance of being burnt out.

In fact, with a new and sound armature, unless the winding is known, it is always safest to use a high reading voltmeter first, as it is quite possible to have the full voltage between segments, as for instance, a Duplex winding.

In the case of an earth in the armature, a test is not of much practical value, as I have found that in nearly every case I have come across it meant stripping and rewinding the armature.

Yours, etc.,
W. Dancer.

THE MALDEN WORKS.

Sir,—There is a part of the comment on the late Mr. Robertson, which appeared in your last issue, to which I must take exception. You say that that gentleman started the incandescent laboratory of the Pilsen & Joel Co., at Malden Works, Kentish Town. This was not so, as I started that laboratory. It had been formed twelve months before I engaged Mr. Robertson. Mr. Joel, or Mr. Margery, could bear me out in this, and, perhaps others. Just previous to the initiation of this laboratory, my services were lent to Messrs. Woodhouse & Rawson, and for them I took the premises at Charterhouse Buildings, where I formed their laboratory, and made 5,000 lamps, for which they had a contract from the Pilsen Co. I also made the first Woodhouse & Rawson lamps from my own design. Mr. Rawson could bear me out in this.

Yours, etc.,
F. F. Bennett, M.I.E.E.

Electric Sheep-Shearing.—An electric machine for operating an improved form of sheep shears has been invented by Mr. R. S. Falkiner, of Moonbria station, New South Wales.

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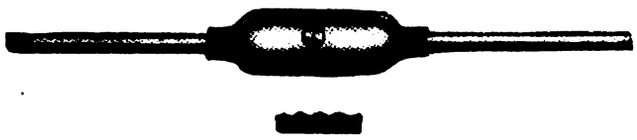
PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

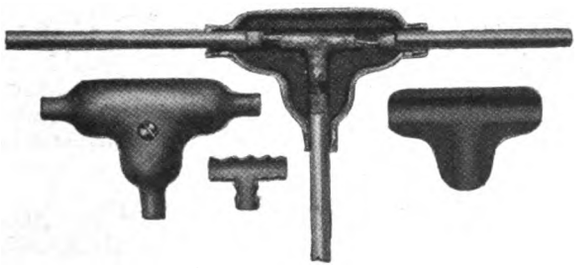
The Stannos System of Wiring.

It was prophesied many years ago that electricity would eventually become the poor man's light, and, with reduced prices for current, the low consumption of metal filament lamps, and improved methods of wiring, we are now within sight of that goal.

By requiring only about one-third the energy for a given candle-power, the metal filament lamp has not only reduced



Straight Joint Box, for concentric work, showing channel.



T Joint Box, for concentric work, showing parts and method of jointing single wire circuit.

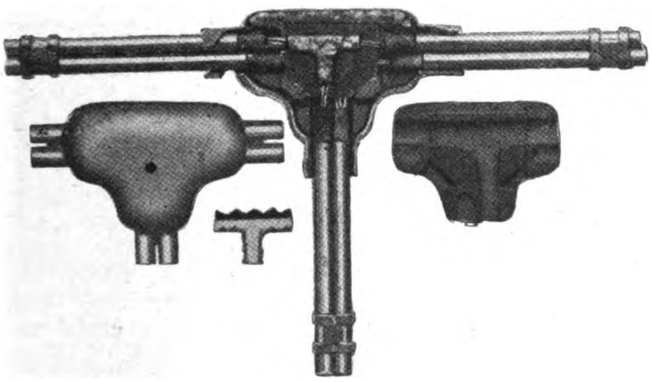


FIG. 1.

T Joint Box, for two-wire, showing parts and method of jointing double wire circuit.

the current consumption bills, but it has also cheapened the wiring. Even at 100 volts, No. 18 S.W.G. wire is sufficiently large for most runs from fuse-boards to lamps, whilst the main wires from the meter to fuse-boards are much smaller than formerly.

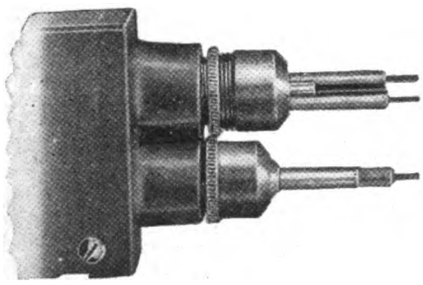


FIG. 2.

Box with two adaptors taking one and three wires.

Hitherto the greatest expense has been in wiring, each point costing something like 15s. to 25s. to connect up. The new "Metacase" conductors, which Messrs. Siemens Bros. & Co., Ltd., have placed on the market are, however, creating quite a revolution, and 10s. a point or less is likely to be the rule in future.

"Stannos" wires, as they are called, consist of a tinned conductor, No. 18, 16, 3-20ths or 7-20ths, and covered with pure and vulcanised rubber, taped and then lapped round twice by a closely compressed sheet of tinned copper, the two layers of sheet copper being sweated together to form one tube. The finished wire can be bent in any direction with the fingers, and the outer tube can be cut off by merely nicking it round with a penknife and bending it backwards and forwards.

The outer tube is of less resistance than the inner conductor, so that when used on an earthed return system, for which "Stannos" wires are particularly suitable, there is very good regulation.

The insulation may be "Unvul," a new kind of dielectric introduced by Messrs. Siemens, which has the advantage that it is free from sulphur and, therefore, does not require vulcanising.

FIG. 3.

Side Entry Earthing Clamp.

The finished diameter of a No. 18 "Metacase" wire is less than $\frac{1}{4}$ in., and two or more of them are clipped together, as shown in Fig. 1. Special metal clips are provided, which hold the wires tightly together and also fasten them securely, steel spikes being driven into the wall.

Where the "Stannos" wires have to connect to steel conduit or Kalkos fittings, special adaptors, as shown in Fig. 2, are used.

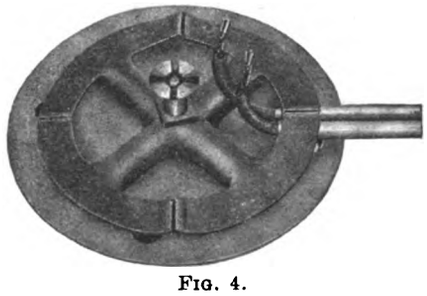


FIG. 4.

Side Entry Earthing Clamp (under side).

The parts of the continuity fittings are shown in Figs. 3, 4 and 5. The back plates are made in two sizes, $2\frac{3}{4}$ in. and $3\frac{1}{2}$ in., and the earthing clamps are all made to give sound metallic connection on to the outer tubes of the conductors.

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It will be understood that Stannos wires can be sunk into the plaster, and this enables the block for holding the switch to be made flush with the wall, a matter of considerable advantage in certain positions and styles of decoration.

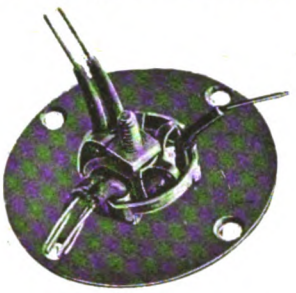

FIG. 5.
Back Entry Earthing Clamp (under side).

In order to enable this to be done, a frog clamp of special but simple design is used in connection with the back plate, and with a view to prevent the wires being damaged during plastering a temporary cap of cardboard takes the place of the switch cover; as soon as the plastering is completed, the cap is unscrewed and the switch with its cover screwed on. This temporary cap and the method of using it is well shown in our illustration (Fig. 6).

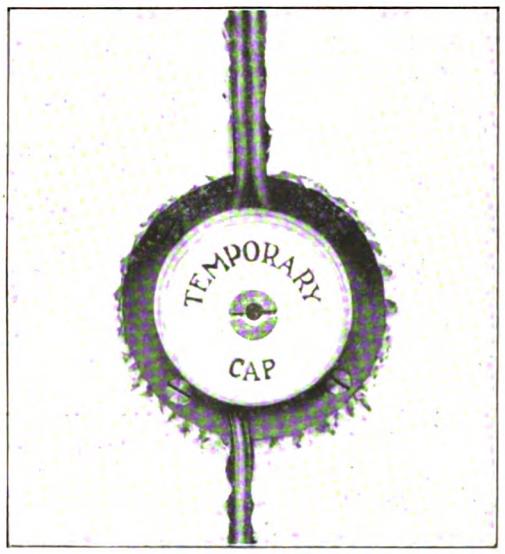

FIG. 6.
Temporary Cap.

An ingenious set of screw clamps has been devised, which is of special service where the concentric system prevails. These clamps are illustrated in Figs. 7, 8, 9. Stannos wires are, of course, water-tight, and by means of the special fittings, shown in Fig. 1, it is possible to make the whole wiring system of a building water-tight.

FIG. 7.
Side Entry, two ways.

FIG. 8.
Side Entry, four ways,

FIG. 9.

When erected on the surface, Stannos wire is almost invisible. It is undoubtedly the nearest to the ideal that has yet come out.

SOCIAL AND RECREATIVE.

The Electro-Harmonic Society successfully inaugurated the 24th season with a smoking concert in the King's Hall, Holborn Restaurant, London. The purpose of the Society is to bring together those interested in electrical matters for musical and social enjoyment, including the provision of high-class evening concerts. The arrangements include smoking concerts on December 17, January 7, 1910, and March 4, 1910, and ladies' nights, November 15 next and February 15, 1910. The hon. sec. of the Society is Mr. W. E. Lane.

THE FOSTER TRANSFORMER.

A type of transformer which is finding increasing favour is that made by the Foster Arc Lamp & Engineering Co., Ltd. Of high efficiency, the Foster patent auto-transformer is made for use with metallic filament lamps, arc lamps, testing purposes, etc., and a transformer with two separate windings may also be obtained from the firm. The Foster transformer (Fig. 1) can be supplied in any size up to 30 kw. One of the features of this type of transformer is the patent heat conducting and fire-proofing material between the windings gives greater reliability, reduces over-load risks, and keeps the coil cool. The iron used in these transformers is of great durability, and moreover, that efficiency of the transformers is maintained for any period of time. There are upwards of 10,000 of these transformers, a fact which speaks for itself. One instance may be quoted in which, we understand, a large draper at Wimbledon reduced his electricity bill from £38 14s. to £8 12s. for the corresponding quarter in 1909 against 1908 by the introduction of the Foster transformer.

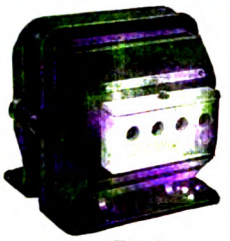

FIG. 1.

FIG. 2.

The firm also produce a Bell transformer, as shown in Fig. 2. These Bell transformers, for use on alternating current supplies only, are making much headway. By their use the possibility of trouble with the evaporation of batteries and constant attention required to them are obviated. They are put forward as absolutely reliable, and perfectly safe both from a fire point of view and from the possibility of shocks.

CIVIL ENGINEERS' AWARDS.

The Council of the Institution of Civil Engineers have made the following awards for the year 1908–1909:—*Telford Gold Medals* to Prof. B. Hopkinson, M.A., B.Sc. (Cambridge), and Mr. G. R. G. Conway (Monterrey, Mexico); *Watt Gold Medals* to Messrs. D. A. Matheson (Glasgow) and W. C. Popplewell, M.Sc. (Stockport); *George Stephenson Gold Medals* to Messrs. E. H. Tabor (London) and A. J. Knowles, B.A. (Cairo); *The "Indian" Premium* and a *Telford Premium* to Mr. T. R. Nolan, B.E. (India); *Telford Premiums* to Messrs. S. J. Reed (Newcastle), C. T. Purdy (New York), L. A. B. Wade (Sydney), G. Hobbs, (Accra, West Africa), W. Cleaver (Port Talbot), J. D. W. Ball (London), Prof. A. H. Gibson, D.Sc. (Dundee), and R. D. Gwyther, M.Sc. (Buenos Aires); *The "James Forrest" Medal* and a *Miller Prize* to Mr. J. A. Wotherspoon (Glasgow); *The Miller Scholarship* to Mr. J. A. Orrell (Manchester); *The "James Prescott Joule" Medal* and *Miller Prizes* to Messrs. W. E. Fisher and E. B. Wood (London); *Miller Prizes* to Messrs. W. E. R. Gurney (London), E. G. L. Lovegrove (London), J. Purser (Birmingham), G. C. Minnitt (Manchester), S. F. Deacon (Manchester), C. H. Bradley and A. E. Marshall (Birmingham).

THE ELECTRICITY BILL.

Conferences have been held at the Board of Trade between the representatives of Glasgow, Partick, and Edinburgh, and Mr. Tennant as to the proposed amendment of the Electric Lighting Acts (Amendment) Bill. When the Bill was before the House of Commons a clause was inserted prohibiting unauthorised distributers from supplying electricity in the areas served by authorised distributers. To this clause the Board of Trade now seeks to add a proviso to the effect that the proposal "shall not prevent any company who at the passing of this Act are empowered by their memorandum of association to generate electrical energy from affording a supply to a railway company for purposes incidental to that company's undertaking, other than the conveyance of public traffic." The municipal delegates considered that these terms were much too wide.

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Full particulars of area of supply, &c., can be obtained on application to the Secretary of the Board.

Tenders will be received up to 31st December, 1909.

R. C. A. S. HOBART, I.C.S.,
Chairman, Municipal Board,
LUCKNOW, INDIA.

PATENTS.

THE PROPRIETOR OF LETTERS PATENT No. 27,449, of 1904, relating to "Method and Apparatus for Electrostatic Separation," desires to dispose of the Patent or to grant licences to interested parties on reasonable terms, with a view to the adequate working of the Patent in this country. Enquiries to be addressed to—CRUIKSHANK & FAIRWEATHER LTD., International Patent Agency, 65-66, Chancery-lane, London, W.C.

THE PROPRIETOR of the PATENT No., 29363 of 1904, for "Improvements in and relating to Electrical Measuring Instruments," is desirous of entering into arrangements by way of license, and otherwise, on reasonable terms for the purpose of exploiting the same, and ensuring its full development and practical working in this country.

All communications should be addressed in the first instance to HASELTINE, LAKE & CO., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

THE PROPRIETOR of the PATENT No. 21,181, of 1905, for "Improvements relating to Electrical Measuring Instruments," is desirous of entering into arrangements by way of licence, and otherwise, on reasonable terms for the purpose of exploiting the same, and ensuring its full development and practical working in this country.

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WANTED TO PURCHASE, 5 or 6 h.p. Motor, single phase, (for alternating current), good second hand.—TURNER, 117, Putney Bridge Road, S.W.

GAS ENGINE, Crossley, 9 B.H.P. and compound dynamo carbon brushes, 220 a, 15 amps, sliding rails and belt, £30. Stockport Gas Engine, about 25 B.H.P., equals new, all fittings, £24.—28, Haslescott Road, Nunhead, London, S.E.

WANTED, METALS, RUBBER, LAMP TOPS, MERCURY PLATINUM, FALSE TEETH, etc.—WASTE AGENCY, 2, Jackson Road, Holloway.

PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND CO., LTD., 44, Clerkenwell Road, London, E.C. N.B.—Platinum Sold.

WANTED—A. C. Motors ∽ 50, any voltage, ¼ to 3 h.p. Also Electric Air Compressor for A. C. State full particulars and cash price.—BOX Q, THE ELECTRICAL ENGINEER, etc., 149, Fleet-street, E.C.

MISCELLANEOUS.

MEN OUT OF EMPLOYMENT in all branches of the Electrical Trade should write to Box No. 20, c/o THE ELECTRICAL ENGINEER, 149, Fleet Street, London, E.C.

AGENTS Wanted, Private Christmas Cards; books free; large profits.—CHIPCHASE, "Cardex," Darlington.

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LAMP Exhauster Wanted; good berth for suitable man.—Box No. 1, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

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WIREMAN, used to all kinds of Wiring, both alternating and direct current work.—R., c/o. THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

POWER Station Assistant, well up in the practical and theoretical side of Electrical Engineering.—S., c/o. THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

RUBBER Cable Work Insulator requires employment; held appointments with good firms.—T., c/o. THE ELECTRICAL ENGINEER 149, Fleet-street, E.C.

ELECTRICAL Engineer, well up in all kinds of work; abstainer, good refs.—U., c/o. THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

ELECTRICIAN, 20 years' experience on large electric light and power contracts.—V., c/o. THE ELECTRICAL ENGINEER, 149, Fleet street, E.C.

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ENGINE Driver, Stoker, seeks berth; experienced, charge corliss and other engines, boilers, generating sets, pumps, repairs; good references.—COLLIER, 152, Butchers-road, Canning Town.

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SWITCHBOARD Attendant, junior; five years with City of London and L.C.C. Generating Station.—Box A, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

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SALESMAN or Traveller.—Advertiser, experienced in Electrical, Mechanical, Power-house and Sub-Station work, desires post in any capacity.—Box C, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

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FITTER.—(Englishman), age 27; experienced in repair and construction of Dynamo and Motor parts, Power-board work, Resistances Electric Light fittings, and Railway work. Can speak Spanish and French fluently.—Box E, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

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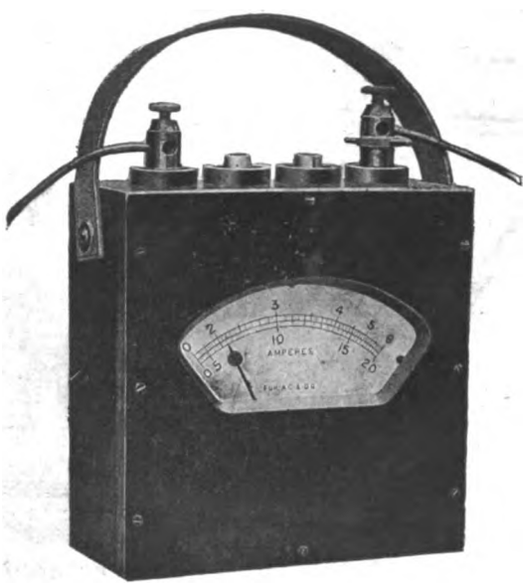

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AN UP-TO-DATE INSTALLATION.

On Saturday last, the students attending Mr. E. Kilburn Scott's lectures on "Quantities and Estimates," at the Northampton Institute, Clerkenwell, visited the new laboratory of Messrs. Fletcher, Fletcher & Co., Seven Sisters-road. Mr. W. R. Rawlings (of Rawlings Bros., Ltd.), who has carried out the work, was present to describe the details and give particulars of the quantities and the materials used, etc. The installation is an excellent one for students to see, because it illustrates the O.S. (Stannos) system of wiring for (1) a two-wire system; (2) a surface concentric system; (3) a watertight concentric system, with Kalkos fittings; and (4) a combination of 2 and 3 in buried work.

In the Stannos wire, as made by Messrs. Siemens Bros., the central wire is insulated with rubber and taped, then wrapped with two layers of tinned copper. On an earthed system the outer copper tube carries current, and for a No. 18 S.W.G. wire it is about ⅓rd. of the resistance of the wire. The Stannos system of earthed wiring is revolutionary, and the ideal.

The supply for the lighting is taken from the Islington Corporation at 100 volts (or 200 if desired) alternating, single-phase, 50 cycles. The mains, consisting of twin-armoured cable, pass from the Corporation fuses through an iron clad D.P. switch and fuse to the first floor, terminating at a Foster double-wound transformer, giving 100 volts on the lamp side and 100 or 200 volts as desired on the supply side. The object of using a separate wound transformer is to isolate the installation, so as to enable an earth return system being used, apart from being able to alter the voltage. In conjunction with the transformer there is connected a Burston automatic switch to disconnect the primary circuit when no lamps are in use. Distribution from this point is made from a four-way board, one pole of which is connected to a busbar forming the return of an earthed concentric system. From this point, single cables drawn into Kalkos tubes are carried to four distributing boards, the tubes being connected to the earthed busbar. From the fuse boards, the O.S. system (Siemens Bros., Ltd.) of wiring has been employed, using Stannos wire and fittings, together with the special continuity fixtures provided for concentric work. On the top floor, and a portion of the ground floor, the system has been made watertight by soldering the Stannos wires into Kalkos boxes.

Two pilot lights have been installed on the ground floor, two Stannos wires being used in the ordinary way without the intervention of the transformer.

The number of points installed are 180, with 121 switches; 1,800 yards Stannos single, 1-18 and 3-20; 50 yards main cables, various; 2,500 O.S. clips; 300 continuity fixtures and fittings for Kalkos boxes and Kalkos tubes, etc.

In addition to the lighting, there is a system of electric fire and burglar alarms worked from the 100 volt accumulators, which are used for the lift control. The wires leading from the accumulators run through fuses to the whole of the bells terminating at a relay. This portion of the wiring is carried out with Stannos wire, the wiring between the relay and the whole of the fire and burglar alarm points being carried out in ordinary high-class bell wire.

The bells which are used for timing (rung three times daily), together with the relay, batteries, etc., are the same as are used for the burglar and fire alarm system, thus ensuring their working condition.

The electric lift has been supplied by Messrs. J. Childs & Co., Ltd., Willesden-green, and it is of special interest, because, although the motor is single-phase, the control gear is worked by direct current from a Hart battery. In order to charge this battery, a 5-cell, 2 ampere aluminium rectifier is employed. The push button for stopping has two contacts, the first putting the brake on partially through a resistance, and the second allowing it to go hard on. In this way the lift is brought to rest without a jerk.

Through the kindness of Mr. J. W. Fletcher, Governing Director, tea was provided for the visitors.

CATALOGUES RECEIVED.

We have received from Messrs. Baxendale & Co., of Manchester, a copy of their latest illustrated catalogue of telephones, fire alarms, wires and cables, overhead line construction material, etc.

The latest catalogue issued by the Mirrlees Watson Co., Ltd., Glasgow, describes and illustrates the various types of condensing plant made by the firm, and sets forth the conditions for which each type is most suitable. The three principal types are the surface condensing counter-current or contra-flow; the jet condensing, elevated, self-draining counter-current type sometimes designated barometric type; and the jet condensing low level counter-current type. A number of pamphlets have also been illustrating the condensing plant, etc., supplied to municipal and other undertakings at home and abroad.

The Electric and Ordnance Accessories Co., Ltd., are sending out a new catalogue of their "Eclipse" electric heaters, in addition to attractive folders describing the "Eclipse" electric heaters and the "E. O. A." high-efficiency metal filament electric lamps.

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Many failures have been caused by bad workmanship. Have your work carried out by responsible firms, whose aim is REPUTATION as well as profit Here are the addresses of a few such firms.

Any of these firms will furnish estimates, will show samples of lamps, fittings, fans, heating arrangements, etc.

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Ayr.—Reid and Co., 108, High-street.
Auld, Wm., and Sons, 70, Sandgate.
Bedford.—Bacchus, Hy., 36, High-street.
Belfast.—Stanley Johnston, 7-9, Queen-street.
Lowden, J., and Co., Ann-street.
Patterson and Co., 57-59, High-street.
Aston Bros., Limited, 38, Donegal-street.
Scott, Hugh J., and Co., Ravenhill-avenue.
Birkenhead.—Heaney and Co., 327, Borough-road.
Stafford and Co., 117, Oxton-road.
Birmingham.—Ellis and Ward, 75, Edmund's-street.
Blackburn.—Thompson, W., Victoria-street.
Blackpool—Fylde Electrical Engineering and Plating Co., 50b, Abingdon-street.
Bolton.—Hart, James O., and Co., Limited, Bank-street.
Townson, Chadwick, and Co., 118, Bark-street.
Bootle.—Scott, J.
Bradford.—Pullan, C., 52, King's-arcade.
Smith and Croft, Providence-street, Westgate.
Bush, E., and Co., 26, Sunbridge-road.
Seaman, J. E., 1, Tanfield-buildings, Hustlergate.
Bridlington.—Bailey and Sons, Quay-road.
Brighton.—Page and Miles, 60, Western-road.
Smith, J., and Son, 33 and 34, North-road.
Adams Bros., 11 and 12, Trafalgar-street.
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Edwards and Armstrong, 4, Colston-street.
Brecknell Munro, and Rogers, Limited, Thrissel-street.
Burnley.—Thornton and Co., 6, Howe-street.
Simpson Bros., Hapton, near Burnley.
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Cardiff.—Price, Friend, and Co., 6 and 7, St. John's-square.
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Chester.—Brook, Hirst, and Co., Northgate Electrical Works.
Clapham.—Stegmann and Co., St. John's-hill.
Coatbridge.—King, Jno., and Co., 8, Dunbeth-road.
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ELECTRIC SUPPLY IN STEPNEY.

NEW GENERATING STATION OPENED.

The Stepney Council's new generating station at Blyth's Wharf, Limehouse, London, E., was formally opened by the Mayor on Wednesday. The Osborn-street station has been found too limited for the rapidly increasing demand for cheap electric power in the district, and it is undoubtedly handicapped owing to its position, which necessitates the running of all machinery non-condensing, and the carting of the coal, resulting in a heavy expenditure for fuel. At the present time the whole of the borough is worked on the three-wire system, with low voltage. With the new station running power will be transmitted at high pressure to the old station, which will be partly utilised as a sub-station. The plant so far installed will give an adidtional 2,000 k.w. supply, and there is also the scheme for an interchange supply with Poplar.

The new station is located on the riverside, and consequently possesses the advantages of cheap sea-borne coal and a plentiful supply of condensing water. The buildings which were commenced in the autumn of last year, consist of a steel structure with ferro concrete walls. The boiler house is 63 ft. in width, and 91 ft. in length, while the engine room is 67 ft. by 91 ft., and to facilitate extensiohs the north walls are of a temporary nature. The whole of the electrical and mechanical equipment is being installed to the design of Mr. W. C. P. Tapper (Borough Electrical Engineer), and erected under his supervision. The work of installing the machinery began last summer and has yet to be completed. The boiler house has so far been equipped with three Babcock & Wilcox Marine-type boilers, two with a heating surface of 2,410 sq. ft. each, and grate area of 59·5 sq. ft., arranged with Babcock & Wilcox patent mechanical chain grate stokers, and one with a heating surface of 4,800 sq. ft., fitted with an integral superheater of 900 sq. ft. heating surface, capable of imparting 150° Fahr. of superheat to the natural steam. All the boilers are constructed for a working pressure of 200 lbs. per inch, and are fitted with the necessary ladders and gangways.

Two other boilers, with a heating surface of 4,800 sq. ft., will also be installed shortly. Ten thousand tons of coal can be stored in the coal bunkers at present installed. There is a Weir boiler-feed-pump, of the compound type, each set being capable of working independently for half the total capacity of 10,000 gallons per hour. The storage tanks have a capacity of 40,000 gallons, and are filled with an Archbutt-Deeley water softening plant removed from Osborn-street. The engine room contains two turbine driven sets, one 2,000 k.v.a. Willans-Parsons turbo-alternator, and one 1,000 k.w. Parsons turbine with two generators in tandem (the latter coming from the Osborn-street works). The larger machine generates high tension alternating three-phase current at 6,600 volts, the smaller machine generating three-phase current at low pressure, which is transformed up to the 6,600 for transmission to the Osborn-street works. At the latter station the high tension alternating current is transformed to low tension continuous current and distributed to customers. The two turbines are completely equipped with "Contraflo" condensers and air pumps.

The larger turbine is designed for an overload of 2,500 kw., it has a speed of 1,500 r.p.m., and boiler pressure per sq. in. of 180 lbs., the superheat being 120 degrees Fahr., and vacuum 27 in. The alternator of this set was made by Messrs. Bruce Peebles & Co., and is of the three-phase type, with direct connected exciter, voltage 6,000-6,600, with a periodicity of 50 cycles per second, the power factor being 8·5. The condenser has a vacuum at full load of 28·5 in., and at overload it is allowed to drop. The temperature of the cooling water is 60 degrees Fahr. The Edwards air pump has three lines, a speed of 158 r.p.m., driven by electric motor of 15 b.h.p. through single reduction gearing, the engine having 790 r.p.m.

The switchboard galleries run the whole length of the engine room on the east side, the operating gallery being well above the turbines. The E. H. T. boards, at both Blyth's Wharf and Osborn-street, are of the Reyrolle iron-clad type, provided with the Merz-Price patent system of control throughout.

The low-tension switchboards are made by Messrs. Crompton & Co., Ltd., of London and Chelmsford, acting as sub-contractors to Messrs. Willans & Robinson, of Rugby. These switchboards have been designed by Mr. Tapper, and are an excellent example of the proper way to handle heavy low-tension continuous currents. The main feature of the design is that the positive, neutral and negative sections of the switchboards are kept entirely distinct from one another, and that connections between the dynamos and feeders are made by means of plug bars, which enable them to be arranged in one or two parallel groups, which may, if required, be worked at different voltages. This arrangement is a departure from the American practice, which has been somewhat prevalent in this country during the last few years, viz., that of providing double pole panels for the generators at

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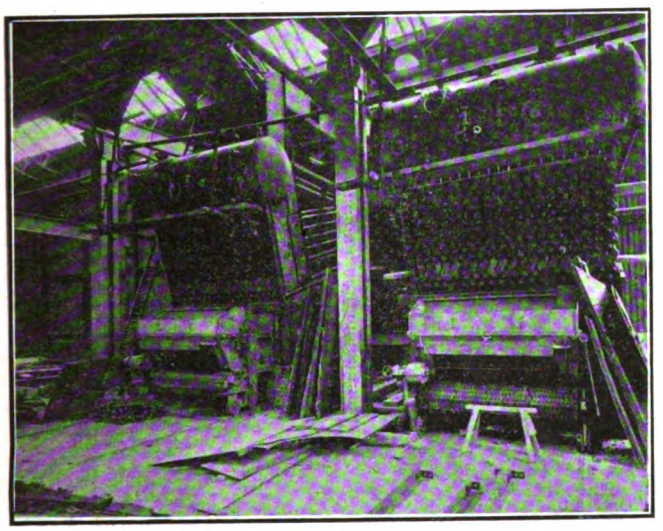
one end of the switchboards, and double pole panels for the feeders at the other end. The Stepney arrangement is preferable on account of the simplicity of the connections at the back of the switchboards; the facilities for running at two voltages without risk of making a wrong connection, and the possibility of seeing by a mere glance at the switchboard exactly the conditions under which the dynamos and feeders are grouped. This arrangement was adopted many years ago on the switchboards which Messrs. Crompton & Co. built for the Kensington and Knightsbridge Co., the Notting Hill Electric Lighting Co., and the three original stations of the Westminster Co., in all of which places the arrangement has been found considerably more convenient than the American type of switchboard already referred to. As the switchboards at the two stations are very similar in their design, differing only in regard to the number of feeder circuits, a description of the board at Blyth's Wharf, which has already been erected and coupled up, will suffice for the two. At Blyth's Wharf the switchboard controls two turbo-driven pairs of generators and eight feeder circuits. The pairs of generators are arranged on either side of the three-wire system. There are thus two dynamos on the positive and two on the negative. Each dynamo has on its outer terminal a wattmeter and amperemeter, and a single-pole, quick brake switch, with renewable sparking pieces; and from thence the current is taken to a vertical plug bar on the face of the switchboard. This vertical bar can be plugged on to any one of four horizontal bars at the back of the switchboard. At one end of the board four additional vertical plug bars are provided, by means of which any number of the horizontal back bars can be put in parallel. Thus it is possible to work the station at either one or two different voltages, and to connect any feeder on to whichever voltage is best suited to its length and conditions of load. The feeders are connected to the back bars by means of plugs

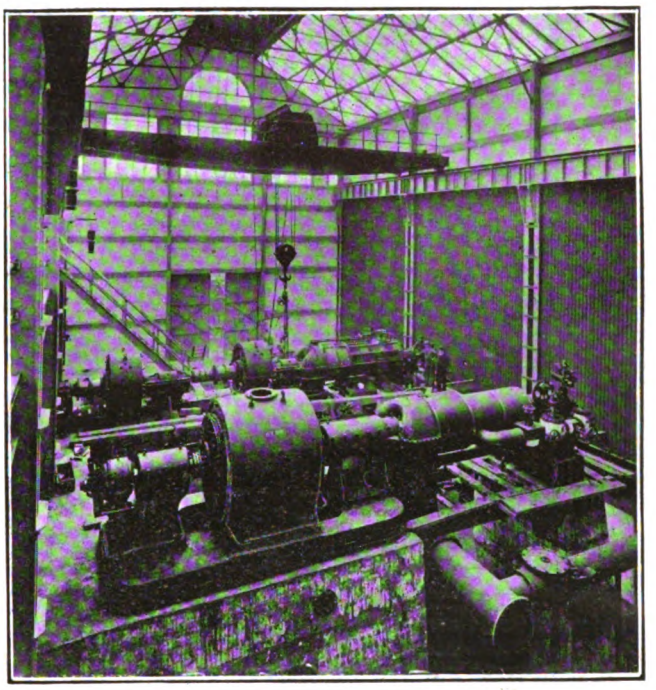


View in the Boiler House.

passing through 8 vertical bars on the front of the switchboard, and the current, after leaving these bars, passes through amperemeters and quick break isolating switches fixed on a subsidiary panel behind the principal switchboard. Voltmeters are provided for the dynamos, the pilot leads from the outer ends of the feeders, and for paralleling, the horizontal omnibus bars. All the dynamo and feeder ampermeters and voltmeters are of the edgewise scale type, and mounted above the switchboard panels themselves; while on brackets at the end of the board are voltmeters indicating the pressures across the busbars. The positive and negative panels are similar in arrangement to the neutral panels, containing means for connecting the middle point between each pair of dynamos on to the middle wire of the system, an amperemeter and an overload circuit breaker being inserted into each of these connections. Two single-pole, quick break switches on either side are also provided for connecting to the two pairs of neutral feeders. The capacity of each of the four dynamos is 1,500 kw., thus the dynamo fittings and plug bars carry 3,000 amperes; the paralleling switches are each of 1,000 amperes capacity; the feeder panels and isolating switches are designed for 1,000 amperes each, and each of the four horizontal busbars will carry 2,000 amperes. The dynamos are separately excited from the special excitation busbar, which may be connected to any of the other busbars through shunt-braking switches, with (discharge resistances) interlocked with the dynamo main switches. The main switch in the dynamo circuits on the negative side is provided with automatic reverse current features, operated by relays. Screw plugs are provided for connecting the vertical and horizontal busbars, each plug being capable of carrying 1,500 amperes. All the instruments are of the moving coil type, calibrated by means of standard milliampere gauges, and interchangeable. On the Osborne-street board there are 8 quick brake isolating switches for the feeders, and, in addition, 4 similar switches for connecting the new busbars to the existing ones on the original low-tension switchboard.

The transformers are of the well-known "Berry" patent type, without oil or any artificial cooling, supplied by the British Electric Transformer Co., Ltd.

They are of the single-phase type, each transformer being of 166 k.v.a. capacity, three units being coupled up together to form a 500 k.v.a. 3-phase set. They are designed for delta connection on both primary aod secondary sides to step up from 145 to 160-6,000 to 6,600 volts at 50 cycles. By the adoption of single-phase units coupled in sets of three for 3-phase supply, the question of spares becomes considerably cheaper and simpler. No cases are supplied with the transformers, as the iron circuit forms an efficient and mechanical protection to the windings. The heavy base plate carrying the transformer is fitted with four wheels to facilitate handling. The H.T. leads are taken to special porcelain protected type terminals, so designed as to prevent any accidental contact with any live metal.



The Engine Room.

The L.T. winding is brought out in sections; these sections are coupled in parallel by suitable links, and a rigid and mechanical terminal arrangement is thus obtained. The cables supplying the transformers on the L.T. side consist of two in parallel on each pole, and the terminals of these cables are arranged to be bolted on to the links coupling the secondary sections. By this means a larger contact surface is obtained, and the current in the coupling bars is kept practically uniform. The transformers give a very high efficiency at all loads, the efficiency being over 98·7% at full load and 25% over load, 98·5% at half load, and the regulation on any power factor does not exceed 2·2%. The type of transformer presents a number of advantages in economy of space, cleanliness, and the readiness with which handling and inspection may be carried out, all of which are points of great importance in any station.

On the riverside a new wharf wall is in course of construction, and, when finished, plant for efficiently dealing with sea-borne coal will be installed.

EDUCATIONAL.

BRADFORD TECHNICAL COLLEGE.

The members of a Special Committee are considering the matter of electrical driving in the new Textile School in connection with the Bradford Technical College, and are experimenting and taking into account the results of other experiments in this direction.

SYDNEY TECHNICAL COLLEGE.

Mr. William H. Mason, B.Sc., M.E., has been appointed assistant lecturer in electrical engineering at the Sydney Technical College. Mr. Mason took his science degree at the Sydney University in 1905, and won the Deas-Thomson Scholarship in Physics. He next graduated at the Cornell University, U.S.A., and afterwards gained practical experience with the Westinghouse Co., Pittsburg, and the Mahoning and Shenango Railway and Light Co., Ohio.

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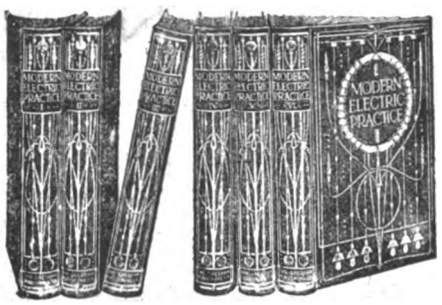
PUBLISHERS' ANNOUNCEMENTS.



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Question No. 1208.—Discuss generally the advantages and disadvantages and methods of working of "central battery" systems of telephone circuits.—"C. B."

Question No. 1209.—Describe the best arrangement of single-phase 2,000 volt 50 switch-gear and transformers for sub-stations up to 300 kw., allowing for six 50 kw. transformers, and one rotary transformer for Röntgen raywork. Show clearly by cross sections and plans the best positions for transformers and plant and cables, showing clearly how the cables are led in and laid.—"E. L."

Question No. 1204.—In a small central station a generator is required to give 220-in. volts for a two-wire system. In the future, as the load increases, it is proposed to alter the same generator for supplying energy at 440 volts, and by means of a balance to supply a three-wire system. Give full particulars with sketches of a special arrangement for the armature winding, so that the change-over from the lower to the higher pressure can be effected without re-winding, but simply by altering several connections. Obviously, field coils would first be used in two parallel circuits and eventually connected in series. What firms supply machines with an arrangement of this description?

Answer to Question No. 1204 (*awarded* 10*s.*).—In plant which is already installed, the changes required by this question might be difficult to make; but where the design of the generator can be carried through with a knowledge of the coming change, there are many points which can be arranged to facilitate the alteration.

The change in field spools—as mentioned in the question—gives the same ampere-turns per pole before and after the alteration, and thus ensures the same flux per pole. For if there are t turns in each spool; of resistance r; and p poles.

In the first case, the voltage is v, and since there are two parallel circuits, the current per circuit is $\frac{C}{2}$ where C is total excite current.

By ohm's law $\frac{C}{2} = \frac{V}{\frac{p}{2}.r} = \frac{2V}{p.r}$

*** Ampere-turns per pole $= \frac{C}{2}.t = \frac{2V}{p.r}.t$

But after the change the voltage is $2v$, and with coils in series total resistance is pr, therefore, current is $\frac{2v}{pr}$ and

Ampere-turns per pole $= \frac{2v}{p.r}t$

Of course, the same speed will be employed, and therefore the only method of increasing the voltage is to increase the number of armature turns *in series*.

No more coils nor turns can be added, as the slots will already be full in a normal machine; so the only arrangement left open is to provide similar facilities in the armature coils, as in the field spools—that is, some arrangement for converting from parallel to series connection.

The chief ways of effecting this are:—

A. Lap Wound Armatures.

1. Provide a double winding on the armature. The coils of each winding occupy alternate slots around the armature periphery, and are connected to alternate commutator segments.

They are quite separate, but the brushes are made wide enough to cover two segments each (necessarily one segment of each winding), and thus current is collected from two windings in parallel.

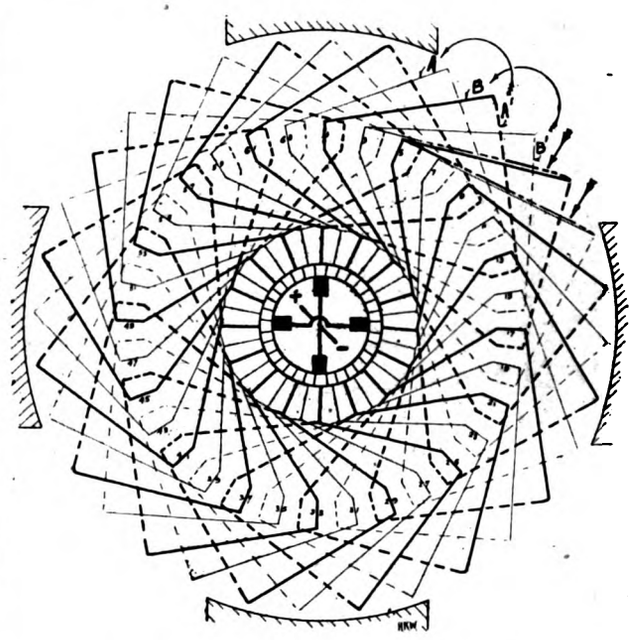
When the higher voltage is required it is only necessary to change the end connections on *one* side of the armature, in order to put *all* the coils in series. The two windings are then connected together as one ordinary winding, with all conductors in series.

This would be a change from a

oo Doubly re-entrant, double multiple circuit winding

to a

o Single multiple circuit winding.



The figure shows the winding for a doubly re-entrant double lap-winding ('doubly re-entrant' implies that each winding closes upon itself after having gone once right round the armature).

4 poles and 64 conductors are shown. The thick and thin lines represent the separate windings, which are dotted to indicate the bottom conductors in slots, or the underneath end connections.

The chain dotted lines — · - · — shown by the arrows indicate the changes necessary on raise of voltage.

In Lap Windings, if

w = total number of conductors.

p = poles.

y = mean winding pitch.

The winding pitch is the number which must be added to one conductor to give the conductor to which the first must be connected. This assumes all conductors numbered in order as on the drawing.

y_1 = forward winding pitch.

y_2 = backward winding pitch.

This is a negative forward pitch and therefore means a subtraction to get the corresponding connection.

In single and double Lap Windings,

y_1 is the *odd* number, equal to or one greater than $\frac{w}{p}$

Then

$y_2 = y_1 - 2$ for single winding.

$y_2 = y_1 - 4$ for double winding.

For our double winding the scheme will be

$\frac{w}{p} = \frac{64}{4} = 61$ *** $y_1 = 17$

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y_2 (for double winding) = 13

Starting from conductor 1 we go to $\overline{1+17} = 18$, then back to $\overline{18-13} = 5$, on to $\overline{5+17} = 22$, and so on as shown thus :—

1--18 ..5--22--9--26--13--30--. . . . .

when we change to single winding y_2 must be 15, and the scheme is then

1--18--3--20--5--22--7--24-- . . . . .

In the diagram the connections have been altered on the side remote from the commutator for clearness ; they would really be changed on the commutator side simply by unsoldering the lug connections. This also necessitates the forward winding pitch taken on side remote from the commutator and backward pitch on the commutator side.

The above is by far the simplest method of effecting the required change. There remains also

2. Change from *Lap* (or multiple circuit winding) to *Wave*, or 2-circuit winding.

A 4-pole lap winding has 4 parallel paths in the armature, while a 2-circuit winding has two only.

It is obvious that by changing from Lap to Wave there will be double the conductors in series and double the voltage.

The reason for not preferring this method is because the Wave Winding has inherent disadvantages, amongst which are :—The conductors required are governed by more limiting conditions than in lap, since for single winding

$$\frac{y_1 + y_2}{2} = y$$

$$w = py = 2$$

Thus a Wave Winding must have 62 or 66 conductors to compare with our 64 conductor Lap Winding shown. This would mean winding with two dummy conductors on the 62 scheme.

There is more likelihood of inequalities of magnetic balance in fields, producing wasteful current in armature windings—parasitic currents which do not come through the brushes to do useful work.

B. Wholly Wave Windings.

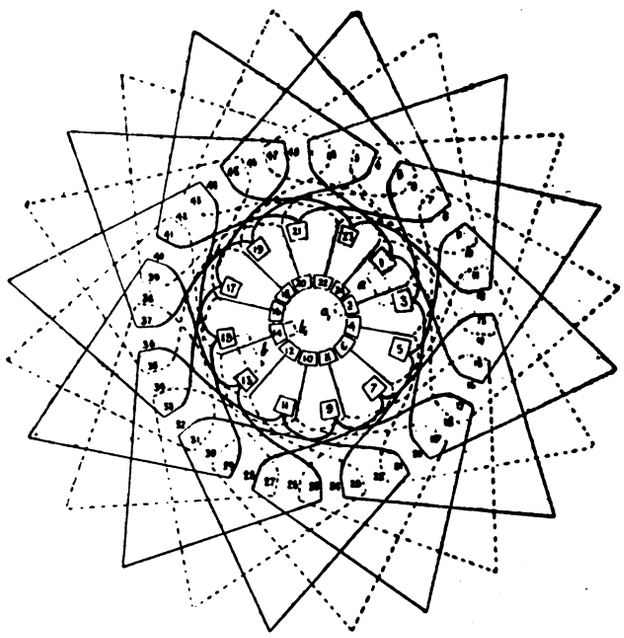
3. Change from double Wave Winding to single Wave Winding.

This is not so difficult, and could be effected in a similar way to the above description (under heading *A*.1.).

The Wave Winding is usually resorted to when a high voltage is required compared with the speed at which armature is run. *If* Wave Windings *must* be used (depending on the speed etc.), then put in a double wave and change to single wave when the voltage raise is required.

"H. K. W."

Answer to Question No. 1204 (*awarded* 5*s*.).—In the figure is shown the complete winding diagram of a 2-pole machine with 48 armature conductors arranged on the double voltage system, here required. This diagram may at once be extended to suit the actual requirements of the present machine, both as regards number of poles and number of armature conductors. The salient and necessary feature of the design is the double commutator employed. In the present case a multiple circuit lap winding is assumed and the pitches are so chosen that one complete circuit of the armature (solid lines) only fills up half the available conductor spaces, another identically similar but independent circuit (dotted) then being wound to complete the armature. In the case chosen the front pitch of the coils =15 and the back pitch =11, the winding being right handed, *i.e.*, advancing clockwise. For example, bar 1 is connected to bar 16, the junction being tapped down to commutator bar 1 : 16 is connected at the back *not* to 3 as in a simple lap winding, but to bar 5, which is in front joined to 20, this junction being joined to commutator bar 3 (*not* 2). There is thus left room for an exactly similar winding starting from bar 3 : the two circuits so formed are electrically independent but may be connected by the brushes as below. Normally, the loop points of each winding are taken to alternate commutator bars, all the commutator segments (1 to 24) (*see* Fig.) being arranged on one circumference and in the order numbered. With such an arrangement specially wide brushes are needed to span three commutator bars but only two sets of brushes are needed (in a 2-pole machine), just as in ordinary multiple circuit machines. If, however, two separate commutators be used as shown, one containing all the even and the other all the odd segments of the original single commutator, then, by employing four sets of brushes ab, a^1b^1 we can either use these as the terminals of two similar but quite independent sources of electrical energy, or by connecting aa^1 and bb^1 and using the composite terminals we shall again have the identical electrical conditions existing when a single commutator was employed. Yet again, by connecting b to a^1 and using a and b^1 as the supply terminals, the two windings are placed in series and a supply at double the initial pressure is therefore available. The two windings being identical and symmetrically disposed can be run in series or parallel as desired.



Such an arrangement is very suitable for the present requirements. The change over from 200 to 400 volts when necessary will involve nothing more than the rearrangement of the field coils, as stated in the query, and an alteration in the brush connections as above. The armature bars must be designed to carry the maximum current required per conductor at the lower voltage, and the insulation must be such as will be satisfactory after conversion to the higher pressure. These two conditions together with the duplicated commutator and brush gear will result in a machine rather more costly than standard types of equal output, but your correspondent will experience no difficulty in obtaining a reasonable tender, for if not an offer from stock of a suitable machine from any of the leading makers of dynamo electric machinery. It will, in most cases, be convenient to have one commutator at each end of the armature, this arrangement being more symmetrical and enabling convenient connections.

If c amps be the maximum current that can be carried by each armature conductor, the output of the machine = $4c \times 200$ watts at 200 volts, and $2c \times 400$ watts at 400 volts ; *i.e.*, the maximum output of the machine is, of course, the same in both cases, but at the higher voltage the well-known advantages of 3-wire distribution become available.

The type of winding diagram adopted in the figure is the ordinary radial form, the bracket shaped loops representing the commutator connections, the radial lines, the armature bars and the outside V lines, the back connections of the coils. At least two bars will be placed in each armature slot, all the bars numbered odd, say, being at the top of a slot and all those numbered even at the bottom. Each bar at the top of a slot is thus connected to one at the bottom of another and so a smooth finish is secured to the armature periphery.—"L. C."

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REVIEWS.

"Electric Cables: their Construction and Cost." By D. Coyle, M.I.E.E., and F. J. O. Howe. (London: E. & F. N. Spon, Ltd., Price 15s. net.)

It is not a little curious that notwithstanding the vast and primary importance of the subject, there should be so great a paucity in literature on wires and cables for electrical purposes. As a matter of fact, whatever of moment has hitherto existed must be looked for in scattered volumes of the Proceedings of learned Societies. No doubt this is largely due to so much being still little understood outside the close ring of manufacturers and their experts. It is the fact that Mr. Coyle was so long connected with Max Sievert's Fabriks Aktiebolag, Messrs. Siemens Bros., the Kabelwerk Duisburg, and the Kabelwerk Oberspree, and Mr. Howe with Messrs. Siemens and the Kabelwerk Oberspree, enables them to make the present book so comprehensive in plan and detail.

We have here a really authoritative treaty, which enables the electrical engineer, whether engaged in lighting, power, telephone or telegraphic work, to determine the dimensions of cables and their approximate cost with considerable ease and great nicety. The chapter on conductors opens with a brief note on copper wires giving general information and some useful working formulæ, and notes. For instance, we are told that "In the case of extra high tension cables it is very important that curves of small radius be avoided in the periphery of the conductor," and that it may even be "advisable to provide the conductor with a circular metallic periphery by encasing it in a thin tube of lead, or by lapping it with metallic foil," points which, if they had been more generally observed, would have prevented several awkward breakdowns both in European and American practice. Then follow forty-five pages of tables dealing with copper strands, giving their cross sections in square inches and in square milimetres, weight in kilogrammes per kilometre and in pounds per mile, and strands in milimetres. To complete this we find notes illustrated with diagrams, short tables, and formulæ dealing with the diameter of strand, the lay, physical characteristics of copper, and its annealed high conductivity. More tables follow giving weight of copper wire in pounds per nautical mile (the diameters in inches and milimetres): conversion data for reducing lb. per nautical mile to lb per statute mile, per 1,000 yards, per kilometre, lbs. per nautical mile to kilogrammes per kilometre; Brown and Sharpe, or American gauge wires; Brown and Sharpe's rope strands; Continental normal sections of strands; the Birmingham wire gauge; legal standard wire gauge; flexible conductors; voltage drop; weight and resistance; temperature co-efficients; and tables to assist in arriving at cost according to rise and fall in price of copper; and many others. Students, however, should note that the proposed standard specifications of the Wire Committee of the American Society for Testing Materials for hard-drawn round copper wire, grooved trolley copper wire, and cable wire, is not touched upon, no doubt because the report came out too late. But it is a valuable document, which should be noted in this connection.

As regards concentric conductors, we are given a formula for determining the diameter and number of wires necessary for forming a conductor of any cross sectional area. Aluminium comes in for due recognition. Besides special tables on mechanical tests and temperature co-efficients for aluminium, and graphic curves showing its resistance to alternating currents, ratios are given to enable the tables for copper conductors to be applied to aluminium.

Chapters 2 and 3 deal respectively with impregnated paper and jute insulation, thickness, weight and dielectric resistance being considered under varying circumstances, much of the information being reduced to the tabular form. In discussing india-rubber and gutta-percha, the authors again give us concise notes and a valuable collection of tables. We are told of ten substances which are mixed to form the rubber compounds. It would have been interesting if results of tests showing the merits of different compounds had been added. For instance, both oxide of zinc and zinc white (lithopone) are mentioned, but these are very different substances, and behave very differently under varying circumstances. What is their influence, say, on the resistance and durability of rubber? In chapter 5 we have notes on the construction of dry core, or paper and air space, telephone cables, with tables giving weight in pounds per statute mile, diameter of wire and maximum resistance, the figures appearing in the metric and British systems; tests on telephone cable paper; and the telephone cable construction; the last showing number of pairs (from 2 to 1,000), diameter co-efficient, and number of pairs in successive layers. Points in practice are next discussed, with the aid of further tables and diagrams. A brief chapter is devoted to vulcanised bitumen, which brings us to a consideration of tapes and braids, and then to lead sheathing, with details as to appropriate weight and thickness for different classes of work. As regards cables laid direct in the ground, or in positions where they are exposed to mechanical injury steel armouring is necessary, and the authors point out that cables having a less diameter than 12 milimetres should be armoured with steel wire, and those above with steel tape. Two chapters are devoted to this aspect of the subject.

Having brought us so far the authors plunge into a consideration of labour charges, and here their experience in manufacturing both at home and abroad is of immense service in arriving at workable data. They say that labour cost varies from 5 to 15 per cent. and they give examples of 7½ per cent. for paper or jute insulated single conductor, lead sheathed and armoured cable, to 12 per cent. for paper or jute concentric conductors, lead sheathed and armoured, and for paper and air space telephone cables. Twelve tables of curves are based upon actual cost of labour for cables of various types. Of two other items in the estimate of costs they say that 2½ per cent. should be allowed for waste, except in rubber insulated cables when 5 per cent. is the usual figure. while shop expenses they estimate to range from 100 to 200 per cent. Examples of estimating for cost of paper covered, jute, rubber, and paper and air space telephone cables are shown, and in chapter 12 tables set forth a complete resumé of the cost of every description of cable. In a final chapter many points of very great interest are gone into, such as self-induction tests, electrostatic capacity, dielectric constants and resistance, carrying capacity and so on. The couple of pages on extra high tension cables are crowded with data of the utmost value at the present time, for this phase is by no means so well understood as it should be. The authors remark that it may often be more economical to use aluminium in place of copper wires, or to strand either copper or aluminium wires round a dummy core of jute, hemp, or other material, the choice depending partly on the current to be transmitted and partly on the relative prices of the materials. We have mentioned that the authors have adopted the principle throughout of giving weights and other measurements both in British and metric systems, this is well not only on account of the varying sources of supply, but also because it will facilitate making calculations relating to foreign contracts. In this connection there is one of the most elaborate tables for converting metric into British and British into metric measures that we have ever come across.

From this rapid summary it will be seen that the authors have made a notable contribution to the literature of electrical engineering, and in their case we can truthfully say that they have filled a want.

The publishers have done their part of the work excellently. The type is clear, paper and binding good, and the reading of proofs well nigh above reproach. In subsequent editions we would like to see in place of the running title chapter headings over the pages, and a somewhat fuller index.

PUBLICATIONS.

"Proceedings of the Royal Society of Edinburgh: Session 1908-9." (Edinburgh: Robert Grant & Son.)

This number forms the seventh part of Vol. XXIX., and the interesting contents include a paper on "Hydrolysis of Salts of Amphoteric Electrolytes." by Miss Heather Henderson Beveridge, B.Sc., Carnegie Research Scholar, and *Communicated* by Professor James Walker.

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ELECTRICAL PROGRESS AT HOME & ABROAD.

FROM OUR SPECIAL CORRESPONDENTS.

TYNESIDE NOTES.

NEWCASTLE.

In the *Newcastle Evening Chronicle* of October 19 a full report of the General Manager's suggestions to the Tramways Committee of the Newcastle-upon-Tyne Corporation was published, and, as this contains many interesting features, it may be worth while referring to the suggestions made. The system has always been heavily handicapped owing to the variety of cars, the larger ones having a very limited life, and replacement becoming sooner or later necessary. The permanent way is not under the control of the tramways department, and it has been suggested that Mr. Hatton undertakes the complete control and management of the system. The recommendations as to the running of cars are as follows:—

Every car throughout the day shall be run at a minimum 1d. fare, except for school children. On every car running before 7 a.m. the conductor shall issue a return ticket of value 1½d. to cover the return journey over any 1d. section. This involves an increase upon the present ½d. workmen's fare. There are only between 500 and 700 people using workmen's coupon tickets at noon in spite of the great outcry for them some time ago, and it is now proposed to abolish this system, as it has led to considerable abuse. The system of clerk's discount tickets, also provided when the coupon system was first introduced, should be withdrawn unconditionally. The conductors have power to issue these return tickets only to men dressed as artizans, or who are to all appearances of that class. In the case of those men who consider that they are entitled to such reduced fares and men who are entitled to travel at workmen's rates up to 8 a.m. during the winter months, they must make application for these tickets at the head office or at any of the depôt offices provided for that purpose, when they will be provided with books of tickets as at present, but at the rate of 12 tickets for 9d. Any women, the nature of whose labour entitles them to use coupon tickets, have also to make application for these at the head office or any of the depôt offices.

Failing the adoption of these suggestions, Mr. Hatton advises the 1d. universal workman's fare up to 7 a.m., and to those who desire the same a return 2d. ticket allowing for a return journey at any time of that day. The abolition of certain fare stages is suggested, and a redistribution of the penny stages would have to be made. In order to encourage the long-distance traveller, it is proposed that anywhere in the 1½d. section a return ticket covering the whole route should be issued for 2½d.

Men's Grievances.

In view of the conclusion of Mr. Hatton's report, namely, that the course he would adopt if the undertaking belonged to him would be to reduce the working expenses to a minimum by further cutting down the expenditure and awaiting developments, receives a somewhat pointed reply by a meeting which was held on Saturday midnight by the members of the Newcastle and District Tramway Workers' Union. Reference was made to the reduction in the tram service and the number of employés dismissed. It was pointed out that although the Heaton and Scotswood section had yielded 1s. per car mile, the service had been reduced by one-fifth, and as regards the Gosforth route, very little provision was made for extra traffic at busy times. Casual labour was being used to replace experienced men in the depôts, and assertions were made that men who cleaned cars during the night were, in many cases, compelled to drive during the day. Resolutions were passed protesting against the way in which previous resolutions had been dealt with by the Tramways Sub-Committee, and also against the Management's action in causing car cleaners in the several depôts to miss two nights per week instead of one as before, and to bring in casual labour to do their work.

Mining and Mechanical Engineers.

On Saturday, the 23rd inst., a visit was paid by the members of the North of England Institute of Mining and Mechanical Engineers to the works of Messrs. J. H. Holmes & Co., electrical engineers, Portland-road, Newcastle-upon-Tyne. The reason for this visit was a desire on the part of Messrs. J. H. Holmes & Co. to demonstrate the uses of electricity for mining purposes, as in the words of the firm: "Although electricity for mining purposes has latterly in some quarters been regarded with a little misgiving, there is no doubt it provides the most convenient and efficient means of power transmission, and also that it can be installed in mines by experienced firms so as to be practically safe under all normal conditions of work." For this purpose a considerable number of general and mining engineering machinery was shown, including a 200 kw. d.c. generator working at 180 r.p.m., and fitted with auxiliary poles; a 100 h.p. d.c. motor running at the exceptionally high speed of 750 to 2,000 r.p.m.; three-phase machinery, including haulage gear set; squirrel-cage motors with special starting apparatus, including no-volt release and overload cut-outs; auto-transformer starters with fool proof starting handles; a considerable amount of switchgear, and, in particular, the Holmes-Page patent three-pole switch and fuses mounted on an iron pedestal in a cast iron box, which is specially suitable for mining work. It is fitted with a special locking device, so arranged that the door of the case cannot be opened until the switch is in the "off" position; moreover, the switch will not close while the door is open. The outfit can be made either for double-pole or three-pole operation, and can be supplied with an ammeter mounted on the top of the case where necessary. The usual capacities for this switch are for 100, 200 and 300 amperes, and larger capacities can be made specially. The inspection of the works, including the examination of the works plant, which is installed for the rapid and efficient handling of machinery and apparatus, proved of very great interest to the visitors, and should have an encouraging and stimulating effect in the use of electrical mining apparatus in the North.

LANCASHIRE NOTES.

MANCHESTER.

There are signs of a general improvement in the electric business in the district, and the "lighting" season has now commenced in earnest. It is a tribute to the economy and efficiency of electric lighting, especially by metallic filaments and flame arcs, that almost without exception all the old public buildings in Manchester are electrically illuminated. Gas here is 2s. 3d. per 1,000, and electricity for lighting 3½d. per unit; but even at this the use of electricity in Manchester is rapidly extending. The report is the same for neighbouring towns. Gas never seems to be seriously considered at all now for the lighting of new buildings of any importance. This fact has been strikingly shown by the large installations of flame lamps of all makes put up by all the small skating rinks. In the matter of street lighting electrically, Manchester is very far behind the outlying towns, and except for the lighting of Albert Square, Piccadilly, and one or two streets, gas reigns supreme. Salford's main street has been electrically lit for years, while Stockport, Stretford and many of the small towns can boast of public arc lighting. The advantages of electricity for general lighting, signs, window novelties, etc., are rapidly becoming appreciated even by quite small shopkeepers, and it is quite interesting to see shop after shop on the main roads adopting "juice" while the gas ranks thin daily. Immediately one shop in a row adopts it, three or four others take a supply, and the gas mantles rapidly give place to metallic filament lamps until the whole row is "converted."

Mercury Vapour Lamps.

Mercury vapour lamps have not found much favour here, although a few shops use them as doorlights. In this connection they would seem to be singularly suited for exteriorly lighting chemists' shops, as there the light would not appear so strange or out of place. As a means of attracting attention and giving cheap illumination (the efficiency is about ½ watt per c.p.), they have been found useful. They have been used in this way outside the Gaiety Theatre and in the Midland Hotel porch. They are also used in the drawing offices of several local firms, and the light is very soft and restful to the eyes when one is accustomed to it. Another use to which they have been put is for printing blue prints and such work, the light being highly actinic.

Auto-Transformer 50-volt Lamps.

The auto-transformer and the 50-volt metallic lamp is still greatly in demand here, in spite of the much-boomed 100 and 200-volt low c.p. lamps. I understand that quantities of 100 to 50, and 200 to 50-volt coils are being sold in every town round here, where A.C. is available. Automatic no-load switches are not much in favour, and this is not surprising, seeing how delicate is their mechanism; while by adding the price of switch to that of the cheap auto-transformer, a really good coil having high working efficiencies, but very low iron losses (no greater than the loss in the switch itself) can be bought. The 50-volt lamp is popular because in first cost it is much cheaper than the 200-volt, is more efficient, and of course much more robust. Under certain conditions the low voltage circuit is an advantage, both where the installation is old and where new wiring is being employed.

Wireless Telegraphy.

Although not in the county, some particulars of an experimental wireless "station" put up during the week may be of interest. This is at Stancliffe Moors, Darley Dale, Derbyshire, at the top of Burley Fields, the altitude being about 900 feet above the ordnance level. The "station," which consists of two masts 70 ft. high, a rough wooden hut and the receiving instrument, was erected in 12 hours. The object is to test the Balsillie system, which has been acquired by the British Radio.

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T. & T. Co. On Friday morning, after tuning up, messages are said to have been taken from London, 147 miles away, whence they were transmitted with considerably less power than the Admiralty standard of ¼ kw. per 50 miles. Messages from the German Lloyd station at Norcitch, 700 miles away, were also audible. At present the station only receives, but transmitting apparatus is to be brought up and I understand the station is likely to become an important one. The cost of equipment with this system is said to be very low compared with other systems, and great things are expected of it in the near future. The experiments are being carried out with the Government's consent.

New Salt Works.

I hear that the Salt Union are about to embark on an important undertaking at Weston Point, where there are several large chemical works. They have added 12 acres to their present holding, and intend to erect a large power station and salt and chemical works. Their chief object is to compete with Spanish and American salt. The salt will be made by the American vacuum process from brine brought up from Northwich, and during the purification process, caustic soda and bleaching powder will be made as bye-products. In addition to using the power for their processes, it is their intention to supply electricity to surrounding towns, and if they are successful in arranging with these towns, there is no doubt great developments will take place, as there are many industries in the neighbourhood.

MIDLAND NOTES.

BIRMINGHAM.

Important extensions are being made at the Smethwick Power Station of the Birmingham and Midlands Tramways Co., Ltd. Contracts have been placed with the Brush Co. for a large 2,000 kw. turbo-alternator and the necessary three Babcock & Wilson boilers. The contract for the building has been placed with A. H. Guest, of Stourbridge. The necessity for increase has arisen mainly through the increased demands for power for manufacturers in Oldbury and Smethwick. Quite a number of ironworks and metal-rolling concerns have lately changed their power from steam to electricity. The firm are at present driving four rolling mills, each equipped with 200 h.p. motors, besides several smaller ones. Firms utilising the power include Reynolds & Bradwell and the Park Lane Ironworks. The power station has taken its full share of the new business, resulting from the adoption of electric power, and the new apparatus will all be of an up-to-date character. The capacity of the station has been increased from 3,530 kw. to some 5,000 kw.

Handsworth Tramway Scheme.

The Handsworth District Council have adopted a new tramway scheme, the lines of which, extending about four miles, will be electrically equipped. This will have the effect of bringing residents from the more distant parts of the suburb into touch with the cable tram lines, and thus shortening the time required for getting into town by nearly half-an-hour. One object of the extension is to find a dayload for the electric station, the position of which will be very materially improved from the profit-earning point of view. The power house has for some time past been supplying current to the British Electric Tramway Co., and when the cable tramways are electrified, as they will be at the beginning of 1911, a further demand will be made upon the power station. This centre is quite capable at the present time of furnishing sufficient driving power, not only to the cable tramway, if that were electrified, but to the new lines. It is expected, however, that when this supply becomes due the local demands in other directions will have necessitated increased equipment in the power house.

Increased Business Expected.

Although Handsworth is entirely residential, the Council Power House could drive at present a number of machines in the contiguous district of Smethwick and the jewellery quarter of Birmingham, and more business of this sort is anticipated. The capacity of the station at present represents 1,700 h.p. This includes a couple of increases of plants each of 315 h.p. during the last two years. At present there are six generators. There is ample room for others, as requirements necessitate them.

AMERICAN NOTES.

NEW YORK.

I am given to understand, on the best possible authority, that the story circulated here a week ago alleging that the biggest electrical houses in the States were forming a colossal combine with a view to eliminating competition in practically every branch of the electrical industry, is a pure myth. Both the General Electric Co. and the Westinghouse Co. authorise an emphatic denial of the report; and, indeed, such an agreement would be impossible under the Sherman Anti-Trust law. It is quite true that the General Electric has acquired full control of a large number of German lamp patents, and that certain agreements with the Westinghouse Co. still remain in force; but there is nothing new in these agreements, and no new ones are, or have been, contemplated, though these agreements expire next year, after having been in operation 14 years. The fact is, that all the corporations, large and small, are doing excellent business, and the volume of trade is increasing at such a rate that the move suggested—the report of which, by the way, had momentarily a very marked effect on shares—is as unnecessary as it would be impolitic. Another combine story (for which the *New York Sun* is responsible) assumes an amalgamation of all the traction, lighting, power and gas companies of Chicago, representing a total capitalisation of $300,000,000, and declares that Mr. J. Pierpont Morgan is the moving spirit behind the scenes.

New Steel Mill Motors.

With a view to meeting the peculiar requirements of steel-mill power service with its occasional heavy overloads, sudden shocks and reversals, rapid accelerations and other conditions involving exceptional strain and automatic resourcefulness, the General Electric Co. is putting on the market A.C. and D.C. motors of a type which has been especially evolved to meet unusual needs. The motors are wholly enclosed in horizontally split steel octagonal magnet frames, bolted at each corner and supported on four massive feet, each drilled for a foundation bolt. Especial facilities are provided for getting at brushes and collector rings, and for inspecting the motor parts. The stator winding is entirely separate from the frame, and either rotor or stator can be replaced with a minimum of delay. Each half of the frame has ribs extending lengthwise which are bored to the diameter of the stator and are equal in length to the distance between its end flanges. When the stator is lowered into the frame and the upper half of the frame bolted on, these ribs automatically centre it and prevent end motion, while rotation of the stator is prevented by ears projecting from the core. Flanges at the ends permit of the handling of the apparatus without damaging the windings. The coils are assembled in open slots and held in place by non-combustible wedges in such a manner that replacement is very simple. The collector spider is carried on an extension of the rotor spider, to which it is keyed, making it unnecessary to disturb any connection if it is necessary to replace the shaft. The collector rings are bolted to this spider making their removal a very easy operation. The rings are of exceptional size and the collector throughout is ruggedly built.

Storage Battery Wisdom.

Here are some aphorisms on the eternal subject of storage batteries which my Chicago correspondent has "potted down" from a lecture delivered in that city by Mr. H. M. Beck at a meeting of the Western Society of Engineers. "Let initial charging be long and thorough—not less than 60 hours. Overcharge is better than undercharge: when voltage and sp. g. have reached the maximum, give it one to four hours more. Use automatic cell fitters to keep the height of the electrolyte constant. Never let sediment collect till it reaches the plates. Replace evaporation with water, not electrolyte. Don't use the cadmium test unless you have to. To keep your battery in good condition overcharge it every other week and check the overcharge with an amp.-hour meter."

Tantalums for Railway Lighting.

The tungsten lamp has been enjoying a long innings, but now it is the turn of the tantalum again. This week is published the result of the exhaustive tests made by the National Electric Lamp Association, of Cleveland, Ohio, to demonstrate the advantages of tantalum lamps for D.C. street-railway lighting, and the report is wholly favourable. The advantages set forth are as follows: Comparative freedom from flickering under varying voltage and from excessive dimming at points of low line potential; small cost of operation both in energy consumption and renewals; small current consumption, thus increasing the net efficiency of the generating apparatus, especially during rush hours when its full capacity is most needed; 27·2 watts are saved at every socket when a 16-c.p. carbon lamp is replaced by a tantalum street-railway lamp of equal candle-power; the strength of the tantalum filament and the clamped joints of the lamp fit it admirably for withstanding the shaking-up which a railway lamp has usually to undergo. With regard to this last clause, it should be noted that recent improvements have raised the tensile strength of tantalum to 57 tons per sq. in., thus meeting all requirements for heavy service.

As Cousin Jonathan Sees It.

On the principle that it is a good thing occasionally to see yourselves as others see you, your readers will doubtless be interested in the view taken by the *Electrical World* of this city of the progress of your Electric Lighting Acts. "When the history of the electric-lighting industry shall be drawn up and presented," says the *World* in an editorial, "it will probably be shown that, in Great Britain, the development of this industry was long thwarted by over-legislation on the principle of the proverb that 'too much care killed the cat.' The nineteenth century had already witnessed in England another great public industrial development—the steam railroad. When, about the

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year 1882, the advent of a new public industrial development of electric lighting seemed imminent in England, good resolutions were borrowed from the history of the steam locomotive, and it was determined that there should be no napping this time on the part either of Parliament or of the nation. It was imagined that capital was massing impetuously to invest in electric lighting for the spoliation of the worthy taxpayer, and that stringent legislation was necessary to protect the shorn lambs of consumers from the tender mercies of raging electric-lighting capitalists. Unfortunately, then, the reactive movement was carried too far. The Electric Lighting Act of 1882 was passed by Parliament apparently in the belief that private electric-lighting enterprise was a dangerous and vicious policy, to be hampered and restricted; while municipal electric-lighting enterprise was a safe and meritorious policy to be permitted and encouraged. The terms under which the Act of 1882 permitted private companies to engage in electric lighting were so severe that capital held aloof, and hardly any companies were able to enter the field. Moreover, the municipal corporations were new to the undertaking and also held aloof; so that after all this legislative precaution very little happened. A new Act of Parliament was passed in 1888, by way of amendment, and of easing the burden on enterprise in electric lighting. This gave partial relief, and most of the electric lighting of Great Britain has been carried out by companies taking Provisional Orders under this Act. Even then, however, the wretched companies were beset with all manner of hampering restrictions, in the sale of lamps for instance; so that they were virtually limited to being electric-energy distributing companies and could hardly be called electric-lighting companies. As a result of much protest and complaint, a new Bill of amendment was brought into Parliament in 1903 and 1904, with the object of removing useless burdens on electric lighting activity; but partly owing to municipal opposition it failed to pass. At the present time, substantially a repetition of the proposed 1903 amendment Bill is now pending, and has already passed the House of Lords, with certain amendments. It vests increased power in the Board of Trade for the potential benefit of private electric lighting companies. The moral to the long tale of woe is, firstly, that although electric lighting is certainly capable of being effectively carried out by municipalities, yet it can ordinarily be carried out with greater economy and commercial success by private enterprise. Human nature is such that the prospect of winning dividends stimulates to increased exertions, and leads to the selection of the best administrative talent. Secondly, private enterprise should be encouraged and not discouraged, by legislation, to make all reasonable profits. It is sufficient if the customer is protected against dishonesty."

The Cost of Power.

Some instructive and interesting deductions may be drawn from figures which have been published here concerning the cost of power in a 3,000 kw. turbine plant. The station in question is equipped with three 525 h.p. boilers of the Babcock & Wilcox type, built for operation at 175 lbs. steam pressure. There are two 1,500 kw. Curtis-General electric turbo-alternators running at 900 r.p.m., the turbines being of the four-stage type and operated in connection with barometric jet condensers. The operating force consists of four engineers, four oilers, four firemen, three coal passers and three sub-station men. In the first year of service this plant generated 5,858,255 kw. hours and sold 4,605,811 kw. hours, giving a customer-to-station efficiency of 78·5%, including transmission from the generating plant to the sub-station at 13,200 volts and local distribution at 2,300 volts. The total energy sales of the company during the year for power service were 1,247,979 kw. hours, giving 27% of the output for motor applications. The plant burned 8,120 tons of bituminous coal during the year, giving a rate, including auxiliaries, of 3·1 lbs. per kw. hour delivered at the switchboard. The total cost of manufacture for the year was $62,089, or 1·06 cents per kw. hour at the switchboard. The most important items were fuel, $36,255, or 0·62 cent per kw. hour, and station wages, $16,674, or 0·29 cent per kw. hour. Repairs to steam equipment came to $2,996, while the electrical apparatus required only $136 for maintenance. These results show that if the plant had not been handicapped by a high fuel price per ton it would have been feasible to generate electricity at considerably less than one cent per kw. hour.

Current Items.

The City Council of Chicago is considering a proposition formulated by the late Mr. Harriman, and submitted by Mr. M. H. McGovern, of the company of that name, for the construction and operation within two years of a subway system for the city. The McGovern will back the scheme to the extent of $100,000,000 "or more if required."

Rear-Admiral Melville, Mr. John H. McAlpine, and Mr. George Westinghouse, have perfected a reduction gear transmission by which the speed of a high power turbine can be reduced in marine service to the required speed of a steamship's propeller. It is claimed that this invention will perform greater service at a more economical rate than any that has yet been devised. The Westinghouse Machine Co. will have the exclusive right to manufacture this new invention here as well as in Europe.

Traffic on the Interborough Rapid Transit Co.'s lines broke all records during the Hudson-Fulton celebration. On the first day of the celebration, the Interborough lines carried 2,140,521 passengers, and on the following Thursday they carried 2,157,989. Each of these records was far ahead of anything previously known on the lines. The business for the week which ended October 2 was the heaviest ever experienced by the company.

Rumours of the absorption of the Western Union Telegraph Co. by the American Co. are again current here, notwithstanding the emphatic denial recently issued by Mr. Clarence Mackay. It is said that Mr. George Gould has sold his holding to the American Co.

The Westinghouse Co. has secured the contract for the power-house equipment of the Yellow Pine Paper Mill Co. at Orange, Texas, and will instal an 800 kw. turbo-generator set, Le Blanc condenser, turbine exciter, and from 40 to 50 motors.

Lieutenant Ferdinand Helfer, formerly of the German Army, is exhibiting at the New York Electrical Show a small but powerful motor which he claims will be invaluable to future Arctic or Antarctic explorers. The motor is small enough to be carried on one sledge, along with a complete wireless-telegraphy outfit.

In a report submitted to the convention of the American Street and Inter-urban Railway Engineering Association, the impregnation of both old and new field coils is highly recommended. The wire is insulated with asbestos, held on by a thin cotton covering. After winding, the coil is taken out of the form and wrapped with porous tape. The coil is then filled with asphaltum compound by the vacuum process. When cooled down clamping plates are placed on the coil, both back and front, to bring the compounded coil to the exact dimensions desired. After the coil is cold the clamps are removed, the first taping is removed and varnished cambric insulation is put on the coil.

COMPANIES' MEETINGS AND REPORTS.

DRAKE AND GORHAM, LTD.

At the eighth annual general meeting of Drake & Gorham, Ltd., held at the offices of the company, 66, Victoria-street, Wetminster, S.W., Mr. Bernard M. Drake, M.I.E.E. (chairman, and one of the managing directors), presided. The chairman moved the adoption of the report and that a dividend at the rate of 2½ per cent. per annum be paid forthwith, the balance of £484 13s. 5d. being carried forward to next year. The prevailing sense of insecurity among owners of property and the necessity for avoiding anything in the nature of a luxury had, he said, caused a reduction in turnover, besides which the stagnation in trade, especially in Lancashire, had stopped their progress in the electrification of mills. Owing to the new conditions brought about by the advent of metal lamps, the value of individual contracts was enormously reduced, and although a considerable influx of business in lighting small houses was anticipated (for the public were beginning to appreciate the fact that electric light was now the cheapest form of illuminant and undoubtedly the best to instal, even in the smallest houses), yet it must be remembered that these small houses require as much individual attention as larger contracts; so that it remained to be seen whether a corresponding advantage would accrue to the company from a financial point of view. In any case, the cost had hitherto been the deterrent to a more general adoption of electric light, and that objection might now be taken as having been removed. Their trade department for the wholesale supply of metal lamps to the trade and large users had been very busy, a number of important contracts having been secured. This department was worked independently, so as to remove any scruples which contractors might have in dealing with possible rivals. From the large increase in the number of accounts that had been opened with contractors it was evidently appreciated that not only were their interests safeguarded, but that there was a distinct advantage in dealing with a firm which was thoroughly conversant with their requirements under all conditions. Although the dividend was below what it had been in previous years, this was due to special conditions, which he trusted might soon be changed.

ELECTROLYTIC ALKALI COMPANY.

The report of the Electrolytic Alkali Co., Cheshire, shows a net profit for the year, after allowing for depreciation, Debenture interest, general upkeep, etc., of £11,919, making, with the balance brought forward, a credit balance of £22,174. There are now three years' dividends due on the Preference capital. The directors propose to pay 12 months' dividend and to carry forward £15,177.

EDISON AND SWAN UNITED ELECTRIC LIGHT CO., LTD.

The 26th annual report of the above company, for the business year ending June 30, has been issued. It states that the net revenue account shows that the sum of £26,836 8s. 7d. has been brought forward from profit and loss account. Interest on Debenture Stocks has absorbed £15,701 16s.; £5,500 has been set aside as depreciation on freehold and leasehold property,

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plant, and tools; £4,000 has been applied in writing down values of stocks, and the sum of £1,213 6s. 3d. has been reserved on account of bad and doubtful debts. The result as shown in the net revenue account is a credit balance of £421 6s. 4d., to which must be added the sum of £9,606 1s. 2d. brought forward from the previous year, thus making a total of £10,027 7s. 6d., which the directors propose to carry forward. Cost of establishing the business, goodwill, etc., £390,432 8s. 1d., has been brought forward at the figure standing in the last balance-sheet. The freehold and leasehold property and plant have also been brought forward at the value stated in the last balance sheet, with the addition of the amount expended to June 30, 1909, less depreciation charged in net revenue account. The shares of the Altrincham Electric Supply, Ltd., have been taken at par, as in previous years. This concern continues to be satisfactory, and has paid a dividend on its shares of 7% for the year ended December 31, 1908. Its indebtedness to this company has been reduced during the year by £155 2s. 3d. There has been expended on capital during the year ending June 30, 1909, £19,813 0s. 9d., almost entirely on account of additions to buildings and plant in connection with the manufacture of metal filament lamps. The manufacture of metal filament lamps has been considerably extended during the year, and the satisfactory results attained justify the directors in looking forward to a large and remunerative trade in the future. The directors regret to announce the death of their colleague, Mr. H. Wolfenden, junr.; and state that Mr. Wm. Murray was elected to fill the vacancy. Mr. Eustace C. Quilter was elected a director, and both of these gentlemen offer themselves for re-election.

ARGENTINE ELECTRIC COMPANY.

The Directors of the Compañia Anglo-Argentina de Electricidad, in their report on the 3rd year's working, ended July 30, stated that the working of the various stations gave a gross income of $209,772.43, and after deducting expenses, a net profit of $113,380.43. Out of this sum $18,163.91 is written off for amortization and special reserves, this leaves with $4,848.74 brought forward, the sum of $100,065.26, of which $15,000 goes to reserve, $9,521.65 to directors, $71,080 in an 8 per cent. dividend and $4,463.61 forward. The reserve fund now stands at $100,000, which is 4 per cent, of the paid up capital. During the year $85,543.31 has been spent on enlargements and $10,626.34 on meters, etc., making the total amount spent on the five stations $971,785.56 m/n. The monthly income from the stations was $26,424.40, a decrease of $532.10 when compared with the previous year, which is due to a competitor having started in Chascomus, to rebates in the tariff and to the more general use of metallic filament lamps. The receipts for the first month of the new year show an increase of $2,681.07 when compared with that for the year under review.

CORDOBA LIGHT, POWER, AND TRACTION.

The report of the Cordoba Light, Power, and Traction Co. (Limited), to September 30 last, states that the balance of profit to that date, after meeting all charges, including interest on Debenture stock, is £13,410. The directors recommend a dividend at the rate of 2 per cent. (less income tax) and that the balance of £5,191 be carried forward.

COMPANIES' REGISTERED.

Anglo-German Wireless Syndicate, Ltd.—Registered October 12, by S. B. Cohen & Dunn, Audrey House, Ely Place, E.C. Capital, £200, in 1s. shares. Objects: To adopt an agreement with Baron Egbert von Lepel, General Baron von Gayl and Dr. W. Burstyn, and others, trading as the Drahtlose Telegraphicsystem von Lepel, and to carry on the business of electricians, engineers, battery makers, founders, generators, distributors and workers of and dealers in electricity, land, submarine and aerial telegraphy, etc. The first directors (to number not less than four nor more than eight) are: Baron Egbert von Lepel, General Baron von Gayl, W. Burstyn, Sir Thomas Myles, Kt., A. Holt and Viscount Massereene and Ferrard.

Arcade Picture Palace (Portsmouth), Ltd.—Registered October 21, by E. Chapman, 21, Bedford-chambers, Covent-garden, W.C. Capital, £2,500, in 2,250 Ordinary shares of £1 each and 1,000 Deferred shares of 5s. each. Objects: To carry on the business of cinematograph theatre proprietors, musical, theatrical, and dramatic agents, etc. Private company.

Carmarthen Electric Supply Co.—Capital £10,000, in £1 shares (5,000 5% Preference). Objects: To acquire from J. B. Saunders & Co. the benefit of the Carmarthen Electric Lighting Order granted to them under the Electric Lighting Acts 1882 and 1888, for the supply of electrical energy in Carmarthen, and to carry on the business of electricians, mechanical engineers, suppliers of electricity, etc. Qualification of managing director, 100 shares; of ordinary directors, 200 shares. Registered office: Salisbury House, London Wall, E.C.

Electrolytic Apparatus Syndicate, Ltd.—Registered September 28. Capital £5,000, in £1 shares. Objects: To adopt an agreement with J. T. Niblett for the acquisition of inventions for electrolytic apparatus, and to carry on the business of manufacturers of and dealers in all kinds of mechanical, chemical, electrical and electrolytic apparatus (except for electro plating). Private company. Registered office, 11, Victoria-street, S.W.

Franco-British Electrical Co., Ltd.—Registered October 12, by W. B. Styer, 11 and 12, Fenchurch-street, E.C. Capital, £1,500, in £1 shares. Objects: To acquire the business carried on at 99a, Charing Cross-road, W.C., as the Franco-British Electrical Co., and to carry on the business of gas, electrical and general engineers, illuminating decorators and contractors, etc. Private company.

Halesowen Lighting and Traction Co., Ltd.—Registered September 29. Capital £10,000 in £1 shares. Objects: To acquire the rights, powers and privileges granted to G. Balfour by the provisional order granted by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, in respect of the Rural District of Halesowen, Worcestershire, as amended and confirmed by the Electric Lighting Orders (Confirmation No. 1) Act, 1908, and to carry on the business of electricians, suppliers of electricity for light, heat and power, etc. Minimum cash subscription, 10% of the shares offered to the public.

Westminster Tool and Electric Co., Ltd.—Registered September 30. Capital £1,000, in 500 "A" shares of £1 each and 10,000 "B" shares of 1s. each. Objects: To carry on the business of electrical engineers, electricians, suppliers of electricity for light, heat, motive power or otherwise, manufacturers of and dealers in electrical apparatus, etc. Private company. Registered office, Palace-chambers, Bridge-street, Westminster.

LIENS REGISTERED.

Church Stretton Electric Supply Co., Ltd.—Charge dated September 30 to secure £50 (supplemental to a charge dated March 17, 1909). Property charged—Certain freehold hereditaments at Crossways, Church Stretton, Salop. Holder—E. Bond, 43, Thurloe-square, S.W.

Electro-Mechanical Brake Co., Ltd.—Satisfaction in full (a) of mortgage, dated April 15, 1909, securing £575, and (b) of charge, dated June 7, 1909, securing not more than £1,500.

CONTRACTS OPEN.

HOME.

Epsom.—The Urban District Council.—Eight direct current long burning flame arc lamps. November 2.

Llandudno.—Urban Council.—Supply of hand tower-ladder for trimming electric lamps. October 30.

London.—London County Council.—For the supply and delivery for one year, from January 1, of (*a*) electric carbons; (*b*) electric fittings; (*c*) electric insulating materials; (*d*) electric cables and wires: (*e*) electric lamps. Also other fittings, etc. November 1.—Two marine type boilers, etc., for Tramways Department. November 2.—Installation of electric lighting at the Buxton-street Elementary School, Whitechapel. November 3.

Luton.—Corporation.—Supply of medium pressure, single core, insulated cables. October 29.

Warrington.—Corporation Electricity and Tramways Committee.—Arc lowering gear. November 2.

OVERSEAS.

Cairo.—Egyptian Railways and Telegraphs Department.—Stores. November 3.

Johannesburg.—Postmaster-General.—50 silence cabinets. November 3.

Leghorn.—Tramway construction.—Material and rolling stock (Soc. An. des Tramways de Livourne).

Lucknow.—Municipal Board.—Tenders invited for a concession for the supply of electric energy, coal or oil gas, for house and street lighting, and other domestic or manufacturing purposes. December 31.

Madrid (Spain).—Direccion-General de Obras, Públicas Madrid.—For a 60 years' concession for construction and working of an electric tramway from Sans to Coll-Blanch (Barcelona). November 20.—Direccion-General de Correos y Telégrafos.—For a 15 years' concession for working of urban, telephone system at Oviedo. November 2.—Direccion-General de Obras, Públicas.—For a concession for the construction and working of an electric tramway in Barcelona. October 4.

Melbourne.—Deputy Postmaster-General.—Two sets of accumulators. By 3 p.m., November 23.—Postmaster-General.—To supply coin attachments (for coins of different values) for telephones. Spec. No. 184. 370 50 c.p. metallic filament lamps, with bayonet cap fittings, for 110 volts A.C.; 630 25 c.p. ditto; 160 16 c.p. Linolite carbon filament lamps, 110 volts A.C.;

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1,000 16 c.p. T.H. screw socket carbon filament lamps, 110 volts A.C. ; and 100 32 c.p. metallic filament lamps, with bayonet lap fittings, 200 volts A.C. December 7.

SALZBURG.—Municipality.—Water power station. November 2.

SYDNEY.—Postmaster-General.—Switchboard apparatus for subscribers' premises. Particulars of all Australian contracts, 72, Victoria-street, Westminster, S.W. January 10, 1910.

TORBACH (Alsace).—Municipality.—Electric tramway. November 1.

TOULOUSE.—War Department.—Electric motors. October 30.

TURKEY.—Broussa Municipality.—For a concession for the installation of electric light and power, and for the construction of an electric tramway. December 13.

VALENCIA.—Harbour Board.—Six one-ton electric cranes for timber unloading. November 2.

SOME CONTRACTS.

The War Office have accepted tenders of the Edison & Swan United Electric Light Co., Ltd., and the British Thomson-Houston Co., Ltd., for the supply of electric lamps, and that of the British Insulated and Helsby Cables, Ltd., for telephone sets, etc. The General Post Office have accepted the following tenders:—Paper core cable: British Insulated and Helsby Cables, Ltd. ; Johnson & Phillips, Ltd. Cables, submarine: Telegraph Construction and Maintenance Co. Detectors and leather cases: General Electric Co., Ltd. Generators: International Electric Co. Wire, copper, hard-drawn: Messrs. T. Bolton & Sons, Ltd. ; British Insulated and Helsby Cables, Ltd. ; Elliott's Metal Co., Ltd. ; Messrs. R. Johnson & Nephew, Ltd. ; Shropshire Iron Co., Ltd. ; F. Smith & Co., incorporated with the London Electric Wire Co., and Smiths, Ltd. ; and Wilkes, Son & Mapplebeck, Ltd.

A contract for a scheme of main sewerage of Bentley Colliery and Rostall, Doncaster, has been let to Messrs. C. Bushby & Sons, of Leeds. The work, which has been designed by Messrs. D. Balfour & Son, of Newcastle-on-Tyne and London, consists in the laying of the whole of the sewers of cast iron pipes on a concrete bed, which is necessary owing to the treacherous nature of the subsoil. A pumping station is to be constructed of concrete, each of the storage tanks having a capacity of 2,000 gallons, from which the sewage will be automatically pumped by centrifugal pumps driven by electric motors. Floats are to be provided in the tanks so that when full of sewage the motors will be automatically switched on, the power for which is to be obtained from Bentley Colliery power station. The sewage is to be delivered at the existing disposal works, which are of sufficient size to take the increased quantity.

Messrs. Lowdon Bros. & Co., electrical engineers, Dundee, have just secured important Glasgow Corporation contracts in connection with the Shieldhall Drainage Outfall Works. They have had in hand for some time the mechanical installation, amounting to £17,764, and now they have secured the contracts for the electric installation (£,868), and for the oxidiser plant (£1,711). The oxidiser plant is being made in the firm's works in Dundee.

TENDERS ACCEPTED.

BRISTOL.—Annual tenders for supplies were accepted by the Council as follows: General Electric Co., carbons, £367 ; Electrical Co., alternating current meters, £762 ; Messrs. Siemens Bros., dynamo works, arc lamp globes, £31.

FRODINGHAM.—The Urban Council accepted the tender of Messrs. Reid, Ferens & Co., of Newcastle-on-Tyne, £278 13s. 6d., for the electric light standards and the streets and for wiring.

HUDDERSFIELD.—The tender of the Brush Electrical Co., Ltd., for the supply of a new car of the Kavanah type was accepted by the Tramways Committee of the Borough Council.

KINGSTON-ON-THAMES.—The Council accepted the tenders of the W. T. Henley's Telegraph Works Co., 880 yards of ·1 square inch low-tension cable, £191, and Messrs. W. T. Glover & Co., 880 yards of 10 ampere cable, £72.

LONDON.—The London County Council accepted the following tenders: Delivery and laying of high-tension cables, Western Electric Co., £4,757 5s. ; supply and delivery of low-tension cables, British Insulated and Helsby Cables, Ltd., £31,999 12s. 2d.; supply and delivery of tramway feeder pillars, British Insulated and Helsby Cables, Ltd., £1,116 10s. 3d. ; supply of steam, etc., piping, valves, water tanks, etc., for final portion of Greenwich Generating Station, Staveley Coal and Iron Co., Ltd., £7,344 18s. 5d. ; supply of choke coils, etc., for motor generators at sub-stations, Electric Construction Co., Ltd., £1,098 9s. 5d.

LONDON.—The Education Committee, London County Council-received the following tenders for electric lighting and extension at Paddington Technical Institute: British Westinghouse Electric & Manufacturing Co., Ltd. (accepted), £259 ; Whitehead Bros., £260 ; Tilley Bros., £266 ; R. Bridger, £268 5s. ; Westminster Ventilating Co., £280 ; Pinching & Walton, £290 ; R. H. & J. Pearson, Ltd., £296 ; Foote & Milne, Ltd., £298 ; Sweet Bros., £299 ; G. Harland Bowden & Co., £306 ; D. J. Macdonald, £310 ; M. S. Smith, £311 ; Johnson & Phillips, Ltd., £313 ; W. A. Lawrance, £320 9s. ; G. Weston & Sons, £349 ; R. N. Cunningham & Co., £378 ; E. E. Beaven, £378 5s. 8d. ; T. L. Hellyar & Sons, £447.

LOWESTOFT.—Tenders for annual supplies in connection with the Corporation Electric Lighting undertaking were accepted as follows: Mr. W. C. Jones, for the supply of coloured waste at 20s. per cwt., and for white waste at 26s. per cwt. ; Messrs. Rudd Bros., wood bushes ; Mr. F. J. Smith, of Pier-terrace, for screws ; Messrs. J. Bishop & Son, for nails ; the Vacuum Oil Co., for cylinder oil, 2s. 4d. per gallon, crank chamber oil—Vacuum Etna engine, 1s. 4d. per gallon, ditto—600 W., 2s. 4d. per gallon.

SUNDERLAND.—The tender of Messrs. Babcock & Wilcox, Ltd., London, for supplying steam piping and valves for Hylton-road Electricity Works, and the offer of Mr. J. W. White for executing concrete work at the Works, were accepted by the Council.

YORK.—The Municipality accepted the tender of Messrs. Cox-Walker, Ltd., Darlington, £383 8s. 1d., for a traction switchboard.

BUSINESS NOTES.

LIGHTING AND GENERAL—Home.

AINSWORTH.—A parish meeting approved of the lighting of a number of roads by gas or electricity. It was urged that electricity would be the cheaper illuminant.

BRADFORD.—The Electricity Committee passed the annual report by the City Electrical Engineer (Mr. Thomas Roles) on the working of the Electricity Department. This stated that the beneficial effect of the reductions made about two years ago, and the special terms then made to consumers taking a bulk supply, is now beginning to be felt. The units supplied to the consumers affected by these rates have risen from 2,697,381 during the year ended June 30, 1907, to 5,039,274 in the twelve months ended June 30 of this year, an increase of 87 per cent. As a result of the reduction in these charges, the motor hiring department has also shown better results. Despite the fact that £1,200 was deducted as an allowance to the Tramway Committee, the total revenue was £3,970 greater than that of the preceding year, which is attributed to the increase in the consumption of electricity for power purposes. The units sold for lighting purposes during the past half-year were less than those sold during the half-year ending June 30, 1907 and 1908. This reduction has been in part due to a number of lamps having been transferred to the bulk supply, but the metallic filament lamp has had by far the greater effect. The total number of consumers has increased from 2,313 to 2,457, being an increase of 6·22 per cent. This is the largest increase reported since the year 1906, when the increase was 8¾ per cent. The outlook for the present year is most encouraging. The output for general supply purposes shows a gratifying increase, and the costs of generation are being still further decreased, due to additional economy in the working of the plant, and to much more advantageous contracts having been concluded for the supply of coal during the past few years. The total number of motors connected with the mains on June 30, was 1,556, as compared with 1,224 on December 31, 1904.

BRAUNTON.—Messrs. Crompton & Co.'s scheme of electric lighting has been accepted by the Council.

BRIGHTON.—To cope with the increasing demand for current, the Manager of the Corporation electricity undertaking recommended the purchase of another turbine, making the fifth, for the Southwick generating station, as well as additional transformers.

CANTERBURY.—The cable supply and the current to one side of St. George's-street suddenly failed in the early morning, and it took upwards of 12 hours to discover the leakage, some half-dozen openings having to be made in the pavement before the exact spot where the mischief occurred could be located. Many of the shops were more or less in darkness for some hours during the evening.

CARDIFF.—For electric lighting and the supply of an inter-department telephone to the Council's farm, an expenditure of £65 has been sanctioned.

CLEETHORPES.—The Urban Council are applying to the Local Government Board for sanction to a loan of £4,000 for electric lighting purposes, etc.

CROMPTON.—The application of the Oldham Corporation for consent to supply electricity in Crompton again came up for the consideration of the District Council. It was decided to give the Corporation consent to supply in specific cases, subject to certain provisions.

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EPSOM.—The Local Government Board's letter relative to the Council's application to borrow £1,500 for the purposes of services and meters in connection with the Council's electricity undertaking having been considered by the Lighting Committee, they recommended that in future it be a direction to the officers concerned to keep a separate account of the expenditure under each sanctioned loan, and to see that each allocation of capital expenditure was correctly recorded in the published statutory accounts. This recommendation was adopted by the Council. The Clerk was also directed to reply to the further points raised in the Board's communication.

KIRBYMOORSIDE.—An electric lighting plant has been installed in one of the hotels.

LIVERPOOL.—At a meeting of the Corporation Tramways Committee, Sir Charles Petrie stated that the favourable prices charged for electrical energy for lighting, combined with the introduction of the metallic filament lamp, enabled electricity to compete on equal terms with gas as an illuminant. Electrical power was replacing other sources of power, the units supplied this year exceeding by 6% the sales of the previous year. There were now 7,200 consumers connected with the electric supply mains. The equipment of the fourth section of the Lister-drive No. 2 power station was making good progress, and a portion of it would be in service before the end of the year. Referring to the tramways, he said that in 1909, as compared with 1908, there was a decrease in the passengers carried of 518,838, or ·6% ; in mileage a decrease of 2·9%, and in receipts a decrease of £1,968, or ·5%. The car mile earnings had increased from 10·93d. to 11·20d., an increase of ·27d. over 1908. The decrease in receipts and passengers was mainly due to the extremely bad weather and the continued depression in trade. Notwithstanding the decrease in the traffic receipts, there had been an increase in the net profits of the undertaking amounting to £3,250, which had been brought about by economies effected in management. The policy of the committee in deciding to be their own insurers against third party risks had so far proved very successful. During the 12 months ended May 15, 1909, the sum paid in claims amounted to £4,052, as against a sum of £11,579 paid to an insurance company the previous year, or a saving of £7,527, or 65% ; while during the 4½ months ended September 30, 1909, the number of claims amounted to 222, as against 302 during the same period of 1908, a decrease of 80, or 26½% ; and the amount paid to £610, as against £1,191 in 1908, a decrease of £581, or nearly 49%. Since the alteration in the fares on the first-class cars, the average car mile earnings had increased from 5·26d. to 10·88d. The returns from the new route connecting Walton and the North Docks were not as satisfactory as could be desired. The committee had approved the new scale of fares and stages on the Smithdown-road, Pierhead, and Calderstones Park route, which it was anticipated will be in operation very shortly, affording direct tramway facilities to the citizens of Liverpool to that beautiful resort. The committee had decided to lay additional lines in Neterfield-road for the purpose of forming a belt route *via* Everton Church, Heyworth-street, Netherfield-road, and the Pierhead, thereby affording the inhabitants of Netherfield-road district direct tramway communication with the Pierhead. Under the Liverpool Corporation Act, 1909, the committee had obtained Parliamentary powers for the construction of new lines, and had given instructions for the work of laying a number of the lines to be put in hand as soon as possible.

MAIDSTONE.—The accounts of the Urban Council's electricity undertaking show that the sum of £15,595 was received on capital account during the year ending March 31 last. The capital account has also been credited with £974 9s. withdrawn from accumulated profits in order to adjust certain expenditure originally charged to capital, but for which the Local Government Board declined to sanction any loan. The expenditure charged to capital account during the year amounted to £8,078 7s. 10d. The position of the capital account at the close of the year was as follows: Total expenditure, £78,779 6s. 10d. ; total receipts and credits, £78,667 9s. ; over expended balance, £111 17s. 10d. The total revenue for the year amounted to £13,307 13s. 2d., and the expenditure to £7,363 14s. 11d., leaving a gross surplus of £5,943 18s. 3d., of which interest and principal moneys repaid absorbed £4,871. The balance on the year was £1,072 18s. 3d., which has been added to the profit appropriation account, making an available balance of £3,527 17s. 7d. Appropriation of this balance has now been made to the extent of £1,309 19s. 2d. to relieve the capital account of the unsanctioned expenditure mentioned above and certain expenditure made during the current year, which it is considered would be disallowed on an application for a covering loan. The unappropriated surplus remaining at the end of the year appears at £2,217 18s. 5d.

NAVAN.—Application will be made by the Urban Council for a provisional order for the purpose of supplying electricity in the district.

NORWICH.—The Town Council approved of the principle of substituting electricity in the place of gas for the public lighting of the city. The Executive and the Electricity Committees were authorised to confer and to prepare a scheme for submission to the Council for carrying the proposal into effect at the expiration of the existing contract with the British Gas Light Co., Ltd.

RADCLIFFE.—The Electricity and Tramways Committee resolved that tenders be obtained for main extensions included in the scheme sanctioned by the Local Government Board.

SOUTHAMPTON.—The Council decided to obtain Parliamentary powers to carry on the work of free or assisted wiring, to instal wires, fittings, etc., through a contractor, but not otherwise, and to hire out arc lamps, heating apparatus and cookers, either at a rental, or on the deferred payment system.

SOUTH SHIELDS.—The Council have decided to apply to the Local Government Board for sanction to borrow £8,500 for extensions in connection with the electricity undertaking.

STRETFORD.—The accounts of the Urban Council's electricity department (Mr. R. Rowland, A.M.I.E.E., Resident Electrical Engineer) for the year ended March 31 show a total revenue of £11,981 18s. 1d., and an expenditure of £7,494 12s. 9d. After defraying interest and capital charges, there remains a balance of £1,117 0s. 10d. for transfer to the reserve and renewals fund. The supply for the year, in Board of Trade units, was as follow: 209,316 for public lamps, 1,334,502 for traction, and 341,532 for private consumers by meter.

SWANSEA.—The annual budget of the Corporation shows that on the electric lighting account the total income was £22,485, and the profit on the year's working was £1,748. To the Electric Lighting and Tramways Committee the Deputy Town Clerk explained that the insurance of plant would cost between £200 and £400 a year. Mr. Harris suggested that, as they had a reserve fund of £2,000 in hand, the insurance money could well be paid out of that. It was decided to leave the matter in the hands of a small sub-committee. A letter was read from Mr. David James, the manager of the Swansea Tramways Committee, stating that the Glamorgan County Council were desirous of continuing the present arrangement with the company for the working of the extension to Ynisforgan until December 31, and asking whether the Corporation would be willing to continue the supply of current on existing conditions until the date mentioned. Mr. T. J. Davies suggested that proper stopping places should be fixed at Morriston. The matter was referred to the Chairman and Mr. T. J. Davies, who are to interview the Tramways Manager. The Engineer reported that an application had been received for current from a tradesman in Pentreguinea-road, but that he could not recommend the carrying out of the extension, which would cost £182. With regard to an application from the North Central Wagon Co., the Engineer was authorised to make an offer for lighting their works.

UNSWORTH.—To the Parish Council the Clerk reported that he had paid a visit to the Tramways Manager of the Bury Corporation, as to the lighting of the main road from Blackford Bridge to the boundary by electricity. He added that Mr. Clough would meet the members of the Council on the matter.

WHITCHURCH.—The Urban Council asked the Lighting Committee to consider a proposal with a view to the installation of electricity in the district. Mr. Elson said he believed there would be companies willing to instal the electric light for public and private purposes at a cost to the consumer of 20% lower than the present price paid for gas, the Council to have the option of purchasing the concern in, say, five or six years. A letter was read from the Gas Co., declining to negotiate for the sale of their undertaking to the Council on the basis of a draft scheme, and refusing, also, to make any alternative proposals.

WESTMINSTER.—To the City Council the receipt of a letter was reported from Mr. C. S. Peach, the architect of the Westminster Electric Supply Corporation, stating that the company found it impossible to carry out all the Council's conditions in respect of the drainage of their Horseferry-road premises. It was agreed to modify the conditions.

LIGHTING AND GENERAL—Overseas.

AUSTRALIA.—According to a recent decision of the Australian Customs authorities, relay instruments, time elements, used in connection with electrical circuit-breakers, but are separate and distinct from them, are dutiable at the rate of 17½% in the case of foreign productions, those of British manufacture being admitted at 10% *ad valorem*.

RIVER PLATE.—The Western Telegraph Co.'s Direct Cable Bill has become law. It is expected that the new service will be inaugurated within twelve months.

TUCUMAN (River Plate).—The first section of the electric tramways has been inaugurated.

TRACTION—Home.

ABERDEEN.—A lengthy debate took place in the Council with reference to the submission between the Council and the Aberdeen Suburban Tramways Co. in regard to the price of electrical energy to be supplied by the Council to the company. The Electricity Committee—as announced in our last issue—recommended, by the casting vote of the convener, that, without prejudice to the arbiter's award, and with the view of avoiding litigation, a remit be made to the committee to fix a price per Board of Trade unit for the electrical energy supplied

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by the Council to the Suburban Tramways Co., and, if considered desirable, to confer with the directors of the company on the subject. By 16 votes to 13 the Council decided to intimate to the company that, so far as the Council are concerned, the decree arbitral pronounced by Mr. Patchell be accepted as final and binding; and that a remit be made to the committee to give effect to this resolution. The capital expenditure for the year, viz., £1,394 12s. 1d., is the smallest amount spent in any one year since the inception of the undertaking. During the year borrowing powers have been increased from £100,000 to £120,000, principally for the purpose of obtaining additional alternating current plant, which it was anticipated would be required to meet the coming winter's load.

AYR.—The Burgh Electrical Engineer (Mr. Roland Marshall) in his report for the year ended May 15 last, states that the gross profit for the year amounts to £7,032 14s. 5d., equivalent to 7 per cent, on the capital expenditure. In this connection it is interesting to note that, according to the latest figures published in the technical press, there are only three towns in Scotland showing better results, viz.:—Glasgow, 8·44 per cent.; Aberdeen, 7·54 per cent.; Edinburgh, 7·19 per cent.; while the average for 284 towns in Great Britain is 6·71 per cent. After paying interest and sinking fund there is a surplus of £1,424 6s. 5d., a result which, from a financial point of view, makes this year the most successful this department has had.

HUDDERSFIELD.—The Borough Treasurer's financial statement for the six months ended September 30 of the tramway undertaking shows that the capital outlay to date has been £408,326. The car miles run were 1,021,889, as compared with 1,036,093 last year. The income amounted to £45,837 (passengers' fares accounting for £44,011), or 10·62d. per car mile, as against £44,111, or 10·36d. per car mile last year. On the expenditure side traffic expenses amounted to £11,728, or 2·72d. per car mile, as against £10,723, or 2·52d. per car mile last year; general repairs and maintenance £7,345, as against £6,534 last year; power expenses £3,854, as against £4,037 last year. General expenses (salaries, rents, rate, insurance, etc.) amounted to £1,892, and the total working expenditure was £24,819, or 5·75d. per car mile, as compared with £23,031, or 5·41d. per car mile last year. This left a gross surplus of £21,018, or 4·87d. per car mile, as compared with £21,080, or 4·95d. per car mile last year. After deducting £12,163 for rent of leased lines, interest on capital, and taking £4,960 to wards redemption of debt, a surplus was left of £8,855, and the net surplus (after deducting £6,125 for depreciation at 3%) is £2,730, or ·63d. per car mile, as against £2,748 or ·65d. per car mile last year. The reserve or renewals account now stands at £26,289 1s. 6d.

TRACTION—Overseas.

ITALY.—A proposal to construct an electric railway between Rome and Ostia is occupying attention.

PERSONAL.

Mr. R. Macauley, of the Corporation Electric Power Station, has been presented with a testimonial by the staff on leaving to take up the appointment of station engineer at Bloemfontein.

Mr. H. Hearn, of the Natal Government electric power station, has received the appointment of Electrical Engineer for the Kroonstad municipal undertaking.

Mr. Hooghwinkel, of Messrs. Hooghwinkel, Anthony Brown & Partners, has just returned from Canada, where he has been inspecting an important electric water power scheme.

SHEFFIELD ELECTRICAL EXHIBITION.

An electrical exhibition, arranged by the Sheffield Corporation Electric Supply Department, was opened in a large shop in the centre of the city on the 14th inst., and is proving an unqualified success both in regard to the attendance of the public and the business which is resulting in the sale of electrical appliances and new work. It is essentially a domestic electrical exhibition, and no pains have been spared to get together a thoroughly representative display of every useful electrical appliance for the home. A large selection of ovens are on view under actual working conditions. Arrangements have been made for a full dinner to be electrically cooked in the exhibition to-morrow for a party of 12 to 15 of the principal members of the staff. Ironing by electricity proceeds all day long, and obtains for itself many converts when they see how comfortably this previously much dreaded operation can be performed. There is a splendid collection of radiators and convectors, including several forms of the Bastian Quartzalite Heaters, also a large range of electric light brackets, pendants, electroliers and fittings, which cannot fail to satisfy every taste. The metal filament lamp is used almost exclusively in the exhibition, and a number of effective methods are employed to demonstrate the great efficiency of these lamps over other forms of lighting. Mr. S. E. Fedden, the General Manager, is to be congratulated upon the excellency of the exhibition.

DIARY.

FRIDAY, OCTOBER 29.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—At Newcastle-on-Tyne, annual meeting.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—At the Institute, "Development of the Marine Steam Engine," by A. T. Barber.

SATURDAY OCTOBER 30.

EAST LONDON ELECTRICAL EXHIBITION.—At Shoreditch, closing day of the electrical exhibition.

MONDAY, NOVEMBER 1.

ROYAL INSTITUTION.—At 5 p.m., at Albemarle-street, Piccadilly, W., general meeting.

P. AND O. BATTI-WALLAHS SOCIETY.—At 8 p.m., at Holborn Restaurant, London, smoking concert.

TUESDAY, NOVEMBER 2.

INSTITUTION OF CIVIL ENGINEERS.—At 8 p.m., at Great George-street, Westminster, S.W.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Section).—At 7.30 p.m., at the University, "The Electric Ignition of Internal Combustion Engines," by J. W Warr, A.M.I.E.E.

WEDNESDAY, NOVEMBER 3.

INSTITUTION OF ELECTRICAL ENGINEERS (Birmingham Local Section).—At 7.30 p.m., at the University, inaugural address by the Chairman, R. K. Morcom, A.M.Inst.C.E.

THURSDAY, NOVEMBER 4.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—At Caxton Hall, Westminster, S.W., "Technical Popular Fallacies," by A. S. E. Ackermann, B.Sc. (Engineering) Lond., A.M.I.C.E.

TUESDAY, NOVEMBER 9.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.—At 2.30 p.m., at Balfour House, Finsbury Pavement, London, E.C., committee meeting.

INSTITUTION OF ELECTRICAL ENGINEERS, (Manchester Students' Section).—Supper and smoking concert.

ELECTRICAL ENGINEERS (London Div.). TERRITORIALS Orders for the week ending November 6: Monday, November 1, "A" Coy., Technical Drill, 7 to 9.30 p.m.; Tuesday, November 2, "B" Coy., Technical Drill, 7 to 9.30 p.m.; Wednesday, November 3, Gymnasium, 6.30 to 9.30 p.m.; Thursday, November 4, "C" Coy., Technical Drill, 7 to 9.30 p.m.; Friday, November 5, "D" Coy., Technical Drill, 7 to 9.30 p.m. —Officer Commanding, Col. R. E. B. Crompton, C.B. (Signed) P. H. Campbell, Capt. R.E. and Adj. for O.C., E.E., L.D.

NEW YORK ELECTRICAL SHOW.

The New York Electrical Show held at Madison-square Garden from October 11 to 21, proved to be one of the finest and most representative on record. The decorations and illuminations were on a most elaborate scale and at dusk the scene was especially effective. Among the most notable exhibits were the portable electric vacuum cleaners known as the "Positive" and "Reliable," displayed by the Electric Cleaner Co., Chicago. Mr. Chas. Biele, of New York, demonstrated his "Cafe Savoy" coffee on electric stoves with percolators. The Hurley Machine Co., Chicago, displayed "Thor and Chicago" electric washers; and the Electric Home Supply Co. showed a ten room, comp etely equipped and electrically lighted doll house, and a case containing an electric cooking outfit intended for a child. A comprehensive line of heating apparatus, flaming arc lamps, intensified arc lamps and a multiple cut-out and hanger for rope suspension was shown at the General Electric Co.'s stand. In addition there was a wire-braiding machine in operation, showing the method of making cord for heating devices, and other features of the exhibit included motors, fan motors, rheostats, etc. A "Lenix" drive claimed to be the paradox of an ordinary motor belt drive, was shown by F. L. Smidth, of New York, and the Shelton Electric Co., Chicago, displayed a small hand hair dryer which furnishes either hot or cold air by merely touching a button and which weighs 2¾ lbs. The numerous specialities of the Westinghouse Electrical and Manufacturing Co., were prominently displayed, and included electrical heating devices and their latest productions in lamps etc.

METALLIC FILAMENT LAMP PROSECUTION.

The Wolfram (Tungsten) Metallic Filament Co., Ltd., and the General Electrical Co., Ltd., summoned the Welsbach Incandescent Gas Mantle Co., Ltd., before Mr. Bros, at the Clerkenwell Police Court, for alleged infringement of the Merchandise Marks Act, and for having in their possession for sale electric metallic filament lamps with a false inscription attached, On behalf of the defendants, Mr. Walter, J.P., intimated that they would elect to go for trial before a Jury.

Mr. Rufus Isaacs, M.P., having opened for the prosecution, the case was adjourned,

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PATENTS.

Signal System for Railways.

21596.—1908. General Electric Co., Schenectady, U.S.A. Advantage is taken of the existence of skin effect in large conductors carrying alternating current. This effect is particularly marked in conductors of magnetic material, such as steel rails, and its effect is to render the impedance of the conductor very much higher for alternating current than for direct. The invention consists in the combination with a railway having both rails conductively continuous sources of alternating current connected at intervals across the rails, back relays connected in shunt to short lengths of rail, and signals controlled by the relays. Certain connections of relay windings and track circuits are comprised in the invention, whereby the efficiency of the system may be rendered exceedingly high.

Dynamo Electric Machines.

20098.—1908. A. Boeckel, O. Grunberg, J. K. Krukovsk, & E. Luxembourg, St. Petersburg. In this machine the armature and field rotate in opposite directions, and are coupled to one another. The brushes remain stationary. The number of commutator bars is an integral multiple of the number of armature coils. Successive armature coils are connected in the usual manner to successive commutator bars, and corresponding recurring commutator bars are electrically connected together.

Preventing Metal Filaments from Disintegrating into Fine Dust.

19847.—1908. Gluhlampenwerk Anker, G.m.b.H., Berlin. It has been shown that the pulverisation of the filament may be prevented if an extremely attenuated gas mixture is kept inside the glow lamp, acting at the same time as an insulator. Complex gases, phosphoretted hydrogen, and arseniurretted hydrogen are particularly suitable. The process is carried out by introducing the desired quantity of gas into an exhausted lamp. This may be effected by placing generating reagents within the lamp on its leading wires, or in the tube through which the lamp is exhausted.

Trolley Heads for Electric Traction.

19482.—1908. F. G. Holmes, Croydon. One or more pivoted spring arms are attached to the trolley head. While the trolley pulley is running along these, arms come over the top of the conductor wire and prevent the trolley leaving the wire, but when the trolley head comes to the suspension ears or to cross-overs, the arms are forced outwards and allow the wheel to pass.

Controlling the Motors in Electric Cars.

17822.—1908. W. A. Stevens, Maidstone, Kent. The controlling means consists of a dial, which comprises 13 metallic contact pieces, arranged in two concentric rings, operated by four switch arms, each insulated from the arms of a four-armed switch carrier. This enables a first and second speed, a neutral position, and a reverse speed to be obtained. Each motor armature is connected in series with its own field when running in parallel, thus ensuring the automatic balancing of the motors, so that the current is necessarily equally divided between the two motors.

Ironclad Electric Switches and Switch Fuses.

17461.—1908. V. Hope, Manchester. The boss of the switch handle through which loosely passes the switch operating rod extends into the casing, and at such point is provided with a crank. To this crank is connected that end of the spring which has hitherto been connected to the casing. Upon the side of the casing a short lever is pivotally mounted, one end of which engages a pin on one arm of the crank portion of the switch operating rod, whilst its other end is free, and comes immediately below or in the path of a shoulder on the boss of the switch handle. When the switch blades are in the current off position, the spring lies to one side of the axial centre of the handle, and the cranked part of the switch operating rod bears against a suitable stop on the casing. When the switch handle is used to throw the switches out of the current or into the current off position, the shoulder on the handle meets the free end of the lever, which it presses and causes to tilt about its pivot, and thus forces the switch blades out of engagement with the contacts, simultaneously putting the spring in tension and moving the crank of the switch operating rod until it is over its centre, when the spring is free to exert its force and effect the rapid movement of the blades away from the contacts. The switch blade supporting, regulating, and operating devices are arranged within the cover of the casing, instead of in the body of the case, in order that when the cover is opened, the devices shall be out of the way.

Alternating Current Meter.

27283.—1908. H. Landis & K. H. Gyr, Zug. This is an improvement in current meters of the induction type, with a U-shaped iron core for the series coil and an L-shaped core for the pressure coil. An iron frame is mechanically connected to the core of the shunt coil in such a way that an uninterrupted iron circuit is formed for the motively ineffective lines of force pertaining to the pressure coil. The frame has a projection which serves to close the paths of the motively effective lines of force of the pressure coil across an air gap in which the disc rotates.

Mechanical Operation of Electric Motor Controllers.

23341.—1908. Siemens Bros., Ltd., & F. O. Thompson, Westminster. A ratchet wheel is fixed to the shaft of the controlling switch. Two pawl pieces and a plurality of pedals are so arranged in connection with a system of lever arms, rods, and shafts, that when the pedals are in the off position, both pawl pieces are lifted out of engagement with the ratchet wheel. During the movement of the pedals between an intermediate and the full-on position, one of the pawl pieces rotates the ratchet wheel forward, the second pawl engages the wheel and prevents its rotation backward.

Apparatus for Producing Continuous Electrical Oscillations.

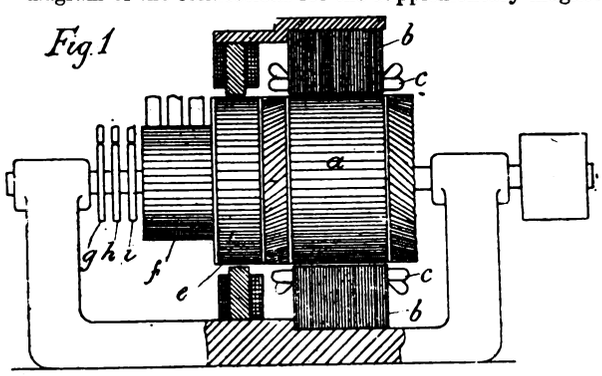
23170.—1908. H. Manders, London, W. The articulating surfaces of the block condenser electrodes are so constructed as to present a central discharger of nipple shape, supported upon a rounded mammary-shaped base. Among other features of the invention is the employment of a double choking coil, constructed to form a closed magnetic circuit.

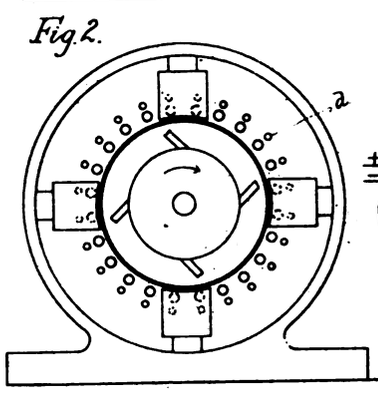
Controllers for Electric Cars.

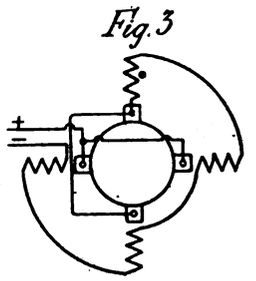
21988.—1908. C. H. Spencer, Gargrave. This is an improvement in controllers provided with a slide in combination with a rack and pinion. The slide has pins, which engage with a disc. When the reversing lever is actuated, it causes the slide to engage with the disc, and automatically operate the reversing barrel in a single operation.

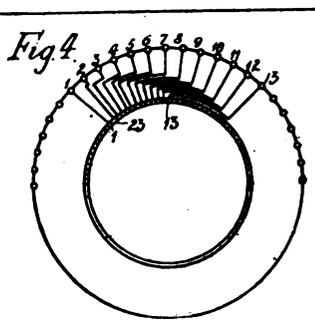
Dynamo Electric Machines.

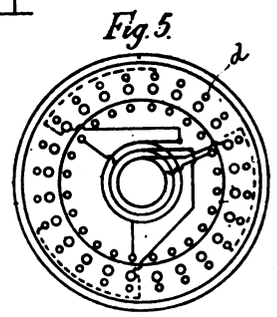
72.—1909. A. Boeckel, St. Petersburg. This is a dynamo electric machine, applicable as a generator or as a motor, wherein the armature and field rotate in opposite directions, while the brushes remain stationary. Fig. 1 is a longitudinal section of the machine, Fig. 2 is a front view, Fig. 3 is a diagram of the connections for the supplementary magnetic











poles, Fig. 4 is a diagram of the connections of the armature with the commutator rings and of the latter with the field and the supplementary winding. The armature *a* rotates within a stator *b*, which serves to weaken the armature reaction. The windings arranged on the whole circumference of the armature are connected to the commutator sections on half of its circumference, as partly shown in Fig. 4. The windings on the part *e* of the armature projecting beyond the stator are arranged in the same manner as the sections of the commutator *f*, so that the angular distance

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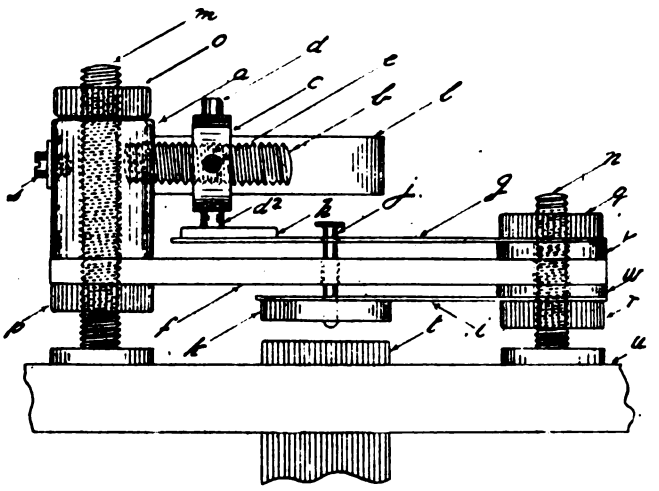
between these coils is the same as the angular distance between the commutator sections. Opposite the part *e* are arranged stationary supplementary magnetic poles, which are supplied with continuous current from the main brushes of the machine, and serve to prevent sparking. As the winding of the armature opposite these poles exactly corresponds to the arrangement of the commutator sections, the poles will be situated in the same radial plane as the brushes. The winding *d* is so arranged as to produce a magnetic field, which will be about 90° behind the field produced by the current feeding the winding of the stator. In order to obtain this result, the coils of the supplementary winding, shown by small circles in Fig. 5, are connected with the coils of the stator, indicated by the large circles in Fig. 5 —in the direction of the dotted lines—in such a manner as to obtain an angle of 90° between the field of the winding *e* and that of the winding *d*. From three points of the armature winding connections are made to the collecting rings, *g*, *h*, *i*, which are provided with brushes. These brushes are connected with three stator points, so that a rotary field is produced in the stator, the rotation of which is in the opposite direction to the rotation of the armature. By arranging the winding in the part *e*, according to the disposition of the sections of the commutator, all the coils of the winding of the part *a* are connected with the coils of only one-half of the part *e*. Then the stationary spools, regardless of their being stationary, would always retain their relative positions towards the contacting sections. It is clear that if the machine be supplied with continuous current at the main brushes, it will work as a motor.

Multiple Contact Vibrator.

25788.—1908. F. J. CLARKE, Havant. In the common form of vibrator or circuit breaking device great difficulty is experienced by reason of the points of contact becoming corroded and burnt by the arcing of the current. This necessitates the removal of the contact points, cleaning, rubbing down, and readjusting to their correct distance. In this improvement the usual contact stud is replaced by a circular nut having a number of such contact points so arranged that any one point can be brought into the contact position. The vibratory contact point is also replaced by an elongated strip, so arranged that the points can touch it at different positions along its entire surface. The diagram shows a longitudinal view of the device, as adapted to an induction or ignition coil: *a* is a brass block about ¾ in. long by ½ in. diameter, with a clearance hole through it vertically; *b* is a short threaded pin, screwed at right angles into the block; *c* is a circular nut running free on the pin; *d*, d_2 represent two of a number of contact points of non-corrosive metal projecting from the nut; *e* is a peg of insulating material ebonite, or the like, projecting the same distance from the nut, and in like manner as the pins; *f* is a strip of insulating material about 2 in. long by ⅝ in. wide, bored with clearance holes for studs; *g* is a flat spring of brass or steel bored with clearance holes; *h* is



an oblong piece of non-corrosive metal, which makes contact with the studs it is attached to, and forms part of the spring *g*; *i* is a flat spring of brass or steel, bored with clearance holes; *j* is a pin, the stem of which passes clear without touching through the spring and strip *f*. The head of the pin, as shown, is much larger in diameter than the stem, it will, therefore, not pass through the spring. The pin is attached to, and forms part, of the spring *i*; *k* is a piece of iron forming the armature of the coil or magnet; It is shaped according to the type of magnet or coil, and is attached to, and forms part of, the spring *i*: *l* is a flat spring of brass or steel attached to the block by a screw. It has an elongated hole, the same length as the contact strip and width of the pins. When the spring is in its normal position, it presses against the loose nut, one of the studs projecting through the elongated hole. It thus holds the nut in the desired position; *m* and *n* are screwed studs having a flat flanged base to permit them being attached to the base of the coil or magnet; *o*, *p*, *q*, *r* are milled edge nuts, threaded to fit studs *m* and *n*, and permit the adjusting and locking at any desired height or distance the vibratory portion of the device; *s* is the screw that binds the locking spring *l* to its position on the block; *t* is the core of the coil or magnet; *u* is the insulated base of the coil made of ebonite; *v* and *w* are small distance washers, which enable the springs to vibrate without coming in contact with the strip. The action of the apparatus is as follows: The current enters through the stud *m*, passes to the nut *c*, thence through the contact *d* to the contact *h*, through the spring *g* to the stud *n*, then to the coil or magnet windings. This magnetises the core *t*, which attracts the armature *k*. This being attached to the pin *j*, is drawn down until the head of the pin strikes the spring *g*. This breaks the contact between the strip *h* and the stud *d*, when, the circuit being broken, the current is cut off from the magnet windings, the core loses its magnetism, and the armature *k* returns to its normal position, re-establishing contact between the strip *h* and the stud *d*. It will be seen that one quarter turn of the loose nut *c* will bring into contact another of the points *d*, and the fact that the nut is threaded, causes it to travel horizontally, thus ensuring touching a fresh spot on the strip *h*; also that by the milled nuts the armature can be brought to or from the core, thus giving an absolute adjustment of distance between the armature and the core; further, the stud being of ebonite, when brought into the contact position makes an effective cut off without interfering with the adjustment of the springs or their relative positions. The locking spring *l* is operated by pressing away from the nut. When the nut is placed in the desired position, the spring is released, and effectually locks the nut in that position.

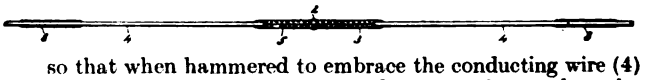
Anchoring Overhead Electric Conductors.

24701.—1908. F. E. SAUNDERS, Maidstone. It is well-known that in the majority of instances, when the conductor wire breaks, the fracture takes place at or near to the outer ends of the supporting sheath carried by the hanger. The hanger is usually soldered to the conducting wires, and when the conducting cable snaps, a length of live wire falls, with the attendant danger to life and property. The object of this invention is to overcome this disadvantage in a simple and effective manner, and at the same time provide means to prevent a live wire falling to the ground. Fig. 1 is a side elevation of the improved anchoring arrangement for suspending a straight conductor, and Figs. 2 and 3 are top and underside plan views of Fig. 1. A metal support (1) is furnished at its upper side, with a screwed socket (2) for attachment to the usual depending screwed plug or insulator pin at the underside of the road standard supporting bracket or span wire. Extending longitudinally at the underside of this support is a grooved web (3) of a cross-section adapted to receive the conducting wire (4). This wire, when in place, is connected to the support by folding under it the longitudinally extending sides of the grooved web. The sides of the grooved web are made of a depth,

Fig.1

Fig.2

Fig.3



so that when hammered to embrace the conducting wire (4) their lower edges meet at 5, and more or less enclose the wire, as illustrated in Fig. 3. Projecting longitudinally from each side of the supporting socket (2), there are formed eyed webs (6) for stiffening and bracing the grooved web. Anchored to the eyed webs by means of cables (7) are two grooved supports (8), which, in use, are soldered on to the conducting wire (4) at points longitudinally in front and behind the centre support (1), sufficiently apart for the wire anchoring cables (7) to be kept normally stretched. These grooved supports ensure a firm bearing attachment to the conducting wire (4), and only cover half the section of this wire, thus ensuring smooth under running, and that the supports (8) never come in connection with the trolley wheel. The grooved supports (8) are strengthened at their upper part by a projecting web (9), to which the outer ends of the anchoring cables (7) are connected. From the foregoing it will be seen that any tendency of the live wire (4) to shear at the two ends of the centre support, grooved web (3) is obviated by the method of its connection, which provides for ready contraction or expansion due to the different degrees of temperature.

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COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last prices. £
British Insulated and Helsby Cables, Ord. 1-100,000	5	7½-7⅝
—— 6 p.c. Cum. Pref., 1-100,000	5	6⅛-6¼
—— 4½ p.c. Mortgage Debentures	100	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100	89-94
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 1-200,000 and 275,001-475,000	3	⅛-¼
—— 4 p.c. Mortgage Debenture Stock	100	42-44
Callender's Cable, Debentures	100	105-107
—— Ordinary	5	10⅝-11⅛
—— 5 p.c. Pref.	5	5⅛-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1	⅛-¼
Dick, Kerr, and Co., Ordinary, 1,260,000	1	1-1⅛
—— 6 p.c. Cum. Pref., 1-305,000	1	1-1⅛
—— 4½ p.c. Debenture Stock.	100	100-103
Edison and Swan United, "A" Shares, 1-99,261	3	⅝-⅝
—— "A" Shares, 01-017,139	5	1-1⅛
—— 4 p.c. Deb. Stock, Red.	100	68-73
—— 5 p.c. 2nd Debentures	100	82-85
Electric Construction, Nos. 1 to 112,100	2	7/16-11/16
—— 7 p.c. Cumulative Pref.	2	1 3/16-1 7/16
—— 4 p.c. Perp. 1st Mort. Deb.	100	63-68
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100	68½-74½
General Electric Company (1900) 5 p.c. Cum. Pref.	10	8⅛-8⅜
—— 4 p.c. 1st Mort. Deb. Stock	100	83-87
W. T. Henley's Telegraph Works, Ordinary	5	12½-13¼
—— 4½ p.c. Preference	5	5⅛-5⅜
—— 4½ p.c. Debentures	100	106-108
National Electric Construction Co., 1-170,000	1	⅜-½
Telegraph Construction and Maintenance	12	34½-36
—— 4 p.c. Bonds	100	101-103

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Bournemouth and Poole, Ordinary	10	9⅞-10⅛
Brompton and Kensington, Ordinary	5	6⅛-7⅛
—— 7 p.c. Preference	5	6⅞-7⅛
Canadian General Electric Co., Common Shares	$100	117-122
—— 7 p.c. Cum. Pref. Stock	$100	119-121
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5	3⅞-4⅛
—— 4½ p.c. Cum.. Pref., 1-80,000	5	4⅛-4⅜
—— 4 p.c. Debenture Stock, Red.	100	100-102
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5	3⅞-4⅛
City of London, Ordinary	10	10⅝ 10⅞
—— 6 p.c. Cumulative Pref.	10	11⅞-12⅛
—— 5 p.c. Debenture Stock	100	121-124
—— 4½ p.c. 2nd Deb. Stk. Red.	100	100-103
County of Durham Electrical Power Distribution Co., Ordinary, 1-50,000	5	1⅛-2
—— 5 p.c. Preference, 1-50,000	5	2⅞-3⅛
County of London Elec. Supply, Ordinary	10	7⅞-8⅛
—— 6 p.c. Cum. Pref.	10	10⅞-11⅛
—— 4½ p.c. Debentures Prov. Certs. Al pd., Rd.	100	105-108
—— 4½ p.c. 2nd Debentures, Red	100	100-103
Edmundson's Electricity Corporation, Ord., 1-80,000	5	⅛-5/16
—— 6 p.c. Cum. Pref.	5	⅛-¼
—— 4½ p.c. First Mort. Deb.	100	57-60
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100	91-94
Kalgoorlie Electric Power and Lighting, 6 p.c. Non. Cum. Pref., 1-150,000	1	⅜-27/32 xd
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000.	5	7-7½
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100	95-98
London Electric Ordinary	3	1⅞-2⅛
—— 6 p.c. Pref.	5	4⅞ 5⅛
—— 4 p.c. 1st Mortgage Debenture Stock, Red.	100	93-97
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	73½-77½ xd
Metropolitan Ordinary, 100,001-300,000	5	4-4⅛
—— 4½ p.c. First Mortgage Debenture Stock	100	105-108
—— 4½ p.c. Cum. Pref.	5	4⅜-5
—— 3½ p.c. Mortgage Debenture, Red.	100	83½-86½
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,050 ($500) M 1-4,400 ($1,000)	—	82 84%
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb. Red	—	98-100
Newcastle-upon-Tyne Electric Supply, Ord., 1-50,000 and 57,010 to 137,500	5	4⅛-4⅜
—— do. 50,001 to 57,009	5	4⅛-4⅜
—— do., 5 p.c. Pref., 1-137,500 Non. Cum.	5	4⅜-5⅛
Notting Hill Electric Lighting	10	12½-13¼
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	6-6⅛
—— 4 p.c. Debenture Stock	100	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1	1⅛-1⅛
—— 6 p.c. Non-Cum. Pref., 1-100,000	1	1⅛-1⅛
—— 5 p.c. Debenture Stock, Red.	100	105-106
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5	5⅝
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5	6-6⅛
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	—	105½-107½ %
Smithfield Markets Electric Supply, Ord., 1-12,000	5	⅛-¼
South London, Ordinary	4	2⅝-3
South Metropolitan Electric Light and Power Ord.	1	5/16-9/16
—— 7 p.c. Cum. Pref.	1	1 1/16-1 3/16
—— 4½ p.c. 1st Mort. Deb.	100	100-103
St. James's and Pall Mall, Ordinary, 101-20,080 and 40,081 to 60,100	5	8⅛-9
—— 7 p.c. Pref. Non. Cum.	5	7-7⅛
—— 3½ p.c. Deb.	100	84-88
Urban Electric Supply Co., Ordinary	5	⅜-½
—— 5 p.c. Cumulative Preference, 50,001-100,000	5	1⅛-1⅜
—— 4½ p.c. First Mort. Debenture Stock, Red.	100	77½-78½
Westminster, Ordinary	5	8⅛-9
—— 4½ p.c. Cum. Pref., 110,101-191,379	5	5-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 5 p.c. Cum. 1st Pref., 1-640,000	5	4⅜-4⅝
—— Debenture Stock, Red	100	91-92½
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1	⅛-¼
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1	⅛-¼
Birmingham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	87-90
British Columbia Electric Railway Co., Ord. Def.	100	150-155
—— Ord. Pref.	100	123-128
—— 5 p.c. Cum. Perpetual Pref. Stock	100	109-112
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	100-102
—— 4½ p.c. Vancouver Power Deb.	100	102-105
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10	⅛-1
—— 6 p.c. Cm. Pf., 30,001-60,000	10	2⅛-2⅜
—— 5 p.c. Perpetual Debenture Stock	100	82½-85½
—— 4½ p.c. 2nd Deb. Stock	100	60-64
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100	98½-100½
Calcutta Tramways, Ord., No. 1 137,610	5	4⅛-5 xd
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5	4⅛-5
—— 4½ p.c. 1st Deb. Stock, Red.	100	101-104
Cape Electric Tramways, Nos. 1-491,222	1	3/16-7/16
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5	4⅝-5⅛
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100	96-100 xd
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5⅛-6
—— 4 p.c. Deb. Stock, Red. (1985)	100	98-101
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12⅞-13⅛
London United Trys (1901) 5 p.c. Cum. Pref.	10	2⅛-2⅜
—— 4 p.c. 1st Mt. Db. Stock, Red.	100	67-70
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	1/32-5/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1	37/64-39/64
—— 4½ p.c. Deb. Stock, Red.	100	94½-96½
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100	100½-103½
Provincial Tramways Co., Ordinary, 1-24,912	10	4-4⅛
—— 6 p.c. Cum. Pref., 1-10,000	10	9½-10⅛
San Paulo Tramway, Light, and Power Co.	$100	148-151
—— 5 p.c. 1st Mort Deb, Red. (1929) 1-12,000	$500	101½-103½%
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅜-½
—— 4 p.c. Deb. Stock, Red. (1940)	100	69-73
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5	⅛-¼
—— 6 p.c. Cum. Pref., 1-46,261	5	1⅞-2⅛
—— 4½ p.c. 1st Deb. Stock, Red.	100	81-85

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100	60-62
—— 4 p.c. Pref.	100	85-87
—— " deferred	100	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	101-103
City and South London, Consolidated Ordinary	100	30-31
—— 4 p.c. Debenture Stock	100	101-103
—— 5 p.c. Pref. Stock '91	100	108-110
—— " " " '96	100	104-107
—— " " " '01	100	100-103
—— " " " '03	100	96-100
Underground Electric Railways of London, 5 p.c. Prior Ln. Bds.	—	102½-103½

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10	3-3⅛
—— 5 p.c. Debs., Red., within 1-1,609 Red	100	95-98
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000	96-98
Anglo-American Telegraph Co., Ordinary	100	61-63 xd
—— 6 p.c. Preferred Ordinary	100	102-103
—— Deferred Ordinary	100	21⅛-21⅜
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100	87-89
Direct Spanish Telegraph Co., Ordinary	5	3-3⅛
—— 10 p.c. Cum. Preference	5	8-8⅛
—— 4½ p.c. Debs., 1-600	50	100½-102½
Direct United States Cable Co.	20	13-13¼ xd
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 p.c. Mort. Debs., within 1-8,000 (1913)	25	100-102
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	—	—
Eastern Extension, Australasia and China, 1-300,000	10	11⅛-12⅛ xd
—— 4 p.c. Mort. Deb. Stock, Perp.	100	102-104
Eastern Telegraph Co., Ordinary Stock	100	126-129
—— 3½ p.c. Preference Stock	100	83½-85½ xd
—— 4 p.c. Mortgage Debenture Stock	100	104½-106½
Great Northern Telegraph Co. (of Copenhagen)	10	28-29
Marconi's Wireless Telegraph Co., Nos. 1-394,190	1	⅜-½
National Telephone, Preferred	100	107-108½
—— Deferred Stock	100	120-122
—— 6 p.c. Cum. First Pref.	10	10⅛-11
—— 6 p.c. Cum. Second Pref.	10	10⅛-10⅞
—— 5 p.c. Non. Cum. Third Pref.	5	5 7/16-5 11/16
—— 3½ p.c. Deb. Stock, Red.	100	98-100
—— 4 p.c. Deb. Stock, Red.	100	100-102
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100	100-102
West Coast of America, 1-30,000 and 53,001-53,008	2½	1⅛-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	100-102
West India and Panama Telegraph Co., Ordinary	10	11/1613/16
—— 6 p.c. Cum. 1st Preference	10	8⅞-9⅛
—— 6 p.c. Cum. 2nd Preference	10	8⅛-9⅛
—— 5 p.c. Debs., Red., 1-800	100	101½-103½
Western Telegraph Co., 1-207,930	10	13⅛-14
—— 4 p.c. Debenture Stock, Red.	100	103-105

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1909.	1908.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Oct. 20	1,243	1,313	— 69	— 677	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940.	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Sept.	6,538	7,241	— 703	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Oct. 17	1,076	1,083	— 7	— 398	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Oct. 16	6,966	6,491	+ 475	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,2 3	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Oct. 16	5,028	4,596	+ 432	+ 4,000	98	98	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	Oct. 24	930	765	+ 165	+ 1,524	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Oct. 22	5,596	4,954	+ 642	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Oct. 23	1,214	1,072	+ 142	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Oct. 24	264	260	+ 4	— 189	10	10	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Oct. 23	5,430	8,833	— 3,403	— 40,675	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	Sept.	6,678	5,642	+ 1,036	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Oct. 24	3,192	3,347	— 155	+ 1,343	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Oct. 21	496	480	+ 16	—	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Oct. 8	1,793	1,552	+ 241	+ 2,906	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Oct. 22	121	122	— 1	+ 83	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Oct. 22	5,285	5,082	+ 202	+ 1,737	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Oct. 23	989	886	+ 103	+ 103	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Oct. 16	17,531	18,017	— 486	— 5,156	189	181	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Sept.	9,693	9,264	+ 429	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Oct. 23	1,606	1,550	+ 56	+ 1,640	28½	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	Oct. 23	2,689	2,383	+ 306	+ 2,770	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Oct. 16	474	469	+ 5	+ 907	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Oct. 20	139	134	+ 5	— 238	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Oct. 20	1,310	1,291	+ 19	— 743	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Oct. 9	10,929	11,035	— 106	— 2,228	106	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Oct. 17	1,281	1,299	— 18	+ 21	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Oct. 9	39,757	37,840	+ 1,917	+ 38,069	126	122½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	„ 17	216	258	— 42	— 743	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Oct. 23	194	173	+ 21	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Oct. 23	10,378	10,357	+ 21	+ 5,742	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Oct. 24	16,330	17,119	— 789	— 5,976	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,710	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Oct. 16	3,912	3,846	+ 66	— 1,397	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Oct 21	600	602	— 2	— 128	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,596	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Oct. 10	5,935	5,667	+ 268	— 736	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,285	5·04
Southampton Corporation	Oct. 13	1,078	1,059	+ 19	— 427	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·842	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Sept. 22	169	156	+ 13	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 17	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Oct. 23	867	831	+ 36	+ 737	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Oct. 14	2,377	2,250	+ 126	+ 4,104	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Sept. 22	879	804	+ 75	— 784	22½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train miles. b Half-year's figures.

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NOTES.

MINING COMMITTEE.

There is little to be said about the Departmental Committee appointed by the Home Secretary to inquire into the working of the existing special rules for the use of electricity in mines, and to consider whether any, and if so, what amendments are required. It is practically an official body, consisting of Mr. R. A. S. Redmayne, H.M. Chief Inspector of Mines, who will preside, Mr. Charles H Merz, and Mr. Robert Nelson, H.M. Electrical Inspector of Mines. Though many will criticise the presence of Mr. Merz, his inclusion is a decided gain. No doubt he is largely identified with certain lines of thought, but his experience has been extensive, and free from bureaucratic prejudices. It would be well, if it is not too late, that expert assessors should be appointed, one at least to be a mining electrical engineer, and another a working miner or foreman. Besides the collecting of evidence and visiting of works, what is needed is the carrying out of experiments on certain lines suggested by recent experience or criticism.

MUNICIPAL INTER-COMPETITION.

A momentous proposal was before the Bradford City Council the other day, when it was moved that the Electricity and Gas Committees should be merged into a joint Lighting Committee. The avowed object was to save expense and to avoid duplication of labour. But the proposal was rejected on the ground that it was put forward to suppress competition between the Committees, which, it was contended, would mean stagnation. It was argued that the electricity and gas undertakings should be run as separate affairs and be allowed to develop along their own lines, and for that purpose rivalry was good. It must be remembered that much is at stake, for the City Electrical undertaking represents a capital of nearly a million sterling, and the gas undertaking of a million and a quarter. On the whole, the merging would probably have been a mistake. Reasonable competition is undoubtedly good. At the same time inter-rivalry is often carried to absurd lengths in municipal matters, as witness the difficulties so constantly supervening between the lighting and tramway committees. The truth of the matter is that committees ought to have a great deal of latitude as to details, but should be more directly under the control of the Council as a whole on matters of general policy, and even then routine work should come up for more frequent and effectual revision. If this was the guiding principle, then competition could be kept within reasonable bounds. Speaking generally, it is electricity that usually suffers from unreasoning actions of the older vested interests of gas.

DANGEROUS GAS FAILURE.

Sunderland had a most unpleasant experience on the night of the 27th ult., when the gas in part of the centre of the town and considerable outlying districts suddenly gave out. Had it not been for the electricity more than half of the town would have been in darkness. It appears that someone from the Water Company had turned the wrong cock, thus cutting off gas from chief arteries of supply. It was some time before the matter was put right, and lamps re-lighted. But even then something like a panic reigned, for it was suspected that many people had gone out from their houses or rooms, leaving gas fires and burners alight, so there was considerable risk of explosion when the gas was turned on again. This is a danger that is often overlooked when considering the merits of illuminants. It is certainly a very serious risk, and one from which electricity is free. Sunderland's recent inconvenience ought to convert its citizens, and should in the long run prove a blessing to the municipal electricity undertaking.

ELECTRIC DRIVE IN TEXTILE MILLS.

Professor Charnock's report on electric driving in textile mills, printed in another column, although in no way decisive, presents many points of importance. The inquiry is to be continued, and experiments on a practical working scale are to be carried on at the Bradford Technical College. Meanwhile, sceptics are maintaining that the report does away with the claim that the electric drive enables speeding up, with its corollary of larger output. Here, however, experience has quite clearly demonstrated that electricity does permit of speeding up both in spinning and weaving. Ordinary routine manufacturing both at home and abroad has demonstrated this. There is, too, greater facility in adapting electricity to extensions and alterations than is the case with steam power, and less loss of efficiency in doing so. Critics tell us of the greater expense of installation, and instance the necessity of having dustproof covers for motors when used in textile or other dusty factories. But even this can be overcome, as has been done at least in one instance up North, where the motors work in a brick tower adjacent to the factory, the shaft passing through properly stuffed wall boxes.

THE CHINESE MARKET.

Belgian manufacturers have recently been presented by their Legation in China with a report on the demand for electrical appliances and accessories on the Chinese market. There is pretty keen competition as matters stand, but there appears to be a growing market out there that is worth cultivating. According to the latest available statistics the imports amounted in 1907 to about £200,000 as a whole, but as the increase through Tientsin alone rose by nearly fifty per cent. from 1907 to 1908, it is clear that the trade is really much larger than the first figures show. At Shanghai there are two electrical stations, the general municipal establishment, and a company concern run in the French concession. Last year the municipal station generated 4,632,775 units, of which 2,391,586 units were sold for private lighting, 445,143 for public lighting, 3,805 for heating, 154,650 for motive power, 1,430,889 for traction, and the balance for use in the works. At Peking the lighting is carried on by two companies, a Chino-Japanese concern using alternating current for general service, and a European concern generating continuous current for use in the Legation quarter. At Tientsin private companies supply current respectively in the British, German and Japanese concessions, while the French Compagnie des Tramways supplies light to the French concession and to the Chinese town, as well as to Austrian, Italian and Russian concessions. Electricity is being used for manufacturing purposes and also in mining and railways. In order to do any business out there it is necessary either to make arrangements with one or other of the big importing firms or to have local resident agents, the latter course being generally adopted by foreign manufacturers.

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SMALL STREAM POWER.

We have repeatedly dwelt upon the possibilities presented by comparatively small streams as sources of power for the generation of electricity, so it is all the more gratifying to be able to record a success in this direction. Grassington, with its modest population of 500, is now provided with electricity which is generated by hydraulic power derived from the picturesque Wharfe river. Already the village street is illuminated and the inhabitants are taking to the innovation with amazing alacrity. In one case, the landlady of a boarding house proposes not only to use electricity for lighting, but also for cooking and utilising the power for washing and other domestic purposes. What is being done at Grassington might well be repeated in many another place. The small stream is not to be despised.

RENT AND PENNY PER UNIT.

A short time ago we printed Mr. A. Hugh Seabrook's scheme for charging the customers of the St. Marylebone Electricity Department a rental plus a uniform rate of one penny per unit. This departure was welcomed by the local tradesmen, who saw in it an opportunity for securing electric supply on a really business footing. By Mr. Seabrook's plan the Electricity Department secures fairly long contracts, knows approximately the likely demand, and obtains a suitable rental on plant, thus being able to sell current at wholesale rates. It appears to work admirably, giving satisfaction both to producer and consumer. This should prove an encouragement for others, and lead to a general understanding among central power station authorities.

SOLAR SPOTS.

Professor George Hall, lecturing at the Royal Institution on "Solar Vortices and Magnetic Fields," said that it was practically demonstrated that sun-spots are electric vortices. He produced much convincing evidence on this point. Nevertheless, he shattered many of the theories deduced therefrom. Certainly these electric vortices, setting up magnetic storms, could have no effect on our atmosphere or earth. "It is evident," he concluded "that the rapid decrease upward of the strength of the field in spots would prevent it from having an appreciable influence on the higher solar atmosphere. At the distance of the earth, as Schuster has shown, the combined magnetic effect of several spots, all assumed to be of the same polarity and not taking into account such rapid decrease in strength at higher levels as is actually observed, would be altogether incompetent to account for terrestrial magnetic storms."

ONTARIO AND ELECTRIC POSITION.

Much misunderstanding has arisen over the electric power transmission situation in Ontario owing to the institution of a Government body, the Hydro-Electric Commission, which buys current in bulk and retails it to townships or private customers. It has been alleged that this interference of the Government in trading matters is unfair. But it must not be forgotten that the step was taken at the direct request of municipalities and manufacturers. The real position is this. Ontario is avowedly served by three large generating companies: The Ontario Power Co., Ltd., the Canadian Power Co., Ltd., and the Electrical Development Co., of Ontario, Ltd. Now, the second of these has its hands pretty full with American business, and the last-named, in order to secure way-leaves from the City of Niagara, agreed to sell current in bulk within the city limits at exceptionally low rates. Hence arose a certain amount of dissatisfaction in distant townships, where higher rates had to be paid, partly owing to distance, but far more owing to their inability to buy in sufficient bulk to obtain power at the lowest rates. As this threatened to cripple development, the Government harkened to pleas and brought into being the Hydro-Electric Commission. The mission of this body is not to generate power, but to buy it in bulk, guaranteeing a large and increasing annual outlet, and to retail at a price only sufficient to cover cost and expenses. The Commission twice called for tenders, and on each occasion only received replies from the Ontario Power Co., so its tender was accepted. This ensures the company a good customer at a remunerative price, lessens its expenses, while leaving it free for development within certain limits. It must be remembered that the Government Commission holds no monopoly. The other two companies can trade freely. It is mainly a question of rates. Much the same protective policy has been adopted in many cities and states in America.

ELECTRIC IGNITION OF INTERNAL COMBUSTION ENGINES.*

By JOHN W. WARR, A.M.I.E.E.

There is not the slightest doubt that in whatever form it is applied, electric ignition is a notable advance on what previously existed. It provides absolute immunity against fire, the spark is well suited to the explosive mixture, and the charges which are so weak as to give irregular impulses with the hot tube can be fired with absolute certainty. Further, an increased efficiency is obtained by being able to fire the charge at the moment of maximum compression, it admits of automatic timing and consumption of current, and the use of higher compressions.

The electrical ignition of all modern automobiles is produced from either a primary or a secondary current. The primary current is, of course, a low-tension one, and the devices that can be used may be tabulated as follows: 1, Accumulator; 2, accumulator and series coil; 3, magneto.

The hot-wire system, which is named "Catalytic Ignition," has never been put into commercial operation, but a brief description of the apparatus will no doubt be interesting. The battery, which must necessarily be of large capacity, has a fine platinum wire, made up similar to the present high-tension plug and a sliding rheostat, connected in series with it. Cutting in and out resistance respectively decreases and increases the temperature of the platinum wire, which advances or retards ignition due to the interval of time that elapses before the wire has sufficiently reached its correct temperature to fully inflame the mixture. The great disadvantages are: the large current required to bring the platinum to the required temperature, liability of fusing the platinum by over-running the resistance, waste of energy in the resistance, inflexibility and the uncertain inflammation capacity. The weakness of this system will be clearly indicated by the fact that the advancement and retardation of ignition is not nearly so perfectly controlled as the systems to be considered.

The accumulator alone with a pressure of 4 to 6 volts appears to be one of the very earliest devices, but owing to the large current taken on short circuit, the ignition points were quickly destroyed, and the high temperature of the points set up by the large current frequently caused premature ignition. This was more marked with high compression. Of course, large capacity cells were necessary, and on account of heavy duty they had to be of massive construction.

Later, the accumulator and series coil was introduced, the presence of self-inductance or extra current making its appearance as a bright hot spark at the tappet points at the moment of breaking circuit. The coil consisted of nothing more than several turns of No. 16 S.W.G. cotton or silk-covered copper wire wound on a wooden former, with a bundle of soft iron wire in the centre. This was an improvement in the right direction, at any rate as regards the reduction in battery capacity, but the appearance of a reliable low-tension magneto probably crushed it out of existence.

The low-tension magneto driven from the cam shaft was rapidly brought forward, perhaps on account of the necessary recharging of the accumulator and other attendant evils which the electrical profession are well acquainted with. Even to this day there is diversity of opinion with motorists as to whether the magneto has any advantage over the accumulator.

Contrary to the high-tension system, all low-tension ignition has to be operated with mechanical make and break tappets from the cam shaft. Tappet gears of present-day design differ very much from each other, and in each case the patents are the property of the motor manu-

* Abstract of paper submitted before the Institute of Electrical Engineers Manchester Local Section, Nov. 2.

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facturers. The gear shown in Fig. 1 is representative in principle of those used by leading builders, and is attached vertically to the sides of the cylinder. The fixed insulated plug is shown at "A," and can be made and screwed in the plate in a similar manner to the modern high-tension plug, but having only one electrode. The tappet "B" is also fitted into the plate to rotate through a small arc, both "A" and "B" projecting into the combustion chamber. With the striker rod "C" in the normal position,

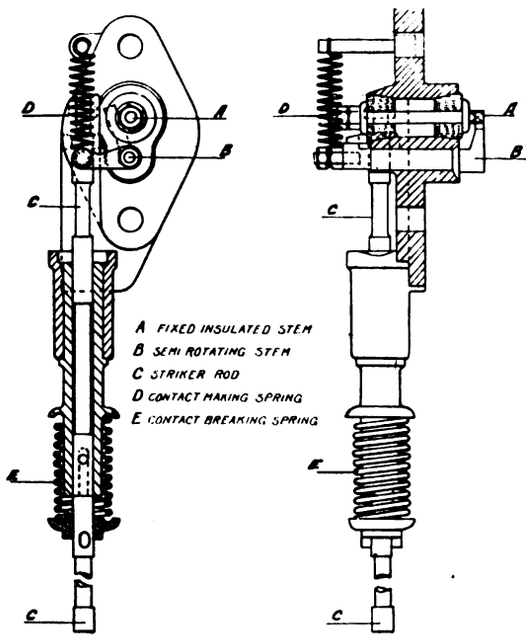

Fig. 1.

the tension of the spring "E" keeps the contacts apart internally. Shortly before ignition takes place the cam raises the rod "C" through an intermediate pusher rod, not shown, but fixed directly underneath "C," and allows the spring "D" to bring the internal contacts together. A step in the cam then passes the foot of the pusher rod, and allows rod "C" to fall quickly, due to the influence of spring "E." The momentary making of the circuit is at once followed by a quick break, thus producing a spark at "A" and "B." As a rule, in multi-cylinder engines the

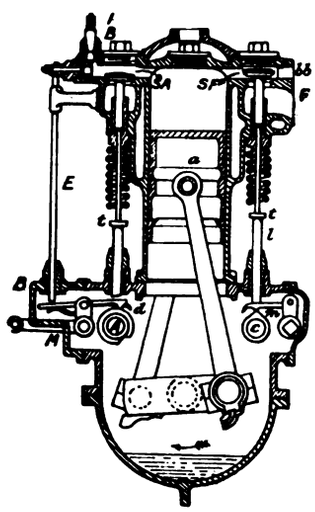

Fig. 2.

insulated plugs are all electrically connected in parallel from a common busbar through a knife switch, so that any individual cylinder can be disconnected for testing the action of the tappets when the engine is running. By the use of the busbar only one lead is necessary from the magneto.

A simple method of retarding and advancing the tappets of low-tension ignition is shown in Fig. 2. "IB" is the insulated plug, and directly below the tappet is fixed at right angles, which is connected to the striker rod "E." The foot of the rod "E" rests on the follower "*d*" at "B," and when the V-shaped end of the follower falls into the stem of the cam "A" on the half-time shaft, the tappet points make circuit. Immediately the V end of the follower mounts the symmetrical surface of the cam, circuit is broken, thus producing a spark and firing the mixture. A flat spring holds "*d*" in contact with "A." It will now be clearly seen that the cranked lever "*m*" can rotate the follower through a certain arc on the cam "A," thus retarding or advancing ignition when desired, the operation being controlled from the steering pillar. Some car builders with low-tension ignition permanently fix the period of firing so that no adjustment to suit high or low speeds is obtained.

In order to dispense with complicated mechanical striking gear and tappets, magnetic plugs or electrical tappets are used. The current is generated in the two windings of the revolving armature from the permanent field, and attains a maximum voltage twice during each revolution, the two maximums being 180° apart and producing two sparks per revolution. The armature is driven at crankshaft speed. In the diagram of connections the dotted lines represent

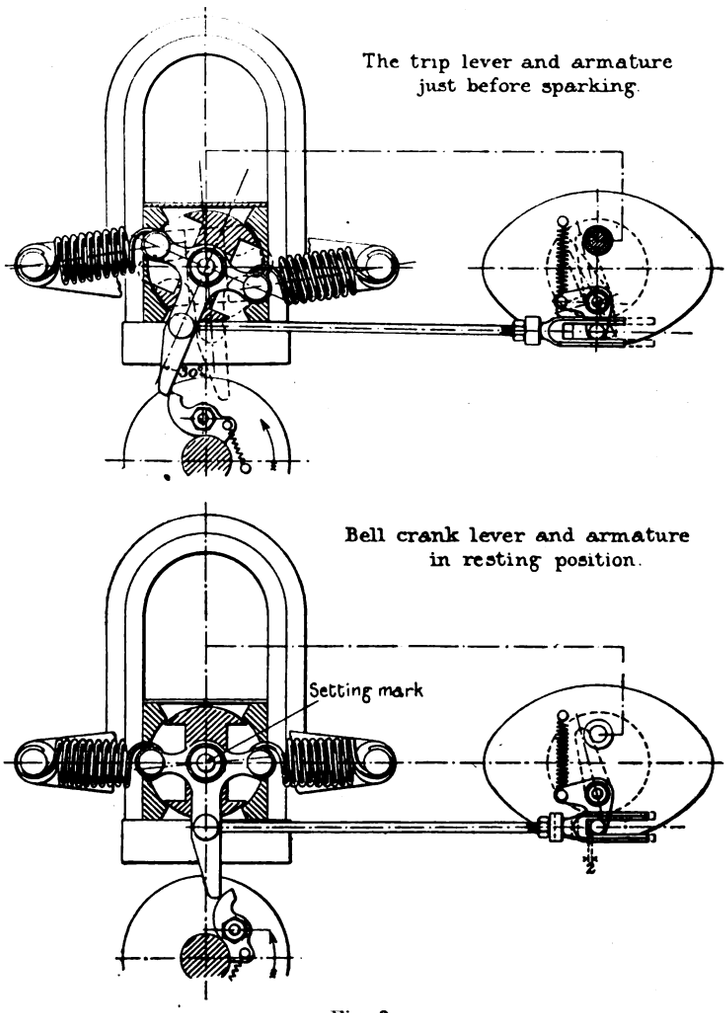

Fig. 3.

the completed circuit by the car frame. On the right-hand side of the armature is shown the contact breaker through which the auxiliary winding is periodically short-circuited just previous to the current attaining its maximum. At the moment of short circuit a sufficient current in the main winding to attract the plug interrupter is not produced. However, when sparking is to take place within the compression space of the cylinder, the platinum points of the contact breaker are severed, the current in the main winding being suddenly reinforced by the extra current of the auxiliary winding. Thus a powerful current flows through the coil of the magnetic plug by way of the distributor, vigorously attracting the armature interrupter of the plug and effecting a quick breaking of the contacts. This, in turn, produces a powerful and very hot spark in the same way as the mechanical tappets. The variation in timing is effected by rotating the lever embracing the make and break contacts shown on the right-hand side of the drawing, directly below the distributor. By this means the interruption and the spark are produced earlier or later. For a 4-cylinder engine the rotation of the lever is about 50° on

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the crankshaft. The engine is stopped by short-circuiting the armature to the frame through a single pole-switch.

There is just one other low-tension magneto igniter that is used chiefly with single cylinder engines. The current is produced by an oscillating motion of the armature, and is moved out of its position of rest through an angle of 30°, a thumb on the cam shaft striking the trip lever on the armature shaft. The horizontal springs bring the armature into its normal position. The whole arrangement is shown in Fig. 3, including the striking rod, which operates the mechanical tappets. The tappets break circuit when the armature has passed a few degrees beyond its normal position. The length of the spark depends largely on the swiftness of the movement of the armature. The variation of ignition is obtained from a device on the cam shaft, so that the releasing of the trip lever takes place early or late as required.

In comparison with the high-tension system, which is now to be considered, the low-tension ignition is not so popular. The objections are: wear of the tappet points and the moving parts within the combustion chamber, wear and tear of striking gear whilst operating at high speeds, and constant need of adjustment, which in many cases can only be perfectly carried out by experts.

The high-tension ignition does not require any of the gear mentioned above, the apparatus used being of such a character as to produce a flaming jump spark between the electrodes of the plug screwed in the combustion chamber. The means used for producing the high-tension spark are: 1, Battery and induction coil; 2, magneto and induction coil; 3, high-tension magneto.

The battery and coil ignition is so well known, that it is not necessary to go into lengthy details concerning them. With the modern ignition accumulators we have compactness and fairly large capacities. The celluloid case enables one to see the condition of the plates at any time, and especially during the progress of charging. On the other hand, acid spray and bad joints between the celluloid and the lead terminals has brought them into great disfavour with a large number of motorists, the acid playing havoc with everything that comes in its way. Then we have the question of recharging. If every motorist and the persons who usually charge ignition cells knew how to deal scientifically with the accumulators given into their care, we should not have such reports of their behaviour on the road. Too much reliance is placed on the voltmeter reading after charging, and unless the cell is doing service on its own coil or a suitably closed circuit, a fictitious reading is likely to be the result due to recuperation characteristics. How many persons take readings of each individual cell, or how many make observations of the colour and condition of the plates? Then there are shorted plates due to disintegration of the active material which usually appears at the bottom of the cell, undercharging, over discharging, bad acid, and laying the cell aside for a long period in a semi-discharged state. It is doubtful if the accumulator is so black as it is painted.

In view of the fact that recharging can now be expeditiously carried out at nominal charges by the various supply authorities, the accumulator is not likely to be rejected for the present, and there are scores of cars, both ancient and modern, with accumulator ignition, that are likely to remain equipped in this way for many reasons; therefore, manufacturers will do well to investigate the various details that contribute to its imperfection.

The primary dry battery has come into great favour lately, and there is no doubt it is being used with satisfactory results. The multiple cells giving an e.m.f. of 6 volts is suggested with a variable resistance connected in series with the primary of the induction coil and the battery, so that the pressure can be reduced to about 4 volts. When the battery has been used for some time the e.m.f. falls off. This can be detected by misfiring, and instantly restored by cutting out a small section of the resistance, thus raising the e.m.f.

Some dry-battery makers recommend multiple series connections for heavy ignition service on automobiles. In determining the number of sets to be used, it has been found best to use as many sets as there are cylinders. The following is a summary of the various ways of connecting: Single-cylinder, one set of four 1½-volt cells in series; twin-cylinder, two sets of four 1½-volt cells in multiple series; four-cylinder, four sets of four 1½-volt cells in multiple series; six-cylinder, six sets of four 1½-volt cells in multiple series.

Increased life is obtained by multiple series arrangement, due to the fact that the amount of current used by the coil is drawn equally from each set. The objection to this system of connection will be the weight and accommodation.

Where it is difficult to get accumulators re-charged, the dry battery is to be recommended if made by a reliable firm. The author has now used dry batteries for ignition for a considerable time with most encouraging results.

Induction coils may be divided into two classes: the plain type, with primary and secondary winding and condenser; and the trembler type, with the same internal equipment, but an external high-speed trembler is fitted to it. Apart from the fact that a multi-cylinder engine cannot be started on the switch with a plain coil, the timing seems to be more exact with a given piston position. In an experiment the author tried on a twin-cylinder engine with two simple make and break contacts and plain coils, steadiness of running was more distinct than with a rotary make and break. The improvement may be accounted for by the fact that the firing-point can be fixed more correctly, due to the platinum contacts being in use for a short and equal period, whereas with the segmented rotary make and break, the period of contact and unequal spacing cannot be made exactly alike. Further, since the segments have to be morticed into an alien substance—*i.e.*, brass and insulation—the wear is uneven, and metallic particles are carried in the insulation and give circuit when it is not required. A plain coil may be unintentionally left in circuit if the main switch is left closed, which is liable to burn out the coil and exhaust the battery. The trembler coil gives warning when left in circuit.

With the great number of cheap coils on the market, it is surprising that roadside troubles are not more frequent; what with imperfect tremblers and incorrect condenser capacity, the conditions are far from being satisfactory. It is generally supposed that the condenser is simply used to "absorb the extra current" from the primary winding. Though this is no doubt true, the best results are obtained when the self-induction of the primary and the capacity of the condenser are balanced, producing resonance. From results arrived at experimentally, the larger the current passed through the primary (which can be produced by overscrewing the contacts) the greater should be the capacity of the condenser. On the other hand, the gradual burning away of the platinum reduces the current in the primary and produces unbalanced effects with the condenser. Therefore, the desirability of an adjustable condenser seems clearly demonstrated. If the condenser is too small the secondary spark is short and feeble, with incurable sparking at the platinum. If the condenser is too large, the spark is short and fat.

There should be no practical difficulties in the way of turning out every coil perfectly balanced, but until there are better means provided to suitably adjust the contact screw, excessive pitting of the platinum points is bound to take place when handled in ignorance.

In the hands of an expert the adjustment of a trembler blade apparently requires very great care. When testing a coil some time ago, the ammeter connected in the primary showed that a current of from 1·5 to 6 amperes could be drawn from the 4-volt battery by altering the contact screw, and on closed circuit 15 amperes was indicated. In this instance, how could the motorist say which is the correct current, for both the 1·5 and 6 amperes produced sparks that appeared to have equal inflammation capacities? Inexperienced persons adjust their trembler blades by the note that is produced from the rapid vibrations of the armature, a high, shrill note being considered the best. The author has proved that a moving-coil ammeter in the primary of the coil is the only guide, both as regards the most effective spark and economical current consumption. It is quite clear that the more pressure put on the blade by the screw the nearer the contacts approach short circuit.

A very light fuse would be a useful addition in the event of the contact screw being lowered too far. This would indicate the presence of too large a current in the primary winding.

A trembler that will give absolutely perfect timing at

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a very high speed, that is not over-sensitive to alterations.

After being in use for some time, the platinum appears to leave the positive contact and builds up on the negative. A reversing switch would tend to keep the contacts level and do away with the filing of an expensive metal. Of the many faults in connection with ignition coils, internally punctured insulation of the windings and condensers make up a large percentage. The author is of opinion that a permanently fixed spark-gap would prevent a number of troubles, as the coil is very often operated with the secondary on open circuit by inexperienced persons when endeavouring to locate the causes of misfiring.

In either type of coil it is of the utmost importance to have an iron wire core that will admit of rapid changes of the magnetic flux. Lagging magnetic effects seriously hamper the period of inflammation. For instance, when the engine is running slowly it is possible to get correct ignition at the right position of the piston, but when running at high speeds ignition does not take place when expected, evidently due to the time taken to magnetise and demagnetise the core of the coil. With an engine running under practically full impulse, ignition should occur just as the piston starts on the expansion stroke. Without considering any difference in compression pressure, and supposing the period of inflammation is $\frac{1}{120}$ of a second, and the engine speed is 600 revs. per min., then

$$\frac{600 \times 360^\circ}{120 \times 60} = 30^\circ,$$

or ignition should take place when the crank has still 30° to turn, *i.e.*—$\frac{1}{12}$ of a revolution or 30°

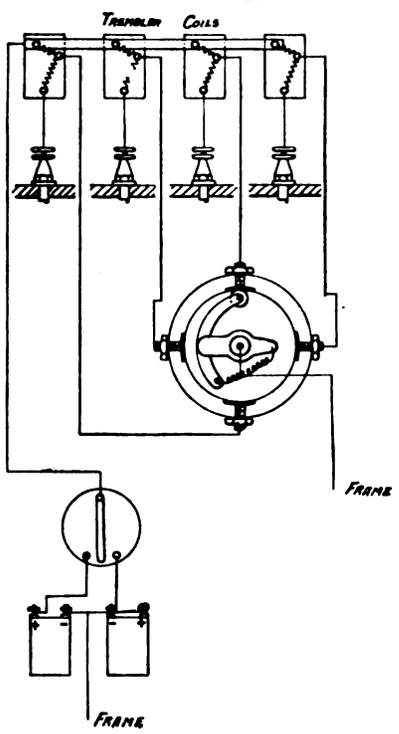

Fig. 4.

in advance of the dead centre of the piston. From this it is evident that when running at high speeds on the level with the spark correctly advanced, better results will be obtained when mounting a gradient in high gear by retarding the spark because the engine speed is lower.

We now come to the question of distributing the high-tension current in multi-cylinder engines. With the single cylinder this is effectively carried out by rupturing the primary current with a simple make and break contact on the half-time shaft. A common method is to provide a low-tension rotary wiped roller contact, with as many points of rupture as there are cylinders. This type is shown by Fig. 4, and makes and breaks circuit at the correct period in the primary circuit of the coils. The high-tension leads from the trembler coils go direct to the plugs. Levers and connecting rods rotate the fixed contacts through a given arc so as to produce early or late ignition. The sketch clearly shows all the connections, etc.

Another system consists of a combined low-tension contact maker and high-tension distributor, both being exactly synchronised and timed with the piston. Only one trembler coil is used. The contact maker and distributor is driven from the half-time shaft in the same manner as the one mentioned above. The primary circuit of the coil is made immediately the contacts come together, which are shown separately at "A" (Fig. 5) for clearness. The induced high-tension current is carried from the secondary winding of the coil to the centre rotary carbon brush of the distributor "B," through the stationary contacts, and away to the various plugs in the cylinders.

A high-tension battery system can be operated without trembler coils. As most of the troubles arise from the tremblers, this method has a great advantage over the others. A make and break contact is fixed to the half-time shaft, similar to that illustrated by Fig. 5, and is capable of being moved to vary the timing. A single plain coil is used.

When using the plain coil the timing is different to the trembler type. In the first case the primary circuit of the coil has to be made and then broken before the spark can be produced, and in the second case the primary circuit is made, and immediately the spark follows by the action of the trembler blades.

Fig. 6 shows the general wiring diagram. Two tremblers are provided which work at each end of the iron core, but only one is in operation at a time, a single pole throw-over switch putting either one or the other in circuit. A reversing switch is also fitted so as to enable the platinum points to wear evenly. The system is a remarkable one for ignition purposes, as a spark, large in quantity, and thus more effective in inflammation capacity, free from liability to short circuit, with dirty plugs, and rapid in application, is undoubtedly obtained. The idea is due to Sir Oliver Lodge.

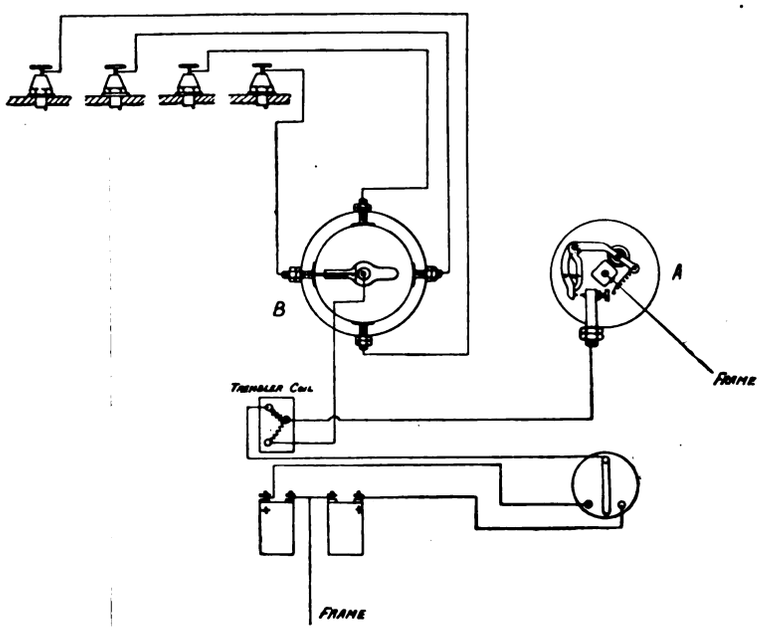

Fig. 5.

Two systems of magneto and induction coil ignition may be briefly referred to. The first consists of three main pieces of apparatus—viz., magneto, condenser, and induction coil. The current generated by the magneto is stored in the condenser, and discharges through the primary of the induction coil, inducing a high-tension current in the secondary winding. The voltage of the magneto follows more or less a sine law, and the commutator of the machine is so arranged that only the maximum voltage is taken off. It is not necessary to drive the magneto synchronously with the engine as long as the speed is sufficient to produce the required number of impulses to fully charge the condenser.

In the second system, a low-tension magneto and plain induction coil are used. The high-tension current is induced in the secondary of the coil on the sudden flow of current in the primary winding from the magneto.

The low-tension current generated by the armature is short-circuited just previous to it reaching its maximum. At the point when the mixture has to be fired, the platinum contacts open by a cam on the armature shaft, the impulsive current discharging in the primary of the coil and reappearing as high-tension current at the plugs by way of the

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secondary winding and a distributor. The distributor is driven through gearing from the armature shaft. Interrupters are placed in circuit at convenient points to stop the engine. The armature is timed with the engine, and advance and retard are obtained from a rocker rotating round the cam centre on the armature shaft.

Probably the most popular form of ignition is the one in which the high-tension current is generated in the winding of a rotating or stationary armature. This system is the simplest when compared with what has already been described. The diagram of connections in Fig. 7 represents a high-tension magneto for a 4-cylinder engine. Between the pole-shoes of the permanent magnets, rotates a shuttle-wound armature, on which are two windings—a primary and a secondary—the latter forming a direct continuation of the primary. The alternating current generated in the primary winding attains its maximum twice during one revolution, the two maximums being 180° apart. The high-tension current is produced in the secondary by short-circuiting and opening the primary circuit through the platinum pointed contact breaker twice in each revolution. At the moment the circuit is broken the high-tension current is collected from the slip-ring by a carbon brush, and taken to the distributor and plugs by the contact brush driven from the armature spindle. The armature is driven at crankshaft speed, so that when the winding is cutting maximum field, its position must correspond to a definite position of the piston.

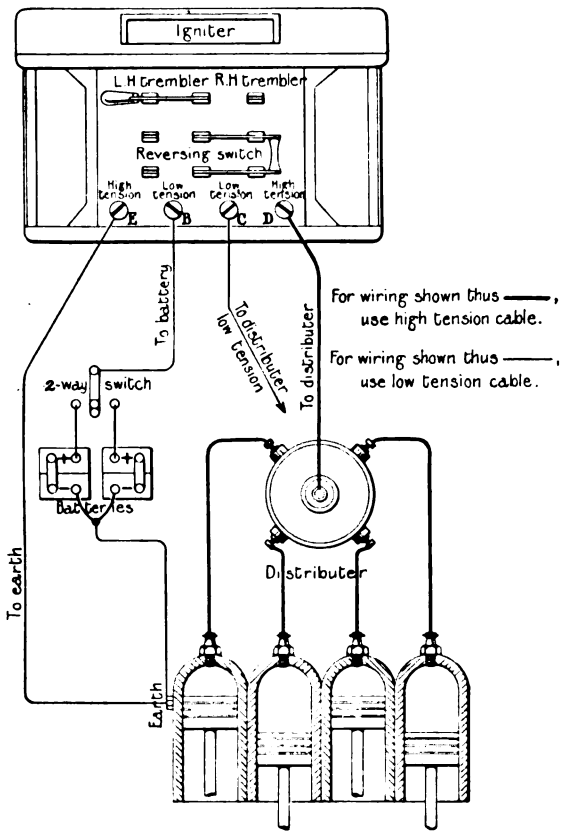

Fig. 6.

Another type of high-tension magneto is one in which the generation is based on the same principle as the well-known inductor alternator. The armature winding is stationary and mounted in the permanent field. A tubular soft iron inductor envelope, having two slots cut in it, each representing a quarter of its circumference, revolves between the armature and the pole-shoes. By this means the current in the primary will attain its maximum when the inductor has rotated through an angle of 90° or four times per revolution. By rupturing the primary circuit during the effective periods a current is induced in the secondary winding four times per revolution. As no slip-ring or collector is required, the high-tension current is conducted straight to the brush contact of the distributor disc.

The spark from high-tension machines of this class is more intense than that produced from ordinary induction coils. As an example, the coil spark in one experiment was only just sufficiently powerful to ignite a mixture of petrol vapour and air in the proportion of 1 to 15, whereas the magneto spark was capable of igniting a mixture of 1 to 19. As in the case of coil ignition, the timing with a high-tension magneto must be set to occur early. The spark can be advanced or retarded through a small angle varying from 25° to 50°, according to the number of cylinders. Some of the machines have a condenser connected across the make and break, but in all cases spark-gaps are provided. Ball bearings can be fitted if desired, which, needless to say, are infinitely better than the sleeve bearing. Wherever possible, gear drive should be used—chain and sprocket wheels severely punish either type of bearing.

The chief advantages of magneto ignition are: an inexhaustible source of current, the induced current is directly utilised, and the sparks have a higher temperature. The vital parts are not scattered in different parts of the car, as is the case with the coil and accumulator ignition. With a spare magneto carried in the car, the faulty one can be removed in a few minutes. On the other hand, it must be remembered that the magnets require reflashing periodically, bearings and platinum contacts require attention, a perpetual load is always on the engine, and the adjustment in the timing is not so flexible as with the coil. Troubles do not end when you have a magneto, for, like the accumulator and coil, they require discreet handling.

Diagram of Wiring

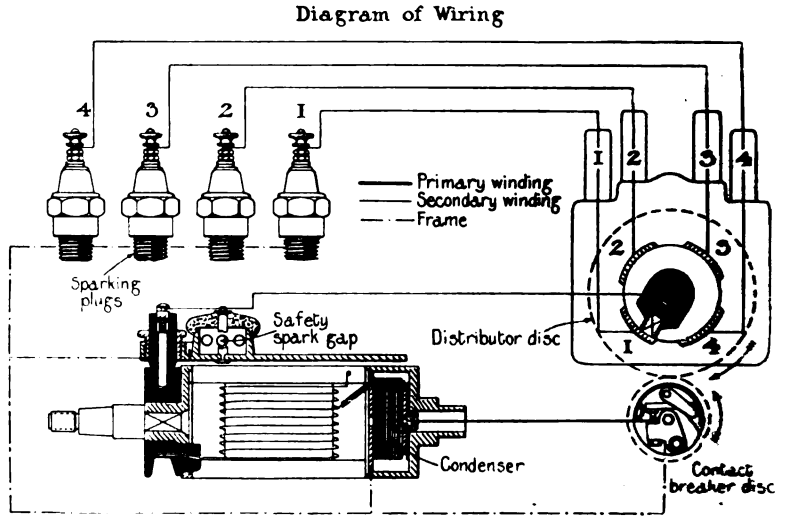

Fig. 7.

In all the systems mentioned, dual and even triple ignition can be fitted. In one instance brought under the author's observation high-tension and low-tension magneto and accumulator ignition was suitably arranged. In any case, it is common practice to provide accumulator and coil ignition for starting the engine, afterwards throwing over to the magneto. Some car builders use a high-tension magneto without its combined high-tension distributor. The arrangement used is similar to that described by Fig. 5. The single trembler coil and battery is used to start the engine, after which both are cut out of circuit and the magneto switched in.

A very ingenious device has just been introduced for starting. The principle is based on temporary use of the primary and secondary winding of the high-tension magneto armature as an induction coil. Current from a dry battery furnishes the current, which is conducted by suitable switchgear to the armature primary winding. If the engine has to be started after it has not been working for a few days, a turn of the handle is required to rupture the dry battery current in the primary winding, but if a charge is left in one of the cylinders previous to running, the pressing of a button switch will start the engine whilst the driver is seated. The author is of opinion that energising the armature in this way will in time reduce the field strength of the permanent magnets.

DISMISSED.—The action, J. H. Holmes & Co. *v.* Associated Newspapers, Ltd., for alleged infringement of the Clatworthy patent for electric driving of printing presses, was dismissed with costs, Mr. Justice Neville holding that the patent was invalid.

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CORROSION OF STEEL WINDING ROPES.*

By M. THORNTON MURRAY, M.Sc.

By far the greater number of the cases of corrosion of iron and steel which have come under the author's notice, have been cases of "rusting," and the present one forms no exception to the rule: in the corrosion of steel ropes, rust—hydrated oxide of iron—is produced, and the corroded areas are typical of those found in other cases of rusting. The old theory of rusting, which was, until a few years ago, almost universally accepted, was due, in the first place, to Crace Calvert, but was extended by Prof. Crum Brown in 1888, while it has since been added to by Jowett, Dunstan and others. For the sake of distinction, this might be called the purely *chemical* theory. It asserts that the essentials for the formation of rust are:—Iron, or steel, oxygen, carbon dioxide, and *liquid* water (not water vapour).

The equations representing the reactions are as follows:

Carbon dioxide and water yield carbonic acid

(i) $CO_2+H_2O=H_2CO_3$

Iron and carbonic acid yield iron "bi"-carbonate, and hydrogen

(ii) $Fe+2H_2CO_3=FeH_2(CO_3)_2+H_2$

Iron "bi"-carbonate and oxygen yield hydrated ferric oxide ("rust"), carbon dioxide and water

(iii) $4FeH_2(CO_3)_2+O_2=2Fe_2O_3.3H_2O+8CO_2+H_2O$

The carbon dioxide does not escape, but remains in the water, and is used over and over again. The action, so far as the carbon dioxide is concerned, is cyclic, and this explains the fact that, although carbon dioxide is necessary for the reaction, such a relatively small proportion as is present in ordinary air, is sufficient to do so much damage. For some time the "chemical" theory, as enunciated above, stood unchallenged; then, quite recently, it has been assailed from all sides. Dunstan and Traube first asserted that hydrogen peroxide (H_2O_2) was formed during the reaction, and immediately broken up again, thus:—

Iron and oxygen and water yield ferrous oxide and hydrogen peroxide

(i) $Fe+O_2+H_2O=FeO+H_2O_2$

Iron and hydrogen peroxide yield ferrous oxide and water

(ii) $Fe+H_2O_2=FeO+H_2O$

Ferrous oxide and hydrogen peroxide yield hydrated ferric oxide (rust)

(iii) $2FeO+H_2O_2=Fe_2O_3H_2O$ (or $Fe_2O_2(OH)_2$)

Mallett asserted also that magnetic oxide of iron (F_3eO_4) was intermediately formed during the reaction, whilst others vary the formula in slight details. Next, Dunstan endeavoured to show that carbon dioxide, or, indeed, any acid, or acid-making gas was unnecessary for the formation of rust. He asserted that water and oxygen by themselves would slowly corrode iron with the formation of the well-known hrydated ferric oxide. This assertion paved the way for the boldest theory which has yet been advanced—that due to Dr. Allerton S. Cushman, of the Department of Agriculture, at Washington, U.S.A. Undoubtedly Dr. Cushman's paper is one of the finest contributions ever made to the literature of rust. He began by casting doubts upon Dunstan and Traube's theory that hydrogen peroxide was intermeditaely formed during rusting. If the formation of this compound was an essential stage in the formation of rust, why was it that rusting could not be prevented by powerful reducing agents? Since the weakest "reducer" was strong enough to break up hydrogen peroxide into water and oxygen.

Next he demonstrated, by means of experiments, that pure iron would partially pass into solution in pure, air-free, distilled water, without the presence of any other dissolving agent. Having established this point as a preliminary, he puts forward his theory of the rusting of iron. This is as follows:—

When iron is immersed in water, the water is broken up into hydrogen and hydroxyl "ions." Now hydrogen is electrically classed as a metal. Therefore when iron is brought into contact with a solution containing hydrogen ions, iron "ions" pass into solution, and hydrogen ions collect on the iron; the action is analagous to the deposition of copper on iron which is dipped into a solution of copper sulphate. Furthermore, hydrogen is electro-negative to iron, so that the hydrogen "ions" actually set up an electro-motive force (analagous to the back E.M.F. in a polarised simple cell) with the iron. The action, thus set up, is prolonged. Iron ions pass into solution (and, in the presence of oxygen, are immediately oxidised). Hydrogen ions are ousted from the water to give them room, and are given off, while hydroxyl ions collect at certain points on the iron. The function of acids, in rusting, is, therefore, simply to strengthen the electrolyte and promote ionisation.

Since Dr. Cushman's paper, the electrolytic theory of rusting has been much discussed, and papers have been brought out by Tilden, Friend, Moody, Walker and others, espousing either the chemical or the electrolytic cause. The publication of Dr. Cushman's paper, by the Iron and Steel Institute has, however, firmly established the electrolytic theory—at least in the main.

Whatever be the merits or demerits of the electrolytic theory of rust formation, it is certain that electrical phenomena are very closely bound up with the corrosion of iron and steel. Steel and iron water-pipes, when laid in the vicinity of leaky electric cables, are corroded with extraordinary rapidity, so that exceptional insulating precautions are now taken, when cables are laid near such pipes. It has long been known that rust itself, in the presence of a suitable electrolyte, sets up a difference of potential with clean iron and steel, and it is probably this peculiarity which partly causes an already rusted surface to continue to rust so much more rapidly than a previously bright one. Even when the surface is covered with some rust-resisting material—either paint, tar, or another metal—and apart altogether from the adhesive power which a clean surface possesses, it must be borne in mind that rusting will proceed even *under* the protector, if the protected surface be already rusted when covered.

Besides the electrolytic action set up between clean iron and "rust," a very much more serious action is set up when clean iron and black oxide of iron, or "smithy scale" are placed in electrical connection in a suitable electrolyte. In this latter case the iron serves as the anode, or positive pole, while the oxide acts as a cathode. Thus the iron is dissolved away, and precipitated (after oxidation) upon the "scale." In the case of ordinary rust and pure iron, the action is reversed, the rust being dissolved and re-precipitated upon the iron. A somewhat striking illustration of the action of magnetic oxide upon iron corrosion is afforded by the fact that upon painted girders have been found little piles of rust, emanating from a mere pinhole in the paint, which is almost invariably situated over a tiny, embedded particle of "scale."

Mr. E. F. Law, in his paper on "Non-Metallic Impurities in Iron and Steel," gives another example. He conducted experiments on welded bars, and found that rusting took place much more rapidly at the weld than elsewhere. This he attributed to the presence of magnetic oxide of iron ("smithy scale") at that point.

The action upon iron and steel of other metals, with respect to corrosion, is yet another proof of the existence of some electrolytic action, in corrosion. The metals in the following table, which are electro-positive, will, if placed in contact

Electro Positiveness of Metals.

Positive End

Potassium	Cobalt	Silver
Sodium	Nickel	Platinum
Magnesium	Lead	Gold
Manganese	Tin	Hydrogen
Zinc	Bismuth	Antimony
Iron	Copper	The Metaloids and
Cadmium	Mercury	Non Metals

Negative End

with iron tend to dissolve away, and reprecipitate upon the iron, thus protecting it. The protective action of galvanising is thus explained. Metals, however, on the negative side, tend to aid in the destruction of the iron, since, if they form a covering, and that covering is once broken through, and the iron exposed to rusting influences, an electrolytic action is set up, and the iron is dissolved away, to be re-deposited upon the covering metal, after it has been oxidised.

* Abstract of paper read at annual meeting of Chemical, Metallurgical and Mining Society of South Africa.

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Mr. Law has demonstrated the influence of non-metallic "impurities" on the corrosion of iron and steel. But it seems to the author that one might go farther, and assert that, under certain conditions, the very constituents of the iron or steel themselves—such as graphite, ferrite, pearlite, cementite, etc.—to which our President has introduced those of us who were not previously familiar with them—that these are capable of promoting corrosion by mutual electrolytic action. The author was first led to this belief by an investigation of the well-known variety of iron or steel, called "double-faggoted iron," which consists, as you know, of alternate layers or "fibres" of wrought iron and mild steel. Under the microscope this specimen exhibited a structure consisting of pure ferrite, and ferrite with small areas of pearlite. Now this specimen was exposed to damp air for some months, as was a piece of wrought iron and a piece of mild steel, of the same composition as the steel in the composite bar. It was found that the composite bar was corroded very much more than either the mild steel or the unwrought iron, and the microscope further demonstrated that the rusting began where the pearlite areas of the steel touched the ferrite of the pure iron. In the steel itself, there was, of course, little evidence of what might be called "intra-granular corrosion," but that was due to the natural and stable contact between the ferrite and the pearlite, attained when the steel was melted, in its manufacture, and cooled. The incomplete junction of the pearlite of the steel and the ferrite of the wrought iron, however, led to the establishment of differences of electrical potential, and consequent rapid corrosion.

A number of samples of steel which had been carbonised to a certain depth and hardened—in other words, "case-hardened"—came under the author's notice. These were fractured so as to expose both the high-carbon hard "casing," and the mild steel core to rusting influences. It was found that corrosion proceeded very much more rapidly than upon a high-carbon, hardened steel, or a mild steel, such as constituted the core. From these, and a number of similar examples, it is possible to assume that lack of uniformity—either in carbon content, in distribution of the constituents, or in the contact of the crystals—tends to promote corrosion.

Corrosion of Winding Ropes.

For a great deal of the information upon which the argument of the following part of the paper is based, the author is indebted to Mr. Hume, of the Mechanical Laboratory of the Mines Department.

For a variety of reasons, steel cables offer peculiar opportunities for corrosion. Firstly, the atmosphere in a mine shaft—especially in the up-cast shaft—generally contains large proportions of "acid" gases, such as carbon dioxide, oxides of nitrogen, etc., together with some water vapour, while the air is generally warm. Secondly, the constructional nature of the cable itself is such as would assist corrosion. It is well known that the presence of actually *liquid* water is essential for the production of rust. In confined spaces, therefore, where evaporation cannot rapidly take place, the rusting action is both prolonged and intensified. Such confined spaces are the interstices between the strands or wires of a steel cable. In many cases cables have been discovered to be internally corroded, when the surface was but little affected. These examples were doubtless due to the phenomenon above described, the cable, at one time or another, having taken up water which could not evaporate easily, even when it was transferred to conditions where evaporation from the surface might have been possible.

There is a third reason, the author believes, for the particular aptitude of winding ropes to corrode, and that is, the continually alternating or varying stresses which they have to withstand.

It would be a work of supererogation for the author to point out to the members of this Society how extensive are the ravages of corrosion upon winding ropes.

A noticeable point in connection with the corrosion of winding ropes, is that owing to the continual friction they are subjected to in passing over pulleys and sheaves, the surface is generally kept fairly bright, and evidences of corrosion are consequently not easily discovered, though the rope is corroded all the same.

Perhaps the most interesting aspect of the corrosion of winding ropes is one which is very closely allied to the mechanical effects of their usage upon the internal structure of the metal.

Most of the members will be familiar with the "flattening" effect of continual friction upon the outer wires of a rope. They will have noticed that not only has the wire been worn away by continued attrition, but that it is, in many cases actually *flattened*. In one case a wire, which had been in service only nine months was flattened out at one place until its diameter had increased 10½ per cent. Furthermore, the wire at such points exhibits remarkable brittleness, so that it may often be broken off short in the fingers when bent with the flattened surface uppermost. Often, too, numbers of transverse cracks have developed on the flattened surface, some of considerable depth and magnitude.

Briefly to summarise the question of the corrosion of steel winding ropes; undue strains, caused generally by careless usage, tend to produce internal strains, which promote corrosion, while the surface hardening effect and consequent formation of transverse cracks materially shortens the life of the rope, not only by impairing its mechanical properties but by assisting corrosion in the manner which has been demonstrated.

To a certain extent these evils may be mitigated; firstly, by bestowing a greater amount of care on the ropes. Especially is this care needed in the case when the ropes are employed on *compound* shafts, for the greatest trouble, both by hardening and corroding, has been found to occur on such ropes. It has been proved, in this case, that the bend-pulleys are responsible for the greater part of the damage; the friction generated when the rope is running over the pulleys being often sufficient to produce actual sparking. It is obvious that under these conditions even good ropes will not last for long. Secondly, the corrosion can be to a great extent arrested by very careful lubrication. Too often this duty is performed at long intervals of time and then in efficiently. Both on the score of the danger to life and limb incurred by such neglect and of the money saved by careful attentoin to the rope, the author believes that these little points would reward attention.

In concluding these notes, let it be understood that the author is offering no universal panacea for corrosion; he is merely placing before the Society the results of his investigations into the question, and he trusts that they will be of interest to the members.

DISCUSSION.

Broken Wires.

(Mr. A. McA. Johnston, President.)

I have made numerous microscopic examinations of broken wires, and the author's results are practically the same as I obtained.

The Electrolyte Theory.

(Prof. J. A. Wilkinson.)

In the first place, the theories which have been formulated to explain the chemical changes taking place during rusting have been very briefly stated, namely, the CO_2 theory—I prefer this name to the one used by the author, because I fail to see why this should be called chemical any more than Dunstan and Traube's hypothesis—the H_2O_2 theory, and the electrolytic theory. With regard to the first, why not have written the first equation according to modern practice

$$CO_2 + H_2O \rightleftharpoons H^{\cdot} + HCO_3'$$

as we now know this to be he case, and more especially as the acid carbonate is supposed to be formed as an intermediate product to be afterwards decomposed by oxygen? This theory still finds supporters, the English chemists, Tilden and Moody, being, at least until recently, its champions.

As regards the H_2O_2 theory, I know of no modern chemist who champions this, but with regard to the electrolytic theory, I think the author is labouring under a misconception. This theory was first advanced by Whitney in 1903. I do not consider the publication of Dr. Cushman's paper by the Iron and Steel Institute to have firmly established the electrolytic theory, since this problem is

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entirely a chemical one, and I have yet to learn that this body is the final court of appeal in matters chemical. There is no doubt that the electrolytic or electro-chemical explanation of rusting is now obtaining general acceptance. From the opening statement of the theory, as given by Mr. Murray, one would be led to believe that the iron caused the ionisation of the water molecule, and hence a correction is necessary. Water, even the purest water, now generally spoken of by chemists as conductivity water, is not entirely composed of molecular parts, but does contain some hydrogen and hydroxyl ions. It is on the presence of these ions in the water, that rusting primarily depends, and the equation representing the changes taking place would read

$$Fe + 2H^{\cdot} + 2OH' = Fe^{\cdot\cdot} + 2OH' + H_2$$

the molecular iron passing into solution and becoming diferrion, its solution pressure being less than that of iron. The second action is caused by the oxygen dissolved in the electrolyte water, whereby the diferrion is oxidised to triferrion and finally precipitated, either in absence of air as hydrated ferric oxide, or possibly in presence of ordinary air, first, as carbonate, and finally, as hydrated oxide. If the function of the hydrogen as given above is correct, any substance increasing the concentration of the hydrogen ions will assist rusting. This will serve to explain the function of acids in stimulating the formation of rust, since, as is well known, they dissociate in solution with production of hydrogen ions. On the contrary, alkalis form in solution hydroxyl ions, which unite with the hydrogen ions forming molecular water, and hence alkalis inhibit the corrosion. This explains satisfactorily the non-rusting of steel girders when imbededd in concrete owing to the alkaline character of the latter due to the lime contained therein. Further, the rusting of iron is confined to local spots, a fact easily demonstrated by a low power microscope; in other words, its solution takes place at some spots and not at others. According to the author this is due to the many and varied constituents of the iron or steel.

ELECTRIC LIGHTING OF TRAINS.*

By A. ROBB.

The system of electric light for railway carriages, as used on the Bengal and North-Western Railway, might be termed a modified Stone's system, as every coach has not its own dynamo and cells, only the front and rear brake vans are fitted with dynamos and cells, the dynamos being the C.R. size 24 volts. They are suspended in the usual manner adopted by J. Stone & Co. In the centre compartment of each brake van are placed the cells, 24 in number, of 13 plates each; in the guard's compartment are placed the main switch, which controls half the train, and the ammeter which registers the amount of current being generated by the dynamo; and on the floor is placed the tension screw, by which the dynamo belts can be tightened or slackened according to requirements. In this compartment there are also two tumbler switches, one being a two-way switch for the tail lights and the other a one-way for side lights. The main cables of $\frac{9}{18}$ S.W.G. are run along one side of the coach on the roof under the corrugated sheeting, and down the ends of the coach, the cables being fixed on wooden blocks one inch thick and about 18 inches to 20 inches apart. In passing water tanks teakwood casing is used, a similar casing being used for the ends of the coach. At a distance of one foot eight inches up from the underframe at each end of the coach terminates the positive cable, and at a distance of three feet up from the positive cable terminates the negative cable. At each of these points is fixed a double socket into which is soldered the main cable and the flexible cable connection used to connect the coaches together; on the top of this double socket is placed a cast-iron cap to protect it, and at the other end of the above flexible cable is soldered a steel slip coupling, by which means the carriages are connected together.

Each coach is fitted with a box under the seat for the reception of auxiliary cells, with a connection to an external switch at one end of the coach, so that when a carriage is reserved and is going over any of the branches or a foreign line, the above cells, which are nine-plate, 12 in number, and placed in three boxes (with spring contacts on the sides of the said three boxes) can be accommodated.

These boxes are pushed into the box under the seat and the flexible positive connection at the end of the coach placed in a hole provided in the external switch above referred to; the switch is then pulled over when the cells will come into action.

The first-class carriages are provided with one duplex, and one single light in the saloon, and one light in the bath room. The second class have two single lights in the saloon and one light in the bath room, these being all 8 c.p. with the exception of those in the bath rooms, which are 5 c.p.

Intermediate and third composite carriages have three 8 c.p. lamps in the former and three 5 c.p. lamps in the latter. Third-class bogies have each four 5 c.p. lamps, and third-class six-wheelers have each two 5 c.p. lamps. Brake vans have two 8 c.p. lamps fixed on the roof between the partitions, each lamp giving light to two compartments, and the side and tail lamps are also of 8 c.p. The first and second-class carriages are provided with tumbler switches for each light with the exception of the bath room. This light being always on, means sufficient light is thrown into the saloon of the carriage through a frosted glass on the top of the bath room door, to permit of the other lights being switched off when the carriage is not occupied and yet enable passengers to see their way in, and is also a saving in lamps.

The normal train for bogie stock is one first and second composite, one intermediate and third composite, five thirds and two brake vans, having a total of 295 c.p., but the average train has six thirds. The normal train for six-wheeled stock is one double first, one double second, one full intermediate, one intermediate and third composite, nine thirds and two brake vans, total 277 c.p., the average train having 11 thirds.

A few coaches may be added to any of the above trains and still have a fair light, but the drop in voltage is very noticeable with the ordinary lamp. The Osram lamp overcomes this to a great extent. When shunting has to be done then one brake van supplies the light for the whole train during the operation, but if the vehicle to be cut off is in the centre of train, then each brake van supplies lights to its own portion of the train.

Again, when non-electric vehicles have to be attached, such as at present, when all stock is not electrically fitted, there are cables in two lengths, one unit length does for a four-wheeled coach, and by joining another length with the ordinary slip coupling it does for a six-wheeled coach. These cables are laid along the centre of the roof, and to hold them on, wooden blocks are attached to the cables which fit into the corrugation on the roof; the cables are also crossed round the roof lamp fittings. A set of above cables is kept at each carriage examining station, and when they are used, the guard of the train to which the coach is attached is responsible for the cables, and when this coach is cut off the stationmaster is advised by the guard about these cables, and he sees that they are taken off and sent back to the issuing station.

At present a man travels with each train who is termed a switchman. His duties are to attend to the dynamos and see that all the lights are in good condition and that any oil lighted vehicles that may be on the train are properly attended to. These men are old lampmen, and have had a few months' training in the shops. At terminal stations and large junction stations, one day and one night fitter with one spare switchman each, are kept to examine dynamos, and do any petty repairs that may come under their notice.

During the summer months it is stated that the oil gives a lot of trouble. The dynamos have an oil well both back and front, and when the machine has run about a month the bushes get worn a little and the oil, which is very thin, is thrown up with the oil ring and leaks through the bush. If this is not attended to every day the wells get dry, and the machine runs hot, with the result that the bush is cut up, the armature falls, and the winding is torn. One or two instances of this have occurred, and at first there was also some trouble with belts and the combs;

* Abstract of report by Electrical Engineer of the Bengal and North-Western Railway.

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the belts dropping off owing to the switchman keeping the belts too slack and the combs getting burnt.

The brake vans are brought into shops every six months to have their batteries washed out and re-charged, and dynamos overhauled.

There are two charging stations, one at Gorakhpur, for the main line trains, *i.e.*, 14 rakes, and 12 saloons whose batteries have to be changed every trip, as they are not fitted with dynamos. The other charging station is at Samastipur, which deals with the Tirhoot Section, or seven rakes of vehicles.

SCOTT'S PATENT FLEXIBLE SUSPENSION.

The advantages of Scott's Patent Flexible Suspension to reduce the wear and prevent the break of trolley wire merit careful consideration by those responsible for overhead systems of tramways. The principle of the invention is to give greater flexibility to the trolley wire, and its adoption has been found to result in a great saving in maintenance costs. The renewal costs for trolley wire are also greatly reduced, inasmuch as, beyond the actual saving in wear of the trolley wire, the lengths of wire which are too short for use from pole to pole can be utilised. The system is equally adaptable to span wire, bowstring, or bracket hanger suspension. By the adoption of this method, each trolley wire is independently supported in a manner which ensures flexibility. Double suspension is provided for each wire and greater safety is attained, while the wear on the trolley wire and clips is much reduced. When the wire becomes worn at the point of entry to the clips, the clips may easily be extended by lengthening the suspension wire to take up the wear, the short length of wire between the clips being renewed from old stock. Lengths of trolley wire under 40 yards, too short for a span with ordinary suspension, may be used, and greater economy effected thereby. On a side running system, the wear on the overhead work is generally excessive; this suspension not only provides the necessary flexibility, but also affords a convenient means for adjusting the height of the respective trolley wires to prevent the booms touching the inner wire. Full particulars of the system may be obtained from Messrs. Thomas L. Scott & Co., Ltd., 28, St. Martin's Lane, Cannon Street, London, E.C.

PROMOTION OF AN ELECTRICAL COMPANY.

In the King's Bench Division the case of Kerley & Sons. *v.* Robertson and another came on for hearing before Mr. Justice Coleridge.

For the plaintiffs, Mr. Beecheroft explained that the claim was to recover an amount due to plaintiffs as solicitors for expenses incurred in connection with the promotion of the Electric Industries Development Co., Ltd. The defendants, Mr. Robertson and Mr. Meeks, were director and secretary of the company, but Mr. Meeks, he said, had not been served with a writ, as he was an undischarged bankrupt. The defence appeared to be that there was no written agreement, but plaintiff said that he had had no denial of defendants' personal liability.

Mr. F. G. Kerley, of the plaintiff firm, submitted particulars as to the flotation and promotion of the company in May and June, 1906. The company was registered on July 11, 1906, and it was to take over the benefit of an agreement with the defendant Robertson. The company was formed, and the statutory meeting was held in due course. Mr. Robertson had never denied his liability.

In cross-examination, he admitted that, although he got his instructions from Mr. Robertson, the work was done for the company. He believed that Mr. Robertson was indemnified by the company.

Mr. John Campbell Robertson declared that he never agreed to be personally responsible for the expenses which Mr. Kerley now claimed. They were charges on the company.

Mr. Phillips said the defendant was being sued for an amount of £178 odd, a claim of which he had had no particulars delivered to him.

His Lordship said he had come to the conclusion that there was no arrangement by which plaintiff was to look to the company, and not to Mr. Robertson. There had been a cheque from the company for £100 which must be taken to pay a liability of the defendant. The defendant, Mr. Robertson, was liable, and after going into the accounts he gave judgment for plaintiff for £48 7s. 4d., subject to taxation and costs.

DIARY:

MONDAY, NOVEMBER 8.

INSTITUTE OF MECHANICAL ENGINEERS (Graduates' Association).—At 8 p.m., at Storey's-gate, St. James Park, Westminster, S.W., "The Commercial Testing of Railway Materials," by T. H. Sanders, graduate.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—At Newcastle-on-Tyne, meeting of Council.

TUESDAY, NOVEMBER 9.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.—At 2.30 p.m., at Balfour House, Finsbury-pavement, London, E.C., committee meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Students' Section).—Supper and smoking concert.

INSTITUTION OF CIVIL ENGINEERS.—At 8 p.m., at Great George-street, Westminster, "The Single-phase Electrification of the Heysham, Morecambe and Lancaster Branch of the Midland Railway," by Messrs. J. Dalziel and J. Sayers; and "The Equipment and Working Results of the Mersey Railway under Steam and Electric Traction," by Mr. J. Shaw.

THURSDAY, NOVEMBER 11.

INSTITUTION OF ELECTRICAL ENGINEERS (London).—At 8 p.m., at the Institution of Civil Engineers, Presidential address by Dr. Gisbert Kapp.

FRIDAY, NOVEMBER 12.

INSTITUTION OF ELECTRICAL ENGINEERS (Birmingham Section).—At the *Grand Hotel*, annual dinner.

SOCIETY OF MOTOR MANUFACTURERS AND TRADERS.—At Olympia, London, motor exhibition opens.

PHYSICAL SOCIETY OF LONDON.—At 8 p.m., at the Imperial College of Science, Imperial Institute-road, South Kensington. "The Absorption Spectrum of Potassium Vapour," by P. V. Bevan, M.A.; "Some Further Notes on the Physiological Principles underlying the Flicker Photometer," by J. S. Dow, B.Sc.; "Exhibition of a Colour Perception Spectrometer," by F. W. Edridge-Green, M.D., F.R.C.S.; and "Table of Ber and Bei and Ker and Kei Functions, with Further Formulæ for their Computation," by H. G. Savidge.

TUESDAY, NOVEMBER 16.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Local Section).—At 7.30 p.m., at the University, "Telephones," by L. E. Wilson.

JUNIOR INSTITUTION OF ENGINEERS.—At 8 p.m., at the Royal United Service Institution, Whitehall, Presidential address on "Recent Warship Machinery," by Engineer Vice-Admiral Henry J. Oram, C.B.

INSTITUTION OF ELECTRICAL ENGINEERS (Glasgow Local Section).—At Bath-street, Chairman's inaugural address.

WEDNESDAY, NOVEMBER 17.

SOUTH WALES INSTITUTE OF ENGINEERS.—At 7 p.m., at Institute-buildings, Cardiff, special meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Leeds Local Section).—At 7.15 p.m., at the University, Sheffield, "Some Experiments on Single and Stranded Fuses," by W. T. MacCall.

FRIDAY, NOVEMBER 19.

INSTITUTION OF MECHANICAL ENGINEERS.—At 8 p.m., ordinary meeting.

ELECTRIC LIGHT CO.'S CLAIM.

The Isle of Wight Electric Light and Power Co. brought an action, in the Isle of Wight County Court, to recover £8 19s. 1d. from the Sandown Gas Co. for damages sustained by the plaintiff Company to their main in Albert-road.

Mr. Hiscock, on behalf of the plaintiff Company, described the method adopted in laying an electric light main. Afterwards it became necessary for the Gas Co. to take up part of the pavement, and the road, in order to carry the gas connections into a house, and the Gas Co.'s men were found replacing paving stones just over the spot where the "fault" was found. The "fault" was found where the Gas Co.'s service pipe crossed the Electric Light Co.'s pipe, and it was probably made by a pickaxe wielded by an employé of the Company.

It was further alleged, in evidence, that Mr. Faulkner, the manager of the Gas Co., was shown the "fault," and practically admitted the liability on behalf of his Company.

This, however, was combatted by Mr. Marsh for the defendant Company, who said that there was nothing in the subsequent correspondence which would bear out such a contention. He also urged that the excavation of the trench, which was required to put in the gas at Kingsley, was done by the builders, and not by the Gas Co. No pickaxe was used by the Gas Co.'s employés.

His Honour said this was one of those difficult cases which could only be determined by a process of exhaustion, and gave judgment for the plaintiff Company with costs, holding that the damage had been done by the defendants.

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THE

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CONTENTS.

	PAGE
Notes	645
Electric Ignition of Internal Combustion Engines	646
Corrosion of Steel Winding Ropes	651
Electric Lighting of Trains	653
Scott's Patent Flexible Suspension	654
Promotion of an Electrical Company	654
Diary	654
Electric Light Co.'s Claim	654
The Domestic Outlet	655
Correspondence	656
The Electric Drive in Textile Factories	656
Oil-Cooled Transformers	659
Comparisons are Sweet	660
Invisible Lamp Lock	660
Engineer and Flat Rates	660
Wave Power for Electric Lighting	660
Sunbeam Metal Lamps	660
Patent Gas Detector	660
Companies' Meetings and Reports	xii.
Companies Registered	661
Contracts Open	661
Post Office and Electric Railway	661
Popularising Electric Lighting	663
Electrical Power for Light and Tramways	663
Electrical Appliances for Motor Cars	666
Electrical Contractor's Failure	666
Tyneside Notes	667
Midland Notes	667
Lancashire Notes	668
American Notes	668
Lighting and General Notes	670
Traction Notes	671
Educational	672
Personal	672
Catalogues and Lists	672
Tenders Accepted	672
Junior Institution of Engineers	673
Patents	674
High Tension Switchgear	676

THE DOMESTIC OUTLET.

It has been our steady contention that the heavy drop in the demand for current on the lighting side as the result of introducing the metallic filament lamps, although for the time worrying to central station men, should not be a matter for discouragement. We held that the cheapening of the illuminant will cause such an extension as soon to wipe out, and even overtake the drop, a point of view amply justified by experience up and down the country, and very decidedly at Willesden, as reported elsewhere in this issue. Willesden has the advantage of being a growing and fairly well-to-do district, and so it is natural that new houses should be wired from the outset, and new customers booked as the neighbourhood gradually fills up. But there, as indeed at Stepney, the demand for small motors for household and workshop use is greatly on the increase. This domestic outlet for power is, in our opinion, likely to grow to great proportions with a rapidly increasing progression, for our present household economy altogether favours this. In America, where the domestic servant problem is even more acute than it is here, electricity is used for an astonishing variety of household purposes. This was well brought out at the great electric exhibition held in Madison Square, New York, in connection with the recent Hudson-Fulton celebrations. We gave a brief account of this in our last issue, but we may be permitted to particularise here one or two aspects of that most popular show. Electric carpet sweepers, or rather, vacuum dust aspirators, were conspicuous; so, too, were toilet arrangements, such as water heaters, hair curlers, and driers and other appliances. Above all, however, was a round table rotating slowly round a small motor, and displaying egg-beater, cake mixer, ice cream freezer, meat chopper, coffee grinder, fruit squeezer, milk churn, potato peeler, and knife cleaner, any two of which could be coupled on to the motor and set to work simultaneously. Side by side with these were cooking

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appliances: ovens, grills, hot plates, stewpans, kettles, and so on. According to exhibitors the domestic appliances could be run in New York for 2½d. per hour, and so it was pointed out that electricity was not only handier, but cheaper than a human servant. No wonder that a splendid trade was done. Now, what New York can do, London can better. Evidence of this is forthcoming in Mr. R. Borlace Matthew's special little motor, devised for domestic use, to run just the assortment of appliances enumerated above, and many more. Once convince the modern housewife that electricity can either free her from the need of servants, or so simplify their work as to reduce their number in a big house, while saving them labour and thereby sweetening their tempers, and the demand for motors will approximate that for light. It would be superfluous to enumerate in this column the many extremely ingenious appliances by which electricity may be utilised in the hall, dining room, bathroom, bedroom, kitchen, scullery, laundry, and dairy; many manufacturers are turning them out on moderate terms, and these all deserve the encouragement and support of the central station engineers. Outside manufacturing districts, it is the domestic user of power who is going to put right the awkward drop caused by the saving in consumption on the illuminating side. In this matter we may well take example from the gas companies, and do everything to broaden the basis of supply, and in order to do this successfully we must educate the public. In the near past, electricity was largely the luxury of the rich; it is now the servant of the easy circumstanced classes, and we should see to it that in the immediate future it should become the friend of the poor man, not only in the factory, but in his cottage. Then, indeed, the outlook for electrical extension will be practically without limit.

HELD OVER.—Electron's "Notes on Transformers," and "Technical Problems" are unavoidably held over.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "THE EDITOR, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

CONTINUOUS CURRENT MACHINES.

Sir,—We notice, in the current issue of your journal, that a queston (No. 1,204) in the "Question and Answers Column" deals with the conversion of 220-volt continuous current machines to 440 volts, and that the questioner asks for names of firms making machines on these lines. We beg to say that we have for some time past standardised our armature coils, so as to make the same coils applicable to machines of various standard voltages. In the case of a four-pole machine, the changing over from one voltage to another is very simple, as a 220-volt parallel winding can, with the same coils, be altered to a 440-volt series winding; and, in the case of 110-volt machines, it is only necessary to connect up the armature coils—with certain modifications—as a double parallel winding. The practice of standardising one winding of an armature coil for various voltages has the advantage that it is necessary to carry only a comparatively small stock of armature coils in order to suit every standard output and voltage; besides affording the users the option of easily converting their machines from one voltage to another with a minimum of expense.

We write this, as it will probably be of interest to your readers, and remain,

Yours, etc.,
T. W. BROADBENT, LTD.

Victoria Electrical Works,
East Parade, Huddersfield,
November 1, 1909.

Sir,—In the first Answer to Question 1,204, the author (H.K.W.) apparently ignores the fact that the generator is, after alteration, to supply a three-wire system, for he makes no provision for an earth connection to the middle wire, or for any middle wire at all. The resulting regulation on an unbalanced load, at the consumers terminals, would be interesting to observe.

I should expect the second method given to be more satisfactory, although more expensive and more of a makeshift, as the change over could be done more rapidly. It is to be noted that with a reasonable growth in the load, the machine would finally be changed back to 220 volts and put in series with another 220-volt machine.

Yours, etc.,
J. CAMERON RENNIE.

28, Oxford Road,
Putney, S.W.
November 1, 1909.

"WIRELESS" EXPERIMENTS.

Sir,—Such extraordinary reports have appeared in the London and provincial Press with regard to some wireless telegraph experiments that we conducted in Derbyshire recently, that we shall be much obliged if you will afford us the opportunity of correcting any false impression that may have been created.

We erected a temporary station in the Derbyshire hills to test the nature and strength of signals from the London station situated at the above address. The experiments proved a great success, and amply proved the efficiency of both the transmitting and receiving apparatus designed by Mr. J. G. Balsillie, engineer in chief of the company.

It will interest you to know that in spite of the fact that the transmitting station was in the heart of London and the receiving station in one of the hilliest districts of England, communication was established with an expenditure of only ·25 kw. primary energy, 146 miles separating the two stations.

No attempt was, or will, be made to communicate with Germany, and the statement that "A £60 wireless station speaks with Germany" evidently arose from the fact that signals from the German station at Norddeich certainly came in with great distinctness and strength; and, that the apparatus comprising the complete receiving station is sold for £60.

Yours, etc.,
V. VINCENT SMITH.

The British Radio Telegraph and Telephone Co., Ltd.,
5, London Wall-buildings, E.C.

THE ELECTRIC DRIVE IN TEXTILE FACTORIES.

Late in 1907 a lecture delivered before the Bradford Engineering Society by Mr. W. B. Woodhouse, on "Electrical Driving of Textile Machinery." This aroused a considerable amount of interest and discussion, and led to an adjourned meeting for further debate. Subsequently, a paper was read by Mr. R. V. Brook, on "Private Plant v. Public Supply," and, later, the members were invited to attend a meeting of the British Association of Managers of Textile Works to hear a paper on "Electric Driving," by Mr. P. B. Coulston. The discussions which took place at these meetings brought out the lack of agreement as to the method best adapted to the requirements of the Bradford trade. It was stated most emphatically on the one hand, that the only suitable system was

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that of three-phase alternating current, which alone enables a perfectly uniform speed to be maintained; whereas with the older method of transmission by direct current, considerable variation in speed is known to occur. Still, direct current was not without its supporters at the Society's meetings. The question of "individual" versus "group" driving was also the centre of much controversy, and another point on which great difference of opinion was found to exist was the advantage of driving from a public supply as compared with a private plant. In either case, the desirability of adopting the steam turbine as the prime mover was very generally admitted. Great importance was attached to the claim of increased output and improvement of quality as the result of electrical transmission due to steadiness of speed. It was felt, however, that until more general agreement on the main points involved was found to exist, manufacturers will have a good excuse for the position of caution which they are accused of having taken up.

The Society, at the suggestion of the President (Professor Charnock), therefore decided to appoint a commission to collect evidence, to carry out certain experiments, and to enquire fully into the various points in dispute. The first Report of the work of this Committee has now been issued, and is printed below:

A programme limiting the scope of the enquiry was drawn up, and it was decided in the first place to carry out certain experiments to determine the actual cyclical variation occurring in prime movers and electric motors, and in shafting and machinery driven by them.

An exhaustive series of trials was carried out by Prof. Charnock and Mr. Barker at Dock Ing Mills, Batley, by kind permission of Messrs. Brigg & Sons, the proprietors. This mill was selected as an example in which the plan of the buildings necessitates power being taken off in various directions by means of spur and bevel gear, belt and rope driving, with long lengths of shafting intervening in some cases. The machinery driven included mules, cards, drawing, and looms. From a report prepared by Mr. Barker, it was found that even under such circumstances the amount of cyclical variation was not nearly so great as had been anticipated. Further tests were made at the Leigh Mills Co., Ltd., Upper Mills, Stanningley, with worsted drawing machinery driven by induction motor, using current from the Yorkshire Electric Power Co.'s supply, and also on spinning machinery driven by shafting from a compound tandem Corliss engine. Various other tests were made at works in the City, and Mr. W. B. Woodhouse kindly arranged some experiments to demonstrate the speed variation due to slip in three-phase motors under varying load. The Committee also visited the Thor Mill, Whitworth, near Rochdale, on the invitation of Messrs. Siemens Bros., Dynamo Works, Ltd., who supplied the equipment for electric driving. As, however, the large motors installed on each floor could only be said to replace the ordinary rope drive, this mill could hardly be said to constitute a typical example of electric driving. The point submitted was that even with this arrangement the increase in steadiness of turning was such as to lead to increased output, and of better quality, commanding a higher price on the market. Of this no actual evidence could be supplied, and the Committee have been unable to obtain any proof whatever, based on actual experience.

The Committee after very carefully considering the above results, and after a thorough discussion of all the information before them, arrived at the following conclusions:—

(1) That in good installations there is practically no difference in cyclical variation between Mechanical and Electrical Transmission when measured at the end nearest the Main Drive.

(2) That any initial cyclical variation which may exist at the driving end of the above shaft is liable to be increased if transmitted through long shafts. This can, however, in many cases, be controlled by known methods of destroying synchronous vibrations.

(3) That so far as any irregularity is concerned (excluding breakdowns), Electrical Transmission will maintain its condition better than Mechanical Transmission.

(4) That in modern textile, combing, spinning and weaving factories, where those factories are of ordinary dimensions, and where the power is generated on site, power is conveyed with less loss by Mechanical than by Electrical Transmission; but where the plan of the buildings is irregular, involving awkward angles of drives or irregular arrangement of machinery, the saving in power by Electrical Transmission begins to appear. The Committee find it difficult to arrive at a definite decision as to the exact point where the friction due to Mechanical Transmission is excessive, owing to the very varied conditions which obtain, but make the following suggestions:—

(5) That the friction loss with Mechanical Transmission is excessive if over 30 per cent. By "friction loss" is meant the proportion which the collective friction of the engine drives shafting with the belts on the loose pulleys of the driven machines, bear to the total horse power when the whole load is on the engine.

(6) That Electrical Transmission is likely to be most efficient

(*a*) Where there are long lengths of shaft from which power is not taken off at intermediate points.

(*b*) Where machinery is distributed and requires starting and stopping frequently during the day.

(*c*) Where machines require to run at various speeds and have those speeds altered during motion.

(*d*) Where there are excessive lengths of shafting, making it desirable to separate these into two or more lengths.

The question as to the adoption of Electrical or Mechanical Driving is largely one of cost, which can only be decided by careful investigation of each individual case. By adopting Electric Driving, the following advantages can be obtained, whether the power be generated on site or taken from an outside source of supply:—

(1) Ease of checking daily the power required for running individual machines and departments, and of detecting any faults or deterioration of the plant. In the case of Mechanical Driving, this may be done by employing some form of power meter.

(2) Ability to run only a portion of the plant—as for instance, on overtime—without serious loss in transmission. With Mechanical Transmission, the same object may be attained by the judicious application of clutches, or similar mechanical devices.

(3) Reduction in the number of belts, shafts, gears, etc., with consequent improvement in lighting and cleanliness when individual driving is adopted.

(4) Ease of regulating the speed, and of introducing periodical speed variations in certain machinery, if individual driving be adopted.

(5) Ease of utilising the available space to the best advantage, and of extending into adjacent buildings at any time, irrespective of the layout of the same.

(6) Saving in the cost of the engine house and its foundations, the latter made possible by the adoption of a high-speed generating set. Care must be taken that the possible extra cost of other portions of the plant or buildings, or reservoirs, does not more than balance any saving in the direction indicated.

The following further advantages may be obtained if an outside source of supply is available:—

(1) A reduction in the first cost of the installation and buildings due to the absence of power generating plant. This, in conjunction with the corresponding saving in floor space, may be utilised for the installation of productive machinery.

(2) Freedom to run only parts of the plant, and to work overtime without any increase in the cost per B.H.P. of the power used.

(3) Unlimited supply of power available.

(4) Less liability of total stoppage, due to the standing plant of the supply authority, as compared with private generating plant.

It is particularly pointed out that this Report must not be regarded as complete or final, being presented to the Society as an indication of the work already accomplished by the Committee.

In transmitting the above report to us, Professor A. F. Barker, of the Department of Textile Industries, Technical College, Bradford, says that the College authorities are considering the matter of electrical driving in their new Technical School, and are both experimenting and taking into account the result of other people's experiments in their direction.

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WARNING.

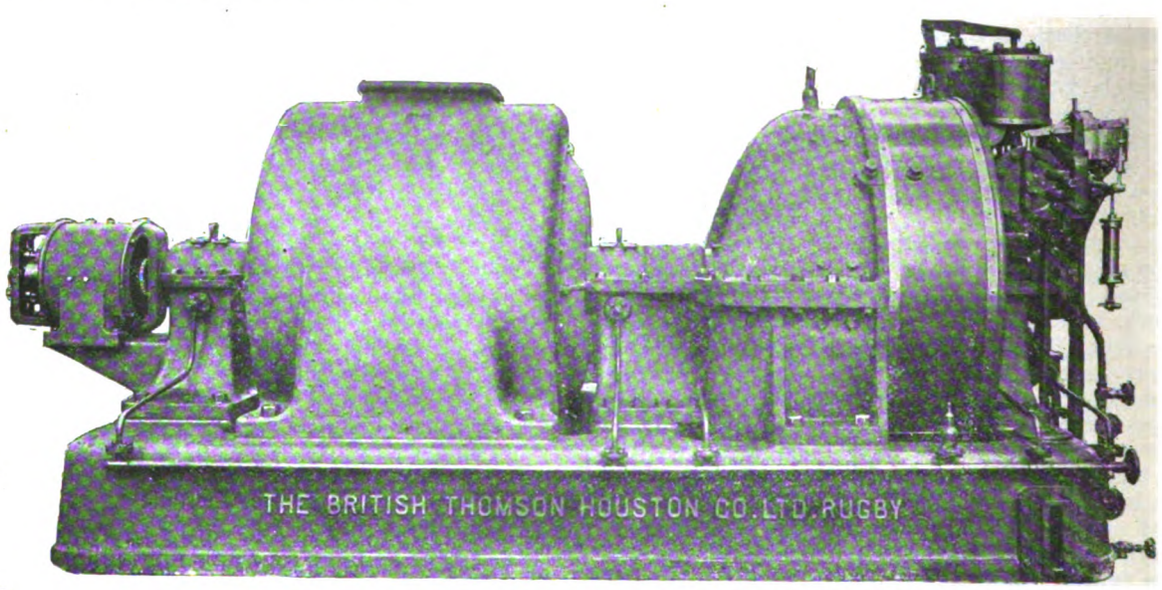
B.T.H. IMPULSE STEAM TURBINES.

CURTIS PATENTS.

The well-known Curtis Turbines are Impulse Turbines in which the steam is expanded in a series of stage nozzles with abstraction of the velocity acquired in each expansion by intervening stage wheels.

These Turbines are sold in Great Britain exclusively by **THE BRITISH THOMSON-HOUSTON COMPANY LIMITED,** and their **LICENSEES.**

Sellers and Users of infringing Turbines are hereby notified that they will be proceeded against.



1000 KW. CURTIS TURBO-GENERATOR.

THE BRITISH THOMSON-HOUSTON COMPANY LIMITED have sold a total of 67 Curtis Steam Turbines aggregating a capacity of 85,000 Kilowatts.

All of these Turbines have been manufactured or are now in course of construction at their Rugby Works.

Supplied in all sizes—either vertical or horizontal.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

OIL-COOLED TRANSFORMERS.

Since the publication of the special description of various leading types of transformers, we have received from Messrs. Siemens Bros., Dynamo Works, Ltd., particulars of their latest productions. Their medium size W.O. or M.O. (Fig. 1), and small size W.O. transformers are oil-cooled without forced circulation, and therefore specially suitable for use in damp situations and in mines. For small outputs, up to 10 k.v.a. these transformers can be made suitable for fixing to a pole. The core is of the shell type, and is built up of highest quality core plates insulated with paper. It is arranged with butt joints of a special kind, so that the yokes can be easily removed to give access to the coils.

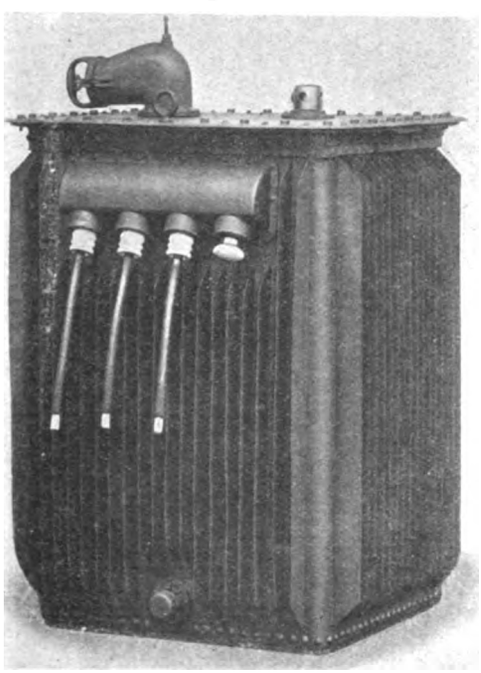

Fig. 1. Medium Size W.O. or M.O. Transformer.

The winding is sub-divided into sections, which are carefully insulated from one another and from the core, and spaces are left between the sections to allow the oil to circulate freely and to assist in cooling. The transformer case is made of sheet iron, and metal ribs are soldered to both the outside and inside in order to increase the effective cooling area of the casting. The largest sizes of transformers, from 200 to 400 k.v.a., are also provided with four to eight special coolers in the form of deep hollow boxed projections to the case. Each transformer in which the pressure of the low-tension side does not exceed 250 volts is fitted with a safety device to prevent an excessive use of voltage with the low voltage secondary in case the insulation between it and the primary should become defective.

The transformer pillar, shown in Fig. 2, contains one 30 k.v.a. transformer type M.O. 210, and one 15 k.v.a. transformer type M.O. 160. The primary voltage is 5,000 volts, secondary voltage, 223 volts; frequency, 50 cycles per second.

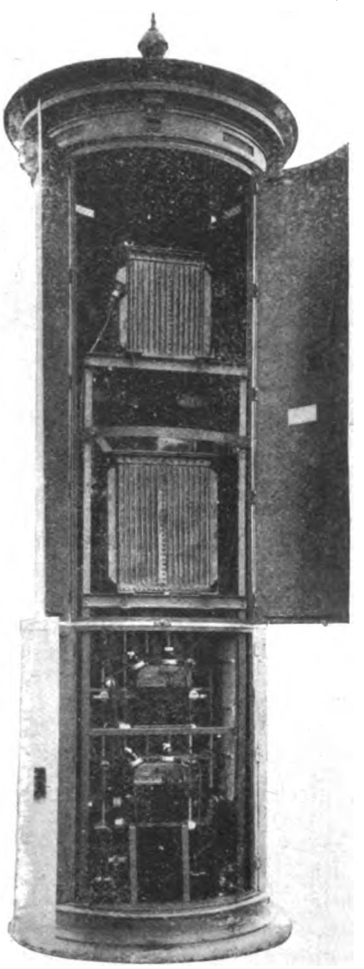

Fig. 2. Transformer Pillar.

NEW STORES AND SHOWROOM.

New premises have been opened by Siemens Bros. Dynamo Works Ltd., at 39, Upper Thames-street, as London Stores and Showroom, where all the business of the Supplies Department will be in future conducted, including that hitherto carried on at 6, Bath-street, E.C., and 1, Abchurch-yard, E.C. The new premises comprise six spacious floors and basement. The ground floor is arranged for counter trade, and every facility is provided for executing customers' orders with the utmost promptness. The first floor is devoted to an extensive show room, where Companies' specialities will be exhibited. One feature will be a tasteful display of the latest designs in artistic electric light fitting and shades, exhibited in conjunction with the well-known "Tantalum" lamps, which have of late years taken such an important place in the electric lighting industry. The third floor is occupied by the manufacturers of Messrs. Siemens Bros. & Co. Ltd., and a comprehensive stock of all sizes of wires and cables is carried. The remaining floors carry a comprehensive stock of all articles required by the Trade. The Siemens firms are in the unique position of being able to manufacture at their extensive works in this country, goods ranging from a small incandescent lamp to motors of 16,000 h.p., and from the smallest bell wire to Atlantic cable. At the invitation of Siemens Bros. Dynamo Works Ltd., members of the technical Press had an opportunity of inspecting the new premises, the visitors being courteously received by Mr. A. H. Bate, A.M.I.E.E. (head of the Supplies Department), and Mr. E. P. Barfield, A.M.I.E.E. (manager of the "Tantalum" Lamp Works, Dalston).

OSRAM LAMP CARDS.

The advantages of Osram Lamps in comparison with carbon lamps are effectively demonstrated by a novel model card just issued by the General Electric Co. The illustration shows an electric lamp and by moving the cardboard "switch" the wording encircling it, "My electric light bill for 1907 with carbon lamps was £10," is changed to "My electric bill for 1908 with Osram Lamps was £2 10s. 16 c.p. Osram Lamps only consume one unit in 60 hours." A blotter for November and December bears the hall-mark "Osram Lamps," which "save 70% current."

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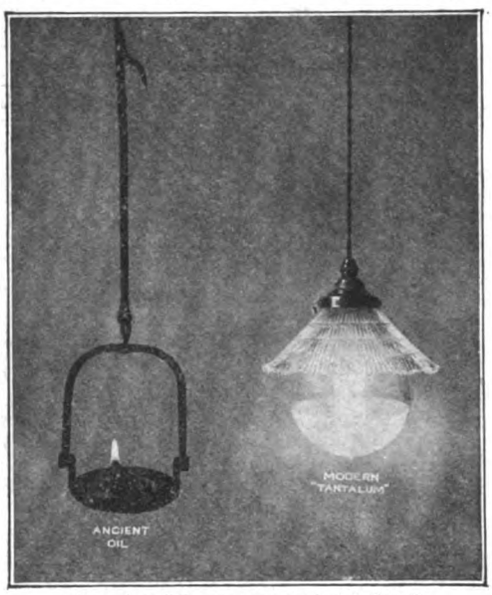
COMPARISONS ARE SWEET.

One of the most amusing, and at the same time instructive, features of the Shoreditch Electrical Exhibition was a comparison of the ancient and modern types of lighting. Curiously enough, during the period covered by the Exhibition, the old-fashioned lamp shown in the accompanying illustration came to light, being found in the destructor of one of the interested Corporations, and was immediately siezed upon for showing a comparison of



"Tantalum" Lamps compared with Paraffin.

lighting efficiencies. On the one hand, we have illustrated the oil lamp giving an efficiency which almost equals that of a "penny dip," and close by its side a 50 c.p. "Tantalum" "Sun" lamp underneath a holophane reflector. The photograph was taken with the two lamps alight, by a special process, and the general effect of illumination can very well be noticed in the illustration. When one thinks of the vast improvement in the amount of light, in cleanliness, in economy, it must be admitted that electric light has come to stay. However, as improvement succeeds improvement, the crude and unsatisfactory arrangements are gradually pressed out of service, and are superseded by newer and more up-to-date. It is interesting to notice here that electric lighting with "Tantalum" lamps works out considerably cheaper than gas in proportion of the amount of light obtained.

INVISIBLE LAMP LOCK.

The problem of securely fixing incandescent lamps in their holders has been satisfactorily solved by the production of the Ellco Invisible Lamp Lock. The new invention is simplicity itself, and has the advantage of being introduced to the public at a comparatively nominal cost. A disc-like arrangement, the lamp lock is inserted between the lamp and holder, and with the ring tightened, security is assured. By its use the annoyance of missing lamps is once and for all avoided, and, moreover, the new lock, holding the lamp tight in the holder, prevents vibration and consequent breaking of the filament. The Ellco Lamp Lock is being placed on the market by the Electric Lamp Lock Co., of Glasgow, the patentees and manufacturers, and should be in big demand.

ENGINEER AND FLAT RATES.

A London electrical engineer, Mr. A. H. Seabrook, tells the *Electrical World* that after about 15 years' experience in electric supply he has come to the conclusion that flat rates of any kind are entirely wrong. Unless various classes of consumers are classified and a separate flat rate applied in each case, the flat-rate system is unfair; but a classification would be exceedingly cumbersome and likely to give rise to much dissatisfaction. "The greatest objection, however, in my opinion," he says, "is the fact that *no flat rate will induce long-hour uses of electricity.* It would not pay the proprietor of a store to illuminate his windows until midnight on a flat rate as low as 6 cents per kw. hour. The maximum-demand system, based on the 'readiness-to-serve' charge plus a small charge per unit, is the only system which will induce consumers to be liberal in their use of electricity."

WAVE POWER FOR ELECTRIC LIGHTING.

A "wave" engine has been invented by Councillor Robshaw, of Sorrento, Victoria. The inventor, says a Colonial contemporary, is so convinced that it will be commercially successful that he proposes to build a pier at Sorrento about 200 ft. long, and instal a 50 h.p. plant, from which the town will be supplied with electric current. Power is obtained by a "free" buoy, which rises and falls with the waves, and this movement is converted into rotary motion for driving a dynamo. The difficulty in obtaining continuous motion has been solved by storing a certain proportion of the energy thus developed in a weight that acts very much in the manner of the weights of an old-fashioned clock.

SUNBEAM METAL LAMPS.

The Sunbeam Lamp Co., Ltd., are issuing some striking showcards and picture postcards setting forth the merits of Sunbeam Metal Lamps. The accompanying illustration shows the design utilized:—

PATENT GAS DETECTOR.

We note that Messrs. J. H. Holmes & Co., of Newcastle, have patented a gas detector, specially adapted for discovering gases in mines before its percentage in the atmosphere has reached a dangerous point. It automatically switches off current from electric motors and other electrical apparatus. By means of a very simple piece of apparatus, which can be mounted in any convenient position, near the switch gear, for example, the presence of gas in the surrounding air is detected, and the contrivance can be arranged to light up a danger signal lamp, to ring a bell to call attention to the fact, or to switch current off from the motor or other electrical plant in the immediate neighbourhood, and to render it impossible to switch current on again until the atmosphere is cleared of gas. The detector is very sensitive, and can be made to operate with 1% of gas in the atmosphere.

ELECTRIC LIGHTING BILL.

On consideration of the Commons' amendments to the Electric Lighting Acts (Amendment) Bill in the House of Lords, an amendment, moved by Lord Belper, to provide that no company should be prevented from supplying electricity to a railway company for purposes incidental to its undertaking, though opposed by the Government, was agreed to. The Commons' amendments were then accepted.

INSTITUTION OF ELECTRICAL ENGINEERS.—At the opening meeting on November 11, a marble bust by Hamo Thornycroft of the late Dr. John Hopkinson, F.R.S., who was President in 1890 and in 1896, will be presented to the Institution by Professor Bertram Hopkinson, on behalf of his mother, Mrs. John Hopkinson.

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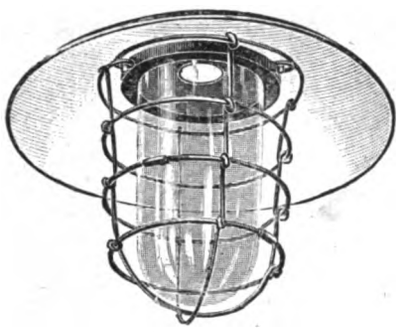
No. 115 N.

Wm. McGEOCH & Co., Ltd.
Manufacturing Electrical Engineers,
28, WEST CAMPBELL STREET, GLASGOW.
Enamelled Iron Reflector Fitting.
ALL KINDS OF
Electric Light Material.
WARWICK WORKS, COVENTRY ROAD, BIRMINGHAM.
90, CHARING CROSS ROAD, LONDON, W.C.

adopted, there would be a sum to carry forward of £15,177, against £10,255, or nearly £5,000 more than last year.

A shareholder asked how much it would be necessary for the directors to have in hand before they paid a further dividend to the Preference shareholders.

The Chairman replied that the directors thought that, in the present bad state of trade, it would not be advisable to pay any larger amount than the 7%. They considered it better to keep this money in hand against any contingencies that might arise. There was no reason why, if trade did not become worse, a dividend should not be paid between now and next year.

The report was adopted.

CAPE ELECTRIC TRAMWAYS.

The report of the Cape Electric Tramways Co. for the year ended June 30 last states that after meeting the service of the Debenture issues, there remains a loss of £2,400, reducing the credit balance of £8,300 brought forward to £5,900. The directors state that the net earnings of the Cape Town system show an increase as compared with the preceding year, but the Port Elizabeth tramway has suffered severely from the overflow of the Baakens River in November last, which did damage to the rolling stock and power station to the extent of £6,000, of which only £1,300 has so far been allowed for, the balance remaining to be charged against future profits.

A TELEGRAPH COMPANY.

The report of the Eastern Extension, Australasia and China Telegraph Co. states that for the half-year ended June 30 the gross receipts amounted to £290,931, and the net balance to £133,954. From this is deducted £3,068 for income-tax payable in England, and £15,048 for debenture interest. Adding £18,006 brought forward, there is an available balance of £133,844. Two quarterly interim dividends of 1½% each, amounting to £75,000, have been paid, leaving £58,844 to be carried forward.

COMPANIES REGISTERED.

FRANCO-BRITISH ELECTRICAL CO., LTD.—Registered October 12. Capital, £1,500 in £1 shares. Objects: To acquire the business carried on at 99A, Charing Cross-road, W.C., as the Franco-British Electrical Co., and to carry on the business of gas, electrical, and general engineers, etc. Private company. Table "A" mainly applies.

HOWE ELECTRICAL ENGINEERING CO.—October 22, by Jordan and Sons, Ltd., 116-117, Chancery-lane, W.C. £5,000 (£1). To take over the business carried on at Liverpool and Blackburn as the Howe Electrical Engineering Co. Private. Mersey Railway-buildings, 18, James-street, Liverpool. (105,542.)

CONTRACTS OPEN.

HOME.

DUBLIN.—United Tramways Co., Ltd.—Tenders for supply of general stores for the year ending, December 31, 1910. By November 29.

OVERSEAS.

HOBART (Tasmania).—Postmaster-General.—Telegraph and telephone material, etc. Part. as above. December 20.

LUCKNOW.—Municipal Board.—Tenders invited for a concession for the supply of electric energy, coal or oil gas, for house and street lighting, and other domestic or manufacturing purposes. December 31.

MADRID (Spain).—Direccion-General de Obras, Publicas Madrid.—For a 60 years' concession for construction and working of an electric tramway from Sans to Coll-Blanch (Barcelona). November 20.

MELBOURNE.—Deputy Postmaster-General.—Two sets of accumulators. By 3 p.m., November 23.—Postmaster-General.—To supply coin attachments (for coins of different values) for telephones. Spec. No. 184. 370 50 c.p. metallic filament lamps, with bayonet cap fittings, for 110 volts A.C.; 630 25 c.p. ditto; 160 16 c.p. Linolite carbon filament lamps, 110 volts A.C.; 1,000 16 c.p. T.H. screw socket carbon filament lamps, 110 volts A. C.; and 100 32 c.p. metallic filament lamps, with bayonet cap fittings, 200 volts A.C. December 7.

MELBOURNE.—Railway Commissioners.—One single-phase turbo alternator, etc. December 17.

PARIS.—Algiers Post and Telegraph Department.—Copper wire, galvanized wire, insulators, brackets, etc. November 9.

SYDNEY.—Postmaster-General.—Switchboard apparatus for subscribers' premises. Particulars of all Australian contracts, 72, Victoria-street, Westminster, S.W. January 10, 1910.

TURKEY.—Broussa Municipality.—For a concession for the installation of electric light and power, and for the construction of an electric tramway. December 13.

POST OFFICE AND ELECTRIC RAILWAY.

Owing to an objection taken by the Post Office Telegraph Department, the opening of the electrified South London line of the London, Brighton, and South Coast Railway has been postponed. The line had been passed by the Board of Trade. The Company proposes to work the railway on the single-phase overhead contact system, at a high voltage. To the proximity of the overhead wires to the telegraph wires between Denmark-hill and London-bridge the postal officials have taken exception. They complain that the presence of the high-tension wires will disturb their own circuits, and in certain instances involve risks to workmen engaged in repairs. By altering some of the posts and improving insulation, the Company hope to overcome the objections, and tentatively the opening of the line has been fixed for December 1.

A branch of the Midland Railway which is worked on the single-phase principle between Morecambe and Heysham came under the same ban, and proceedings were commenced against the Company, but postponed pending the installation by the Post Office of a short telephone circuit. The Post Office has way-leaves in perpetuity over the railway systems of England, and it is on account of the overhead wires erected in pursuance of these way-leaves that the Post Office, in order to defend its rights, has taken action.

CABLE SHOPS BURNT OUT.

A fire broke out at Victoria-road, Charlton, S.E., on the premises of Messrs. Johnson & Phillips, electrical engineers, and resulted in the practical destruction of a block of buildings used as compound cable shops. Nine steamers and 80 firemen were engaged in extinguishing the fire.

LONDON.—A scheme for the establishment of conciliation boards for the settlement of questions affecting the employees of the Tramways Department has been prepared by the Highways Committee of the London County Council.

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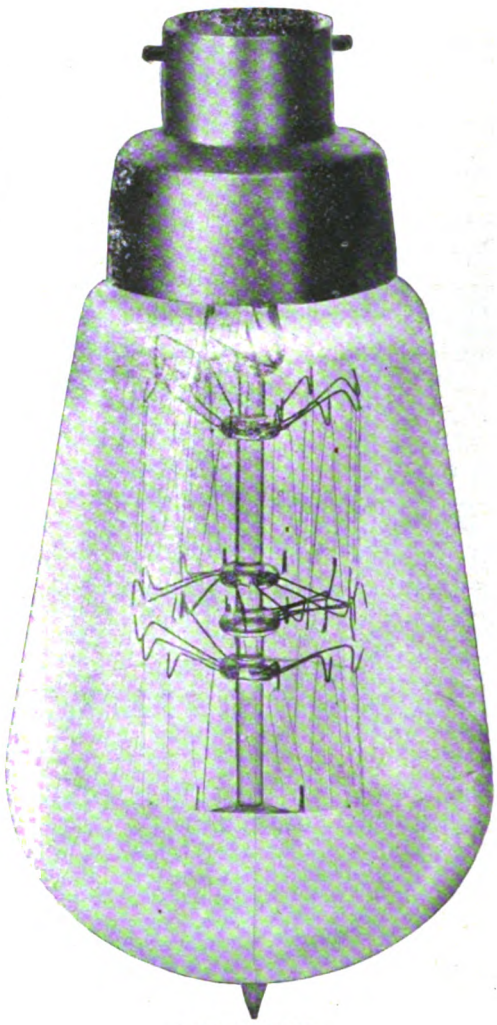
"TANTALUM" LAMPS.

200-240 VOLTS

For Single Burning.



(FULL SIZE.)

25-32 and 50 C.P.

***For Direct Current only.**

SPHERICAL LAMP 3/9 EACH.

BELL-SHAPED LAMP 3/6 EACH.

THE STRONGEST HIGH VOLTAGE METAL FILAMENT LAMP.

Siemens Brothers Dynamo Works Limited,

Head Office:—Caxton House, Westminster, S.W.

Lamp & Fittings Dept.:—Tyssen Street, Dalston, N.E.

Telephone: 8388/9 Central. *Telegrams: "Siemodyn, London."*

BRANCHES:—

LONDON.	BRISTOL.	MADRAS.	MELBOURNE.
MANCHESTER.	CARDIFF.	CAWNPORE.	SYDNEY.
BIRMINGHAM.	GLASGOW.	RANGOON.	CAPE TOWN.
NEWCASTLE.	CALCUTTA.	SINGAPORE.	JOHANNESBURG.
SHEFFIELD.	BOMBAY.	PENANG.	

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POPULARISING ELECTRIC LIGHTING.

THE METAL FILAMENT AND THE NEW CONSUMER.

Since the introduction of the metal filament lamp, and especially during that controversial period when the great saving of current threatened to bring about a proportionate increase in the rates charged to consumers, the ELECTRICAL ENGINEER has consistently maintained the contention that the increased efficiency which was regarded as so grave a menace by many central station managers would soon prove to be an enormously potent factor in increasing central station revenue. The metal filament lamp has advanced so rapidly in public favour, and its many advantages in point alike of economy, high efficiency, and stability have become so widely recognised, that it would be superfluous to reiterate that contention were it not for the fact that even during the past fortnight a provincial electric light undertaking of not inconsiderable importance has felt itself impelled to adopt the short-sighted policy of raising its rates per unit in order to compensate for the decreased consumption of current under the new conditions.

Happily for the consumer as well as for the metal filament lamp manufacturer, and, in the sequel, the central stations themselves, this policy is not a general one. Though the metal filament is still, to all intents and purposes, a new development, it has already been instrumental in extending the use of electricity to those who had hitherto looked upon electric light as the luxury of the few, rather than the necessity of the many; and the number of new users is increasing every day. As its advantages become more and more widely insisted upon, so will the field of use extend; and the wise central station manager is he who gives these advantages the greatest publicity. Most people are familiar by now with the Tantalum poster, in which a delighted householder, radiant under the beams of a metal filament lamp, is exclaiming: "My electric light bill halved!" As a matter of fact, the gain to the consumer is even greater than the poster indicates, for the actual saving in current effected by the Tantalum, Ediswan, Osram, Efesca, Metalik, Boddy's and other metal filament lamps is nearer two-thirds than half, a fact which the gas-user (whether electricity was as admitting or denying that under the old conditions cheap as gas) is everywhere taking into very serious consideration.

An excellent example of the progressive policy advocated by the ELECTRICAL ENGINEER is afforded by the annual report of the Electricity Department of the Willesden Urban District Council, which has just been issued over the signatures of Mr. B. A. Griffin, Chairman of the Electricity Committee; Mr. J. G. Bruce, Electrical Engineer; and Mr. Stanley W. Ball, Clerk to the Council. The Department has been keen to recognise the potentialities of the new era of lighting, and has adopted towards the consumer a very frank and sensible attitude. The annual report of the undertaking instances the fact that one of the Council's Institutes, by adopting metal filament lamps, has not only increased materially the illumination of its rooms, but has reduced the cost of electric lighting from £70 11s. to £33 15s. for the year. The report also sets out in tabular form a statement showing the reduction which consumers are able to effect by the same means:—

Type of Lamp.	Candle-power.	Consumption in watts.	Number of hours burning per unit.
Carbon filament ..	16	64	15½
Ditto	8	32	31
Metal-filament (Tantalum)	25	43	23
Ditto (Osram) ..	30	40	25

Here is a very striking object-lesson for those country municipalities which recently put up their prices in a panic as soon as consumption temporarily fell off.

The report goes on to point out that in some towns the new lamp has been adopted so generally that the accounts of the past twelve months' working show a very heavy decrease in revenue, but in Willesden "the revenue obtained from new consumers during the year more than counterbalances the reduction in revenue received from the older consumers, and there is no doubt that the cheapening of electric lighting brought about by these lamps will eventually bring a great many new consumers to the undertaking."

The accounts show an increase in the electricity sold during 1908 and 1909 amounting to 785,192 units, of which total 284,996 units are under the head of domestic and shop lighting. It has not yet been practicable accurately to apportion the part which the metal filament lamp has played in thus increasing the load, but the fact that the increased sales synchronise with the popularisation of the new filament, taken in conjunction with similar experiences elsewhere, may be regarded as fairly conclusive evidence as to the source of the augmented demand. From other sources we learn that there has been a very material increase in the number of small consumers. It is not surprising to learn that in one extensive section of this large district where ratable values run from £65 to £250 and upwards per annum, there is scarcely a single residence without electric light; but it is a very encouraging indication of progress to find that many very small shopkeepers have risen to the occasion and abandoned gas, to their great advantage, and that householders rated down to £25 per annum are also coming into line.

The essence of the whole matter is that the metal filament lamp has so cheapened the cost of illumination as compared with gas, with its ceiling-blackening and fabric-destroying properties, its dangerous fumes, and its perpetual risks in the way of fires and explosions, that the time is not far distant when electric lighting will be as general with the clerk and the artisan as it has already become with the middle and upper strata of the community.

ELECTRICAL POWER FOR LIGHT AND TRAMWAYS.*

By W. M. ROGERSON, M.I.E.E.

At a time like this perhaps it is useful and even instructive to look back to the early days of a great industry, and to compare those early days with the present. However, in this paper I intend to confine myself to a short retrospect of those two branches with which I have been and am most intimately connected, or which in the end are really one branch, namely the supply of electrical energy for lighting power and tramways.

Ten years ago 93 municipalities had established Electric generating stations, having a total capital of £5,734,938, while some 70 companies were also undertakers with a total capital of £5,261,763. At the end of 1908, which is the latest date up to which the returns are available, there were 541 undertakings, 338 of which belong to local authorities and 203 to companies or private individuals, the total capital involved being £40,016,300 and £40,722,000 respectively. It will be seen, therefore, that the capital laid out both by private companies and local authorities has increased in about equal proportion. The total lamps connected, equivalent to 8 c.p., ten years ago, were 4,106,727 which have now increased to 35,056,700, while the output in Board of Trade units sold both by companies and municipalities has increased in ten years from 60,125,500 to no less than 749,594,200.

No doubt the large increase in output is greatly due to the decrease in the cost of producing electrical energy, and consequently the lower rate per unit at which it can be sold. I find that taking six typical generating stations, the average cost per unit sold in pence, in 1898, was as follows:—Coal, ·46; oil waste, wages, repairs, etc., ·70; works' costs, 1·16; total costs, exclusive of interest and sinking fund, 1·85; while the average costs in the same generating stations to-day are as follows:—Coal, ·26; oil waste, repairs, etc., ·30; works costs, ·56; total costs, exclusive of interest and sinking fund, ·78; or roughly, each B.O.T. unit sold in 1898 cost over 1¾d. to produce, while to-day the cost has come down to almost ¾d.

There are, of course, many things which account for the great reduction in the cost, the largest contributor being no doubt the advent of electric supply for power and tramway purposes, thus providing a day load for the plant laid down, and also spreading the works standing charges as well as the interest and sinking fund charges in the case of municipalities over a larger number of units, in other words the load factor of a generating station used for lighting only has increased from about 13% to 20%

* President's Inaugural Address before the Institution of Electrical Engineers (Leeds Local Section), Oct. 27.

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and in some cases 30%, when combined with electric power and tramways.

Systems of supply have not materially altered, both continuous current and single-phase alternating being still existent, continuous current being perhaps more successful than single-phase alternating, in that a direct supply can be given both for lighting and tramway purposes from the same plant in the station.

Two and three-phase alternating current systems have, however, been evolved, and as by these systems supplies can be given at high pressures for power work, will no doubt be universally adopted when new plant is installed, and more especially where large areas are to be covered.

Coming now down to the details of which make up a supply station it is interesting to trace a few of the developments that have taken place. One remembers the early controversy as to whether single-phase alternating or direct current supply was the correct system to adopt, and bitter was the war of words over the subject. I do not intend going into the matter now, only to say that, had we been able to forsee the advent of electric traction and also the possibilities of supply for power purposes, there can be no doubt that the single-phase alternating current system, would never have been adopted; and again, no doubt, we all wish that three-phase alternating current had been available at an earlier date when perhaps continuous current would have stood a poor chance.

In the early days the Lancashire Boiler was almost universally adopted, though the water tube boiler of the Babcock and Wilcox type was second favourite with other forms of more or less freak boilers. These latter types have long ago been relegated to the dust or scrap heap, and to-day the Lancashire and Water-tube Boilers still hold the sway, with perhaps the Water-tube as favourite; troubles predicted for the latter in early days such as burst tubes, leaky joints, have not been verified, and contrary to prophecy it may now be taken that the useful life of a Water-tube Boiler will be far greater than the Lancashire or similar type under given conditions. There has been very little increase in the efficiency of boilers pure and simple, though the addition of superheat, together with the simplification of systems of steam mains instead of the complicated systems of ring mains, which were designed to guard against all breakdowns possible and impossible by a multitude of steam valves guaranteed to leak or stick when most required, together with greater care and knowledge in the use of coal and methods of firing have advanced the efficiency of the boiler house considerably.

The universal use of steel type of construction has naturally resulted in the boilers manufactured at the present time being far superior in construction to those made 10 or 12 years ago.

As far as the boiler house is concerned, probably the most notable fact is the lower and cheaper qualities of bituminous coal that are now being burnt, and this is attributable to the great success of mechanical stokers. With hand firing it is not practical to have a longer length of grate than 7 ft., but with mechanical arrangements grates can be made as long as 10 ft. and even 14 ft., so that with low grade and dirty fuel the evaporation possible with a high grade fuel can still be maintained.

Much more attention is also given to the critical study of the commercial value of coal by the carrying out of careful boiler tests, a common basis being the cost of evaporating 1,000 lbs. of water from, and at 212 degrees Fahrenheit, or the number of pounds of water evaporated from and at 212 degrees Fahrenheit per penny of cost. Some coals may contain such an amount of sulphur that the mushrooming considerably affects the efficiency of combustion by leaving passages through which the air can pass and by preventing the proper amount of air passing through the bulk of the fuel itself.

The use of an instrument for measuring and automatically recording the water discharged from the air pumps also tends to economy, knowing the quantity used in the main engines, and also the quantity fed into the boilers, one is able to appreciate the losses due to radiation, insufficient auxiliary plant, and so forth, which is many times in excess of that amount Engineers often base on, there is no doubt that money spent in keeping lagging, brickwork setting, and similar items, in first class condition is very soon repaid. The more general adoption of coal and ash handling facilities has also materially conduced to the reduction of costs in the boiler house.

First came the controversy, especially in Lancashire and Yorkshire, as to the use of prime movers of slow speed horizontal or vertical steam engine as against the high speed enclosed or semi-enclosed type.

Who does not remember the arguments used against the latter type, which would knock themselves to pieces in a day, wear out in a few months, or be on the scrap heap under a year.

A large number of stations adopting the high tension alternating current system also adopted the slow speed engine, with rope drive; while generally the low tension continuous current station adopted the high speed engine, direct coupled to the generator, the reason for this was no doubt that in those days it was somewhat difficult to run alternators in parallel while continuous current sets could easily be so run, and perhaps especially in the north the affection of the local mill-owner for an engine which he knew something about, and which with pride he could admire turning round, as against an engine which, while it certainly turned round, nobody could see or explain to his satisfaction what went on inside.

With the extension of demand came the need of larger units, 100 kw. being looked upon as quite a large machine in the early days. Horizontal slow speed sets took up much valuable room, hence the high speed vertical type came more and more into prominence, as well as an added demand for the slow speed vertical type.

However, in 1884, the Hon. C. A. Parsons brought out his first steam turbine, which machine can now be seen in South Kensington Museum, and by 1888 an aggregate of 4,000 h.p., of turbines was at work up to 120 h.p., though none of them condensing. One of the earliest installations of steam turbines was that in the Manchester-square station of the Metropolitan Electric Supply Co., of London, about the year 1894, these turbines were run non-condensing. Since that time the size of turbine has gradually increased, until units of 5,000 kw. are quite common, while steam consumption has been gradually reduced, until the steam turbine seems likely to outrival all forms of prime mover for central station work where large units are required, and adequate condensing water is obtainable, while even in small stations the recent advent of the exhaust turbine, used in conjunction with the existing plant, may tend to bring down working costs and so promote efficiency.

The gas and oil engine may, however, prove great rivals in the field, until that which all are seeking arrives, the gas turbine.

It is interesting to note that two Parsons' turbines, supplied to the works with which I am connected, ten yeart ago, when tested gave 28·9 lbs. of steam per kilowatt. at full load, while a modern machine would take about 25 lbs. per kilowatt under similar conditions. While a large turbine of 6,000 kilowatts capacity may even come down to about 14·5 lbs. of steam per kilowatt under good conditions.

Little advance has been made in the efficiency of the generating plant, and indeed there was little to expect with an existing efficiency of some 90 to 93%, large units have of course been constructed, and the form of generator modified to keep in touch with its prime mover.

Progress in the method of construction and improved quality of material have of course added to the efficiency of modern machines. In high speed machines the use of stalloy iron may increase the efficiency by 1 to 2%, the use of ball bearings is also another improvement especially for increasing the efficiency of light loads. The use of interpoles on direct current machines is beneficial from the efficiency point of view, the losses in the commutator can be much reduced by the use of interpoles, though the losses in the interpoles themselves have to be remembered, and as the air gap can be much smaller than in machines without interpoles, hence smaller field losses.

In transformer construction the use of stalloy iron has reduced the no load losses by 40 to 50% without increasing the prime cost of the apparatus.

Vast improvements have been made in switchgear the

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work being now more substantial necessarily owing to the use of heavy currents and higher voltages.

Considerable economies have been effected both by the use of simple devices and arrangements for the meeting of given service conditions, and also by the simplification of constructional details in individual pieces of apparatus.

The cost of oil switches and circuit breakers for most services has decreased without the loss of efficiency. An instance might be mentioned of the modern traction feeder circuit breaker, consisting of only a copper brush carrying an auxiliary metal and carbon contract, and pressed home on to two plain copper blocks by means of a simple toggle joint and handle. Compare this with the old arrangement of magnetic blow out breaker, or an early design of carbon circuit breaker for the same service.

Another instance for the protection of a high tension feeder circuit, where direct acting trip coils excited off the instrument current transformers and given protection against overloads, with a time characteristic and discrimination against faults to earth, without the use of relays, dashpots, clockwork, auxiliary supply circuits and batteries, auxiliary trip coils to work with same, together with current transformers, which would have been supplied for the same service a few years ago.

Slate is commonly used now where it was once thought necessary to use marble with insulating bushes, and the recent reduction in the cost of aluminium is bringing this material into use in place of copper, now that satisfactory methods of working it have been evolved.

The enlightened application of electrical storage to the needs of a power station, whether direct or alternating current be generated is proving another fruitful source of saving in operating costs. While of course a load which can be economically dealt with by a generator should never be thrown on storage yet there are in every generating station fitful and fluctuating demands that are unremunerative if supplied direct, in which case storage becomes a real boon, and properly proportioned as to capacity, may be made to contribute to revenue, so that the capital expenditure on the battery equipment, plus interest upkeep, etc., are entirely redeemed in the course of a few years.

No great changes in the construction of accumulators have to be chronicled, yet present day cells of reputed makers are in numerous respects an important advance due to careful development and improved methods of mounting.

Negative plates of the "box type," in which the active material is no longer expected to be partly self supporting, retain their porosity and capacity much longer than the plate form.

By thorough screening of plates of opposite polarity by porous diaphragms, the tendency to buckling has been lessened, and there is no need to prospect for likely "shorts" with a battery stick between electrodes, thus disturbing the active surface; again, the avoidance of internal structures as far as possible (plates being now almost universally suspended in tension, instead of resting on bottom blocks) taken together with a liberal clearance for sediment, puts off by years the need of cleaning out operations, and thus tends to increase the useful life of cells. Of course, weight should be the determinating factor in the purchase of a battery, other things being equal, *prima facie*, the more lead there is in the plates to begin with, the greater the life and the residual value at the end.

The revenue earning capacities of a battery on the old time method of floating batteries with cell regulators, charging batteries for hours and then allowing them to stand charged, inactive, waiting to be discharged, is not the most profitable way of using storage, and its real potentialities can only be brought out by the automatic reversible booster. With modern practice, a quick-acting sensitive reversible booster controls the battery, and compels it to contribute its fair share of the work during the entire 24 hours of the day, and thus enables the boilers, engines, and generators to be operated throughout at the point of highest efficiency. Efficient control, in fact, is the crux of Storage Battery Engineering, as in this, far more than in the battery itself, depends the success or otherwise.

Another form of remunerative utilisation of electric storage I can forsee, in the supply of current for lighting purposes and power, in districts served by electric tramways, but to which mains have not yet been extended. Of course, voltage variation at the nearest feeding point would cause the supply to be defective, if taken direct apart from interruptions, which are bound to occur from time to time; but the employment of a battery, together with a suitable booster and motor generator, would solve the problem satisfactorily, a relatively small battery sufficient to watch over the local circuit, when the breakers come out on traction, and after tramway service hours would suffice. There is, I think, much scope for the development of this class of supply, in the interests of undertakings owning combined stations.

Vulcanised rubber was largely used as an insulating material in early days, while pot drain pipes and cast iron conduits were used for drawing into. Rubber insulation has, however, proved unsatisfactory, and to a large extent vulcanised bitumen and lead-sheathed paper cables have taken its place, either drawn into earthenware or iron conduits, or laid solid in pitch or bitumen in wood or iron troughs; the question of joint boxes and disconnecting pillars has also received consideration. Also the type of cable has to a large extent been changed, triple concentric and three-core taking the place of three singles, so diminishing the cost of the necessary protection, and minimising the chance of electrolysis. The fear of electrolytic action in connection with lead covered cables has died out, as is evident by their almost universal use.

Another consideration has been the very greatly diminished cost of service connections, though there is no doubt room for great improvements in this direction still.

Meters will now start on a smaller current, are accurate on much smaller loads and give a straight curve up to full load and also with considerable overload; starting current is indeed of great importance with the introduction of the new metallic filament lamps.

The introduction of this lamp has been the most remarkable event of late years, when it is considered that at least three times the light can be obtained with the same energy, its advent has been and will be severely felt by supply authorities, and although in time losses will be made good, yet it has to be remembered that additional capital will have to be laid down in the shape of service connections to obtain the same revenue, so that it is imperative that energy in another form, as for heating and cooking, will have to be used, if we are to maintain our revenue from the private consumer.

In 1898 only some 40 electric tramways were in existence, with a capital of approximately £24,000,000, while from the latest returns there are at present 305 undertakings in the United Kingdom, with a capital of £68,199,918, the gross receipts being £12,439,625, while the total number of passengers carried per annum amount to the large total of 2,625,532,895.

It is greatly to be regretted that such a headlong rush was made in the construction of electric tramways, as they have, in the case of smaller undertakings, proved to a large extent a failure from a financial point of view. This is no doubt due to the fact that the fares charged have been fixed far too low, that is, if the undertakings are to pay their way and not be a burden on the ratepayers, and that the enormous cost of upkeep was not thoroughly understood, more especially in the case of the track. It has also to be remembered that conditions of labour have been vastly improved, and the rates of pay raised and wages increased, so that there can be no doubt that in the case of a large number of the smaller undertakings the fares charged are inadequate.

The principal improvements which have taken place in tramway apparatus during the last few years refer to mechanical detail and workmanship, and have resulted in increased reliability, freedom from breakdown, and improved facilities for inspection and repair. Motors, instead of having cast iron fields, have the fields now of steel; workmanship has been greatly improved, and motor parts are now made interchangeable.

Grease lubrication was originally used entirely, and is still used to a certain extent, but the tendency is towards oil lubrication entirely, and excellent results are now being obtained.

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Other improvements have been made, such as rigidly fixing the brush holders, better hanging of the motors, while the housings for the armature bearings are now fixed to the top half of the motor, thus permitting the lower half to be dropped, the armature remaining suspended in the upper half.

The general tendency has been to protect the armature winding at the ends to a greater and greater extent, thus ventilation of the rear and back end of the motor has been largely done away with, as it was found that the disadvantages resulting from the very slight increase of temperature, was much more than counterbalanced by the fact that the winding was kept free from dirt.

The use of laminated poles in place of cast iron poles has enabled the pole spacing to be made more accurately, with consequent improvement of commutation, and with motors of large size, commutating poles are now coming into extensive use: but with smaller motors, where the commutating conditions are naturally good, and where there is little trouble from flash overs, it is questionable whether the addition of commutating poles, with their extra cost and complication, is warranted. Insulation, where possible, is treated before placing into position, and complete armatures are further impregnated in vacuum. With controllers, the introduction of mica in the construction of the drums to replace sulphur compositions is an advance, as is also the method of providing fingers with renewable tips, cutting down the cost in this direction very considerably, the number of moving parts in the interlocking mechanism between the main reverse and brake valves has been considerably reduced, thus making the controller simpler and more reliable in its action. Magnetic blow-outs have also been considerably improved, and an interlocking device has been devised, making it impossible to supply power to the motors from the driving end of the car, with the controller on the rear end not being in its correct off position. Thus the up-to-date controller consists of a small number of complete standardised sections, so assisting greatly in its prompt repair, with lessened cost of upkeep.

Power resistances are now almost invariably made of cast grids, which are cheap, reliable, and easily renewable and adjustable to suit the requirements of traffic, gradients, etc.; these also replace the earlier form of spiral resistances of steel, or German silver strips wound in cells.

Resistances are now often placed on the platforms of the cars instead of underneath, and are thus free from snow, wet, and other weather troubles.

A very important improvement has been made in the method of car wiring with multicore cables. In the earlier cars, the wiring was usually carried out in a very lax manner, resulting in no end of trouble in a very short time.

In conclusion, I do not intend to speculate on the future. There will still be trouble to face and worlds to conquer ten years hence, and we shall still have to put in our best energies to the work in hand.

ELECTRICAL APPLIANCES FOR MOTOR CARS.

At the Motor Exhibition at Olympia, which opens on November 12, the section devoted to accessories should prove a most attractive feature, judging from the high quality, novelty, and variety of the exhibits. The whole of the large gallery (with the exception of one side where the tyre section will be staged) will be filled with exhibits of electrical appliances for motor cars, speed indicators, etc.

Of the numerous accessories in connection with motor cars, perhaps the most important is the electric ignition. Every type will be found not only on the various machines exhibited in the main hall, but also on the makers' stands exhibited in the gallery. The Simms Magneto Co. (British) will display working models of their latest and most improved types of magnetos both high and low tension suitable for motor cars, marine and aerial engines. The Electric Ingition Co. will exhibit improvements in coils, contact breakers, sparking plugs, switches, distributors, and accumulators, their chief novelty being the new Hall E.I.C. dual ignition system. Peto & Radford have an entirely new system of electric lighting for motor cars, by means of which the various side lamps, head-lamps, etc., can be immediately removed for cleaning, and many of the mechanical faults peculiar to motor car wiring are removed. The well-known Oleo sparking plugs, terminals, igniters, and tappet plates, and the R.I.P. soldering outfit will be exhibited by Ripault & Co. C. A. Vandervell & Co. will show the now famous C.A.V. system of electric lighting by variable speed dynamo, and its demonstration in a thoroughly practical manner, for the first time in any exhibition, should interest every car owner. This firm will also exhibit a full range of electrical accessories. The well-known E.K. motor ignition cables in great variety will be on the stand of E. Kalker & Co., of Coventry. Thomson Bennett, Ltd., will display their self-contained magneto with patent gear attachment between the drive and the magneto. By means of this, the armature can be moved for retard and advance, keeping the maximum position at all points. It is adapted for starting on the switch without an accumulator. The Lodge Patent system of ignition, the invention of Sir Oliver Lodge, will be on stand 234. An interesting novelty on this stand will be the special Lodge ingitor for aeroplanes. The Bosch Magneto Co. will have a novelty in a magneto capable of giving sparks at the rate of 12,000 a minute. They are also showing specially light British-made magnetos for all-British aeroplanes. H. M. Hobson will display Hobson Pognon plugs of all types. They are also exhibiting Jenatzy tyres, Jenatzy twin wheels and attachable rims. The High Tension Co., besides an exhibit of magnetos and accumulators, will show the Mira electric horn, which is put forward as the most powerful motor horn in the world. It is worked by a small motor which rotates a fly wheel, having on its circumference two small steel strikers, which tap against a steel diaphragm at the end of the horn bell. A powerful penetrating note is produced, carrying at least half-a-mile. The current consumed is small, and the apparatus will work at either 4, 6, or 8 volts. Lithanode accumulators will be shown by Longstreth's, Ltd., on stand 178, and Messrs. Fuller & Sons will have working models of their dual ignition with switch starter. United Motor Industries will have their usual comprehensive display of electrical and other appliances on stand 162, including La Magicienne dynamo for lighting motor cars. A new speed alarm to indicate when a car is exceeding the speed limit, together with many other accessories, will be shown by G. Davenport & Co., on stand 186.

A great variety of speed indicators will be exhibited, amongst them those manufactured by the Stewart & Clark Manufacturing Co., S. Smith & Sons, Ltd., and the Cowey Engineering Co., Ltd. Mestre & Blatge will also have a large assortment of these useful articles.

Accessories too numerous to classify will be found in profusion in the gallery. Mr. Edward J. Hardy will show a new type Longuemare carburetter and electric lamps; and the Electric & Ordnance Accessories Co., coned roller bearings and Warner's speedometer.

The Electric Vehicle Co., Ltd., will exhibit at stand 101 an electric touring car, with weatherproof Victoria body, to seat two persons in front, and collapsible dickey seat at back, fitted with 195 ampere hours capacity battery of 40 cells and capable of a speed up to 30 miles an hour, and of covering 80 to 100 miles on one charge. They will also show a Park Victoriette, with driver's seat, 105 ampere hours capacity battery, 40 miles on one charge; a Victoria runabout, to seat two persons, 105 ampere hours capacity battery, 40 to 50 miles on one charge; and an electric runabout, with enclosed cab body, 105 ampere hours capacity battery, 40 to 50 miles on one charge.

ELECTRICAL CONTRACTOR'S FAILURE.

At the Coventry Bankruptcy Court, Herbert John Burdett, electrical engineer and contractor, late of Regent-street, Rugby, and Earl-street, Coventry, attended for his examination. Debtor stated that he began business on his own account in the early part of 1902 at Rugby. He had about £150 capital to start with; this was money he had saved. About six months previous to filing his petition, by estimating the stock at the purchase price, he considered he was quite solvent. At that time his stock came out at about £400. Asked how he explained his deficiency of £815, debtor said he estimated his stock, bought at £400, would be worth at break-up price, £120. He had had very severe competition, and undoubtedly on a number of his contracts lately he had had hard work to make ends meet. He had been pressed a great deal before he filed his petition, and about fifteen summonses had been served on him. He had had a certain number of loans for the purposes of the business. He borrowed from Mr. Blakemore £400. This was at the time the business was growing and he moved into Regent-street. That money was banked and put in the business. He did not file his petition when he first knew he was insolvent because he had hopes of pulling the business round, and with that object in view he cut down his expenses. He attributed his failure to bad trade, competition, and illness.

Replying to Mr. Albert Cripwell, of Birmingham (trustee), debtor said he had not taken contracts under cost price, but at a very small margin of profit, competition having recently become very keen, both in Coventry and Rugby. He filed his petition a few days—not more than a week—after he had been advised to do so.

The examination was adjourned for debtor to file a cash account.

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ELECTRICAL PROGRESS AT HOME & ABROAD

FROM OUR SPECIAL CORRESPONDENTS.

TYNESIDE NOTES.

NEWCASTLE.

Indications as regards the prospect of increased electrical work in this area are distinctly encouraging at the present time, as reports on all hands seem to show that enquiries are being more freely circulated, and in many cases work has been actually placed on order. For example, the Hartlepool Paper and Pulp Works have decided to go in for the electrification of their premises by means of a self-contained system of electricity supply. Orders are being placed for an electric generator and prime mover, and the system is to include, not only a considerable number of motors and the necessary switchgear and wiring, but also the lighting of the premises. A rubber manufacturing firm is to locate itself at Blyth, in Northumberland, and there is a prospect of a considerable amount of electrical installation work in connection with this scheme. The electrical equipment of the Skinniggrove Iron Works is now approaching completion, this having involved some very large motors, of which details are not at present available; while a rumour, which has from time to time been current, has been revived to the effect that the North-Eastern Railway Co. is contemplating the electrification of the southern portion of their local service, which runs from their Newcastle Central Station to South Shields. If this information is correct, there should be considerable activity on Tyneside among electrical engineers and contractors.

County of Durham Education.

An interesting equipment which has just been completed by Messrs. Thos. G. Usher & Co., electrical engineers, of Newcastle-upon-Tyne, is the electrical work in connection with the large new Council School, which has just been opened at Blaydon. The architect, Mr. L. Morson, sub-let the electric lighting work separately to Messrs. Usher & Co., and the current is supplied from the mains of the County of Durham Electrical Power Distribution Co., Ltd. A peculiar feature of the system is that the lighting is carried out on the low-tension three-phase system, one phase being carried to each of the three schools. There are 58 lamps installed in the infants' department, 57 in the boys and 37 in the girls' section. The class rooms, central hall, and outside lighting are fitted with 50 candle-power metal filament lamps, while the corridors, stores and heating chambers are lighted by means of the older type carbon filament lamps. The wiring is mostly run on the surface in casing, while, in a few places, it has been found necessary to use close joint steel tubing above the ceilings. In each class room there are two lamps fixed, while the central hall is lighted by means of six. The whole installation provides an interesting example of electrical lighting work adapted to the requirements of the Durham County Council Education Committee.

Mining Electrical Engineers.

A general meeting of the Institution of Mining Electrical Engineers, local section, was held at the Armstrong College in order to hear a report of progress and to elect two new members of the local committee. This was rendered necessary by the removal of two of the original committeemen to South Africa and Derby. In the absence of Mr. J. Kirkup, President of the local section, Dr. Thornton, of Armstrong College, took the chair. Mr. McKie, of Ashington Colliery, and Mr. W. C. Mountain, of Messrs. Ernest Scott & Mountain, Ltd. were unanimously elected to the vacant positions. The remainder of the time was occupied by discussing communications from Mr. Maurice, the President of the Institution, regarding propaganda work in connection with this enterprise. The chief point upon which stress was laid was that an effort should be made to obtain the support and membership of colliery engineers and managers, together with deputies and mining students. It was also determined, with reference to the Home Office enquiry regarding mines regulations, to endeavour to obtain a mass of information from those who were actually in touch with the working conditions in mines. The question of the location of the inaugural meeting was discussed. The sense of the meeting was unanimously in favour of its being held at Newcastle. In reference to the Home Office enquiry, Mr. W. C. Mountain had some interesting suggestions to make as to the lines upon which information should be collated, and the draft articles and constitution of the Institution were taken as read and approved.

Electricity in Mines.

While upon the subject of the Home Office enquiry, considerable satisfaction has been aroused by the fact that of the three gentlemen who have been appointed to the Departmental Committee to enquire into the work of the existing special rules, and to consider what, if any, amendments are required, two are, or have been, local gentlemen. Mr. Charles H. Merz is, of course, well-known as the consulting engineer of the Newcastle-upon-Tyne Electric Supply Co., Ltd., and its affiliated companies, the County of Durham Electrical Power Supply Co., Ltd., the County of Durham Electrical Power Distribution Co., Ltd., and the waste heat enterprise. He is also in close touch with the Cleveland and Durham Electrical Power, Ltd. In addition, Mr. Robert Nelson, who is now His Majesty's Inspector of Mines, was at one time connected with the consulting firm of Messrs. Merz & McLellan, whose Newcastle offices are in Collingwood-street. Confidence is, therefore, felt in this area that whatever suggestions are made as to amendment of the rules, they will be due largely to experience derived from mining operations in Northumberland and Durham, and will, therefore, give the best opportunity for electrical manufacturers being thoroughly equitably treated.

MIDLAND NOTES.

BIRMINGHAM.

The South Staffordshire, Warwickshire and Worcestershire branch of the National Association of Colliery Managers, of which Mr. Arthur Hall is President, paid a visit to the works of the Electric Construction Co., Ltd., Bushbury, Wolverhampton. Over twenty members attended, and were conducted round the works by Mr. W. Bulloch, the Manager, and Mr. W. R. Furniss (Engineer). The building occupy 6 of the 28 acres owned by the company. The works are of an elaborate character, and some of the equipment is exceptionally large. There is an employing capacity of 1,300 men, although at present only about 800 are at work. The largest shop is 200 ft. by 80 ft., and the 32 ft. boring mill is believed to be the largest in the kingdom. These mills were engaged upon heavy work, and the planing machine is also of exceptional size. Several generators of 750 kw. capacity are in progress, through the works, and one of 1,500 kw. is in course of preparation for the Sheffield Corporation Tramway. The firm have a connection with the Corporation power station, so that they can instantly couple with the town supply, and take whatever power may be required. Nearly two hours were spent by the colliery managers in passing through the engineering shops and foundry, after which they were entertained to tea in the office. Mr. D. E. Parry (Vice-President) proposed a vote of thanks on behalf of the colliery managers, for the very interesting and enjoyable inspection of the premises, as well as for their hospitable reception. They could not fail to be impressed with the efficiency of the plant and of the general equipment. There were signs of progress in all departments. At the same time they could not help feeling that those strange concoctions of wire and metal and tape were almost bags of mystery. No doubt the company would be glad to see the result of the visit in a succession of orders. Mr. S. F. Sopwith seconded, and said they were very much gratified with what they had seen. The vote was acknowledged by Mr. Hall on behalf of the company, and by Mr. Bulloch, the Manager, who said the company valued their appreciation. As a man of business, he readily acquiesced in the reception of potential customers. They did their best to turn out good machines. They insisted upon thorough efficiency in their staff, and they never hesitated to scrap a machine when they found a better. They were confronted with competition all over the world, and it was a great struggle to keep a place like that going with sufficient orders to make things run smoothly. But they had succeeded in the past, and hoped to continue successful in future, and hold their own against all competition. It was commonly said that electricity was in its infancy, but their firm had been in existence 21 years, and there was now no question that electricity was now efficient and also the cheapest power. They were ready to place their experience at the disposal of anyone who thought of adopting a power which had much to do with large economical and profitable output.

Future of Electric Furnace.

The part played by electricity in metallurgical processes was alluded to by Mr. A. H. Hiorns (Head of the Metallurgical Department of the Birmingham Municipal Technical School) in his address, as retiring President, to the Birmingham Metallurgical Society. He pointed out that hardly a week passed without the introduction of a new form of electric furnace, and expressed his belief that, before long, the electric furnace would be in common use, not only for making alloys but also for smelting ores. He noticed that only that week an electric furnace for smelting copper ores had been brought out. Mr. Hiorns also referred to the fact that electrically driven rolling mills are slowly replacing steam power, and will proably be largely extended in the near future. The question of dry air blast, for which electrical power was largely used, was still on its trial, Mr. Hiorns said, but the balance of experimental evidence was still in its favour with regard to economy, while there was no doubt as to its superiority in producing uniform results.

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LANCASHIRE NOTES.

MANCHESTER.

There has been no marked change in the state of trade here during the week. It is reported that in view of the brighter prospects, an Engineering and Machinery Exhibition on a large scale will be held in Manchester next autumn. No doubt the electrical side will be well represented.

Fleetwood Tramway Assessment.

Judgment was reserved at Preston Quarter Sessions in the important appeal against the assessment of that portion of their tramway which passes through Fleetwood, brought by the Blackpool and Fleetwood Tramroad Co. The Company claim that this portion of their system is entitled to the exemption given to railways. Counsel for the Fleetwood Urban Council, however, contended, quoting authorities in support, that if a tramway was so constructed that any ordinary person would speak of it as a tramway and not as a railway, it was not entitled to exemption, and that if it was decided in this case that the Company's line should be exempt, then every other tramway would also be entitled to exemption. The Company's counsel argued that the whole question for the court was, whether in fact, or in law, the system was used as a railway under powers of Act of Parliament for public conveyance.

The Blackpool and Fleetwood Tramroad, which was opened to the public in 1898, runs along the sea coast between the two towns, a distance of 9 miles, except in the towns, the light railway type of construction is adopted. The generating station and principal car sheds are situated along the line, about 2 miles out of Blackpool, while there is a second shed and battery house near Fleetwood. The run is made in under 25 min., and the cars are always crowded in the season. The result of the Company's case will be awaited with interest by all other Companies.

Electric Driving in Cotton Mills.

There has been a good deal of correspondence in the local papers on this Bradford report dealing with electric driving for cotton mills, and the enemies of the electric drive are rejoicing, for so far no one has seriously taken up the electrical side. A good answer to those who are against electric driving is that all firms giving it a trial in one or two rooms, adopt it all through their mills and for new extensions. I have interviewed a spinner who installed the electric drive in a new mill some time ago. He was so satisfied with the results that he employed it in a second mill as well, making such minor improvements as he had found desirable. This gentleman, who is a mechanical engineer as well as a spinner, was surprised that other spinners, knowing the details of their business so well, were blind to the advantages of the electric drive. I learned that the cost per h.p. for electricity generated on the spot, and for steam driving was about the same; also the cost of plant in the first instance was similar. His first mill had two high speed turbines, but he had found them so satisfactory and reliable that if he were redesigning he would instal one large unit instead of splitting the load, as experience showed that there was no more likelihood of a generator and turbine going wrong than there was of an ordinary mill engine—and no one would think of installing spares in the latter case. The constant working speed produced a finer and more even thread than is got by steam driving direct, and this finer yarn gives the firm a better position in the market and enables it to secure orders in preference to other spinners. Another point worthy of notice was that the starting load on Monday morning in the case of the electric drive was only 6·5 to 7% in excess of Saturday morning's. In the steam drive there are many cases where the Monday morning load is as much as 200 h.p. above normal in a total of 1,300 h.p. As the electric drive is 50% faster than steam, much cheaper and lighter belts are used, and this all reduces the losses. His shafts were direct driven from one end by motors. It was his opinion that electric driving was the only way to modernise old mills, and that for new mills even, it possessed distinct advantages.

AMERICAN NOTES.

NEW YORK.

The most famous city in the United States to-day is the City of Baltimore. In the parlance of the West, it has reached the top notch of progress and development. It has achieved this enviable pre-eminence by a series of scientific discoveries which deserve world-wide publicity. It has discovered, for instance, that electric lighting as applied to public thoroughfares is still in its infancy. Incandescent electric lamps are still (in Baltimore) in a purely experimental stage. The arc light (in Baltimore) is a crude and elementary method of securing inefficient illumination. The tungsten lamp (in Baltimore) is a wild dream of the future based on unscientific data incapable of practical realization. So the net result is that in this electrical era, the City of Baltimore has given to the American Street Lighting Co. (which is a Baltimore incorporation) a contract for the lighting of its streets by means of naphtha lamps. At this rate of progress it is anticipated that three years hence Baltimore streets may enjoy the advantages of oil-lamps, and may even ultimately have recourse to rushlights in horn lanterns.

Electric Commercial Vehicles.

Some very interesting facts are published here in connection with the increased demand for electric vehicles for commercial purposes. The R. W. Macy Co., of New York city, has had a very fortunate experience with electric wagons, and has added to its equipment by placing a repeat order for 12 2,000-pound capacity delivery wagons In 1907 the New York *Sun* put in an equipment of electric wagons, and during this interval has tried out several types of gasoline machines, importing a number from abroad. After a thorough trial of each type, an order has just been placed for three more electric wagons similar to those installed in 1907. The Commonwealth Edison Co., of Chicago, has been using a five-ton electric truck for the past six years, and has just placed an order for a number of electric wagons of a lighter capacity. The Cleveland Electric Illuminating Co. has placed an order for a three-and-one-half-ton truck, with an electric windlass for pulling cable and loading and unloading. All the vehicles referred to are made by the General Vehicle Co., of Long Island City.

International Electrical Standardization.

Commenting on the paper read on this subject by Mr. Ormond Higman, at the meeting of the British Association at Winnipig, this week's issue of the *Electrical World* prints the following note: "An international glossary of electrical terms is no doubt a good thing, but it is of secondary importance to standardization. To construct an international glossary ahead of an international standardization is to put the cart before the horse. What is wanted is a start on standardization, and when the international standardization committee meets terms that are not clearly equivalent in the different languages it must pause to settle the definition of those terms. In this way there will be the minimum waste of labour on purely philological lines, and the international glossary of words will grow *pari passu* with the international agreement upon things and physical actions. Another important duty before the commission is the gradual adoption of an international code of symbols for electrical engineering quantities in literature, so that when engineers discuss such fundamental things as e.m.f., current, resistance, power, etc., in equations the letters used to designate these various quantities shall be, as far as possible, the same."

Tantalum Lamps.

The General Electric Co. reports that the sales of tantalum lamps are more than double what they were a year ago, and the lamp appears to be sharing in the demand for high-efficiency lamps created by the introduction of tungsten lamps. The tantalum lamp, as at present supplied, is giving excellent life service. Contrary to general belief, these lamps will give good commercial life on alternating current of 60 cycles or less. Their life on this frequency will average well above 600 hours. An interesting tantalum lamp order recently received called for 1,900 lamps for the United States war vessels attending the Hudson-Fulton celebration in New York.

Turbines for Battleships.

Both the new American "Dreadnoughts," of 26,000 tons displacement, for which contracts were recently awarded, are to be equipped with Parsons turbine engines. This decision was reached at a conference in Washington, D.C., between Secretary Meyer, Commander Cone, Chief of the Bureau of Steam Engineering, and Rear-Admiral W. L. Capps, Chief of the Bureau of Yards and Docks, who has just returned to the United States from an extensive tour of European shipyards. The New York Shipbuilding Co., which is to construct the Arkansas, was notified some time ago that turbines would be installed. Decision as to the motive power for the Wyoming, to be constructed by the Cramps, was postponed temporarily, but Secretary Meyer and his associates decided for the Parsons turbine, feeling satisfied that this would be more advantageous to the Government that the proposed combination of turbines and reciprocating engines, which had been insistently urged by some naval officials.

As Cousin Jonathan Sees It.

Writing in the *Electrical World* on the subject of "Central Station Commercial Development in Great Britain," Mr. Francis H. Davies says: "In the light of recent developments, it appears curious that when the subject of publicity and systematic new-business work was first mooted in England many were found to condemn, root and branch, any but the old *laisser faire* policy of depending upon natural growth. Needless to say, such belonged mainly to the old school of professional engineer, the man who looks upon his calling more as a scientific pursuit than as a matter of business. In places, he still stems the tide of advancing commercialism, but on all sides there are indications of a new *régime* under which the man who extends the business, and by so doing makes it pay, will take the foremost position. For many years past, in a considerable number of instances, commercial methods have been employed to increase business, but until recently they were anything but systematic. The germ, so to speak, has been lying dormant awaiting the impulse necessary to call it into life. That impulse came chiefly in the shape of a crusade in the technical press

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calling attention to the possibilities of a good commercial organization and quoting the American example, not necessarily for slavish imitation, but rather as an indication of what can be accomplished under one set of conditions. Several prominent English journals have each done yeoman service in the cause, and are continuing to further its interests in every possible direction. So far as the writer is aware, the earliest really systematic effort was that of the Newcastle-upon-Tyne Electric Supply Co., the management of which inaugurated an extensive new-business and publicity department in 1904. It is in active existence now, and is the largest of its kind in the country. The two municipal undertakings of West Ham and St. Marylebone probably afford the next best examples of systematic effort in business expansion. Of the 13 companies operating in London, the County of London Electric Supply Co. and the Charing Cross and City Electric Supply Co. are particularly noteworthy as having in active work properly systematized new-business organizations on a large scale. Practically all the remaining London companies are devoting attention to the work in varying degrees of thoroughness, and many of the municipal concerns have instituted, or are considering, publicity departments. In the provinces, about an equal amount of progress may be recorded so far as important towns, such as Birmingham, Bradford, Bristol, Ipswich, Leeds and Sheffield, are concerned. In Great Britain there is as yet little or no such co-operation as exists in America, a fact that is greatly to be regretted. There is decidedly room for some such organization as the Co-operative Electrical Development Association, and it is hoped in many quarters that the newly-formed Electrical League—an association of men interested in electrical matters—may do something toward the desired end."

Power and Light Combine.

The Electric Bond and Share Co., of New York, with which interests of the General Electric Co. are understood to be identified, has effected a consolidation of a number of important light, heat, power, electric and gas companies of the West. The consolidated company is known as the American Power and Light Co., and will have a capital stock of $15,000,000, of which $5,000,000 will be accumulative 6% preferred from October 1, 1909, and $10,000,000 common. There will be issued $2,500,000 of preferred stock and $5,500,000 common. The new company will commence business with a cash working capital of at least $500,000.

Grounding the Secondary.

At the annual meeting of the Colorado Electric Light, Power and Railway Association, a committee was appointed to investigate the grounding of secondaries and make a thorough trial by actual operation in as many cities as possible. The International Association of Municipal Electricians, at a meeting in New York, has gone a step further, and adopted a resolution urging and demanding "the enactment of proper legislation requiring the grounding of all alternating-current secondary systems, when by so doing the voltage between the earth and any part of the said secondary system will not exceed 250 volts; and this body pledges the support and advocacy by its members of all legislative measures to that end."

Chicago Electrification.

Notwithstanding the earlier announcements on the subject, electrification was given a knock-out blow by the directors and stockholders of the Illinois Central Railroad at the climax of the annual meeting in the Park Row station. President Harahan, as well as the directors and most of the stockholders, expressed themselves as of one mind that the time is not ripe for electrification. For the banishment of smoke, prospects were held out that the only practical remedies rested in the use of smokeless coal, coke or gasoline. President Harahan, in his report, made four points against electrification, as follows: First—electricity has not been perfected sufficiently to warrant the installation of motor power, and that it is not practicable. Second—the cost is too great, and the decreasing earnings is beyond business reasonableness. Third—that the elimination of the smoke nuisance is the great thing to be accomplished, and that it can be done in a more practicable way than by means of electrification. Fourth—that it is inadvisable for any road to attempt electrification until a comprehensive plan is agreed upon to be used by all railroads entering Chicago.

"Electrification Impracticable."

President Harahan's adverse report was followed by a resolution adopted by the board of directors stating in no uncertain terms that electrification is entirely impracticable at this time, as shown by a study and investigation of the situation. The resolution stated that a complex situation was shown by the investigation, and that coke or other smokeless coal could be used for the present. "We recommend," declared the directors, "that electrification be deferred, that the subject be more fully studied, and a proper line of procedure agreed upon." President Harahan, in offering his report, said there was no precedent for the use of electricity in transporting freight. He followed up this by declaring that in passenger service it was used only where tunnels were part of the system, and thereby necessitated electricity as a motive power. Great stress was laid upon the cost, which, it was declared, far exceeded the economy promised. The practicability of electricity had not been shown yet, so far as the Chicago situation has been shown, said the president in his report. The Chicago terminal involves the handling of heavy freight trains, and an interchange of freight, so that one line handles the business brought here by another line. If the suburban business is the only one, it might be said that electrification was justifiable at the present time." The report of the president was adopted by the stockholders, as was the resolution of the directors urging further delay in electrification. The attitude of the directors and stockholders means that the city will have to fight every inch of ground for electrification. The report of the president sets forth figures to show that in an electrified suburban system the net loss in operation would amount to $624,947 a year as compared with the steam system. "Elimination of smoke is a thing to be brought about. We are using a superior quality of coal, and are experimenting with coke and are building new ovens, and hope to get a coke that will enable us to do away with the smoking coal."

Current Items.

Japan and China are adopting the Bell Telephone System. After a very careful study of all the telephone systems in the world, the Japanese and Chinese commissioners finally adopted the bell. In adopting the Bell, they announced that they found it to be more reliable, efficient and economical than any other.

In stating his intention to reserve judgment in the suit for $15,217.97 entered by the Attorney-General against the Canadian Niagara Power Co., Justice Riddell, sitting at Niagara Falls, remarked that the trouble arose through the mis-use of technical words. "'Horse-power' and 'power' are not the same," he remarked, "but they have been used in the same way by one of the contending parties. If this were a dispute between two private parties," proceeded his lordship, "I would have no hesitation in deciding it now, but considering the importance of it, I shall reserve judgment."

A mortgage of $75,000,000 to secure a bond issue of like amount was filed here to-day by the New York Telephone Co. The money will be used, it is said, for the purpose of continuing the campaign of acquiring Bell Telephone Co.'s outside of New York State.

M. J. Ellwood Baird, of Buffalo, has been awarded a contract by the Niagara Falls Hydraulic Power and Manufacturing Co. for the building of a conduit from the Shoellkopf Power Plant on the Shoellkoph Power Canal to the proposed new water plant on the Buffalo road east of Echota. This conduit is to be built so that a reserve cable can be installed and be available if the power cables of the city of Niagara Falls fail between the power station and the proposed new waterworks plant.

Jieki Kobori, M.E., chief electrical engineer of the Uji River Electric Co., with offices at Kioth, Japan, is at Niagara Falls making an inspection of the power plants on the American and Canadian side. He said that the conditions under which this company would develop electric power were very like the conditions at the Falls. He came to get ideas to incorporate in the building of the Japanese plant.

The masonry work at the Canadian Niagara Falls plant for the housing of the sixth generator is completed, and the assembling giant 10,000 h.p. unit is well under way. There is little doubt that early next spring it will be placed in commercial service. The present generating capacity of the plant is 50,000 h.p.

The Norfolk and Western Railway has put into service two telephone circuits for train dispatching; one between Roanoke, Va., and Bluefield, W. Va., 102 miles, the other between Bluefield and Williamson, W. Va., 107 miles. There are 16 stations on the former circuit and 22 stations on the latter. The Western Electric Co.'s telephone equipment and Gill selectors are used on both circuits. This equipment extends through the very mountainous country, and affords a good test of telephone train dispatching under very severe conditions.

The General Electric Co. and the Westinghouse Electric and Manufacturing Co. are now operating at about 80% of capacity. The General Electric can now handle a gross business of $85,000,000 a year and the Westinghouse a business of $50,000,000.

Incorporation papers of the Genesee Light and Power Co., of New York State, the new corporation formed to take over the plant of the Genesee County Electric Light, Power and Gas Co., have been filed in the county clerk's office at Batavia, New York. The capital stock is given as $250,000, of which $150,000 is common stock and $100,000 6% preferred stock in shares of $100 each. The new company, like the old one, will deal in Niagara power.

Major Walter O'Meara (late Royal Engineers), chief engineer of the British Post Office Department, in company with Mr. J. F. Preston, of the same department, has been in Chicago studying American telephone and telegraph business. Major O'Meara has been interviewing Mr. Bernard Sunny, president of the Chicago Telephone Co., Postmaster Campbell, and a number of leading officials interested in the telephone and telegraph business in Chicago. His itinerary takes him to Grand Rapids, Omaha, St. Louis and back to Chicago, then again to New York.

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BUSINESS NOTES AND NEWS.

LIGHTING AND GENERAL—Home.

ASTON.—The Corporation Electricity Committee's report shows that during September the sale of current for lighting, power, and traction amounted to 482,692 units, compared with 301,036 units in the corresponding month last year. The Public Works Committee's report indicates that the tramway receipts for the four weeks ending October 8 were £2,827 18s. 9d. as compared with £2,766 19s. 6d. for the corresponding period last year.

BARNSLEY.—At the Town Council meeting, Alderman Wray, on behalf of the Lighting Committee, mentioned that they were now spending £3,500 per year on street lighting. They could not go on spending money in that way, or they would have the rates up to 9s. in the £. The cost of incandescent lamps with the mantles, etc., had been found to be prohibitive, and they considered the best way was to go on extending the electric mains.

CLEETHORPES.—A Local Government Board inquiry was held into the application of the Urban Council for sanction to borrow £4,000 for electrical extensions. Mr. E. B. Chapman, representing the Council, stated that by arrangement with the Grimsby and District Tramways Co. a power station was erected for public supply, and the Council had power to acquire that installation in 1910 at a price of £17,000, or at a later date, 1912, at that figure, less depreciation. At present the Council, through the Tramways Co., were supplying current for lighting at a net profit to themselves of £120 per annum, and by the present scheme it was proposed to lay mains in the busiest part of the area, where a canvas had already yielded promises from 54 business houses and 27 private houses to become consumers of current.

FRODINGHAM.—The Urban Council decided to apply for a provisional order for electric lighting purposes.

GLOUCESTER.—The General Manager and Engineer (Mr. L. Johnston, A.M.I.E.E., A.M.Inst.Mech.E.) of the Corporation Light Railways, reports that the total revenue for the year ended March 31 last amounted to £15,243 7s., and the operating expenses £11,393 16s. 3d., showing a gross profit of £3,849 10s. 9d. Repayments of loans absorbed £8,958 5s. 6d. The passengers carried numbered 3,347,447. The amount paid to the Electricity Department for power, lighting, etc., was £2,567 5s. 10d.

GRIMSBY.—The Chairman of the Lighting Committee and the Electrical Engineer were asked to attend a conference in London on the question of Corporations hiring out motors as a means of raising revenue.

HAMMERSMITH.—The Guardians appointed a special committee to report on the question of electric supply to the several establishments of the Board, and with power to engage expert advice if they considered this course desirable.

HAMMERSMITH.—The London County Council Finance Committee recommended that the borrowing by the Hammersmith Metropolitan Borough Council of £10,000 for electric lighting purposes be sanctioned, the amount to be repaid by equal yearly, half-yearly, or quarterly instalments of principal, or of principal and interest combined, as to £69 for sub-station buildings, and £5,406 for mains by equal payments within 30 years, as to £2,183 for transformers and switch gear by equal payments within 20 years, as to £1,593 for house services by equal payments within 12 years, and as to £749 for meters by equal payments within 10 years, in each case from the date of the borrowing.

HANLEY.—The Corporation Electricity Committee reported that in August 99,480 units were sold, against 94,496 in August, 1908. The total generated were respectively 122,325 and 116,435 units, and the maximum loads 815 and 856 kw. The coal consumption per unit was 10·10 lb. against 9·90 lbs. a year ago, and the works cost 1·013d., compared with the 1·119d. per unit sold. The Electrical Engineer reported that in the month of September, 1909, there had been connected six new lighting consumers, taking 74 lamps, that extensions had been made on the premises of six consumers, equivalent to 92 lamps; and that one new motor consumer and extension of power consumers had been coupled to the mains, together equivalent to 88 lamps. Alderman Coates said they had instructed their Engineer to lay further mains for the purpose of more effectively lighting the Birches Head district. He added that they were steadily improving the works for the supply of electricity in the borough.

HULL.—At a meeting of the Chamber of Trades, the Secretary acknowledged a letter from the Town Clerk stating that the resolution passed by the Chamber with respect to the question of discount for the users of electric light, and of placing it on an equality with the discount allowed the users of power, had been referred to the Electric Light Sub-Committee to take into consideration in connection with the estimate for the coming year.

KINGSTON-ON-THAMES.—The Electrical Engineer (Mr. Edgcome) reports that the accounts of the municipal electricity undertaking show a deficit on the year's working of £1,251, compared with £884 last year. He states that there was an increase of 82 consumers and 5,734 lamps, etc. of 8 c.p., which was the largest increase in any one year since the beginning of the undertaking. For the fifteen years the concern has been carried on by the Council the net loss to the town has been £12,378.

LAMBETH.—The London County Council Highways Committee decided that no action be taken with regard to the supply of electrical energy by the South London Electric Supply Corporation, Ltd., to certain consumers outside its area; and that the Board of Trade be informed accordingly. The Board had advised the County Council that certain consumers outside the area of the Order had been supplied with energy, the supplies having been given under agreements with the authority owning the adjoining undertaking. The agreements, however, had not been confirmed by the Board. In the circumstances the Board were advised that the Order might be revoked by them.

LONDON.—A loan of £4,110, repayable on the annuity system, has been granted by the London County Council to the Shoreditch Borough Council for electric lighting purposes, and one of £12,000 to the Stepney Borough Council, in connection with Blyth's Wharf generating station.

NEWCASTLE (Ireland).—The Council had under consideration letters from a number of electrical engineers quoting their fees for a report on an efficient and economical scheme of electric light for the town: also a reply from Mr. M'Cartan, the Council's solicitor, giving his opinion on the proposals of a Lewisham firm to instal electric light in the urban district, wherein it was pointed out that owing to the proposers having failed to give the necessary notice prior to July last their application for a Provisional Order was belated for the present year. The Council decided to inform the Lewisham firm accordingly, and directed the Clerk to communicate with such Irish towns as are electrically lighted in order to ascertain the inital cost, cost to consumers, and other particulars, with the view of ascertaining as to the feasibility of the Council themselves undertaking the work.

NEWPORT (South Wales).—The increase of electricity supplied by the Corporation undertaking during the vast year was equal to 11,598 eight-candle power, and this is the largest increase which has yet been recorded. In consequence of the electric power to meet the demands becoming insufficient, the Electricity and Tramways Committee propose to provide a new transformer in one of the cellars of the Corporation Provision Market, and this, with the existing transformers, will contribute to meet the requirements of the increasing number of customers. At a meeting of the Committee, the question of the proposed trailers for some of the tramcars was again discussed. The connection of trailers with the cars would mean doubling the accommodation for passengers. A communication was read from the Board of Trade stating that they could not at present give their consent to trailers, but they would be willing to give the matter further consideration if it was desired. The Committee decided to recommend that additional information should be forwarded to the Board of Trade.

ROCHDALE.—The negotiations between the Rochdale Corporation and the Littleborough District Council for the supply of electricity to a portion of the district are nearing the final stage. At a meeting of the Tramways Committee of the District Council the draft revised agreement with the Corporation for the supply of electricity in bulk was considered. It was resolved to leave the further consideration of the agreement with the suggestions made to the chairman (Councillor Ormerod), Councillor Hallett, and the clerk with, if necessary, Mr. Hawtayne, the Council's consulting engineer. Messrs. Hawtayne and Zeden were authorised to prepare the necessary plans, sections, and estimates for taking a supply of electricity in bulk from the Rochdale Corporation sub-station in Butterworth-street, Featherstall, for the purpose of making application to the Local Government Board for borrowing powers.

ST. ANNE'S-ON-SEA.—The Electrical Exhibition promoted by the Urban Council has been largely patronised. Among the novelties shown may be mentioned an electric lamp which can be regulated at will by the simple process of turning a knob. Electric heaters and cookers have attracted considerable attention in the domestic department, and demonstrations and lectures on cookery and electricity appealed to hundreds of visitors.

ST. HELENS.—Electricity has been introduced for street lighting in the lower part of St. Helens' Ward.

STEPNEY.—At the opening of the Borough Council's new generating station at Blyth's Wharf, described in our last issue, the Mayor (the Hon. Harry Lawson) said they were able to

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work under conditions permitting them to save 25% of their coal bill, and the capital charges, which formed such a large part of the cost of production, had been reduced to a minimum. The station was supplying current practically within one year of starting work on the site. Stepney had the lowest average charge to consumers in London. From 1901 the price had fallen from 2·37d. to 1·62d. per unit, and that compared with a charge in 1901 over all other London undertakings of 4·35d., and now of 2·67d. If 2·67d. had been the average charge in Stepney last year they would have had a net surplus of £34,000 instead of £1,800. The average price for the whole of the country was 2·2d. They were giving the ratepayers and the employers of East London facilities for the use of electric power which must do a great deal to revivify the industries in that great quarter of the Metropolis. The people owed a great deal to Councillor Gordon (Chairman of the Electricity Committee), who had not spared himself in their service. The Mayor also complimented the borough on possessing such capable officials as the Town Clerk, the Electrical Engineer, and Borough Engineer.

SUNDERLAND.—At a meeting of the Corporation Electricity Committee it was stated that the half-yearly report was of a more satisfactory nature than that of last year. The outlook was regarded as more hopeful all round.

WOOLWICH.—The Metropolitan Borough Council having asked the London County Council for sanction to the borrowing and for the advance of £2,199 for electric lighting purposes, the Finance Committee recommend that the application be granted, the amount to be, as to £899 for coal handling plant and £557 for mechanical stokers by equal payments within 20 years, and as to £743 for mechanical stokers by equal payments within 10 years.

WITHAM.—At the Urban Council meeting the Surveyor pointed out that more light would be required in the machinery at the Waterworks during the coming winter. He suggested that a dynamo might, without great expense, be erected, and that the motive power would be supplied from the engine. Mr. Hubbard remarked, "Why not have a large dynamo, and supply the whole town with the electric light?" Mr. Bawtree said they might let the Gas Co. have a little opposition. Capt. Abrey said the outlay for a dynamo would be too much at the present time. The Chairman said they could have more lamps!

YARMOUTH.—The Council received sanction to the borrowing of £2,000 for purposes of the electric lighting undertaking.

YORK.—The Corporation accounts show that the expenditure on revenue account from the date the tramways undertaking was taken over, under the Light Railways' Order, by the town (February 27, 1909) to March 31 last was £689 13s. The expenditure in excess of income was £92 1s. 5d. The income of the electricity undertaking totalled £18,119 13s. 10d., and the working expenditure £9,477 18s. 3d., and, allowing for interest and sinking fund charges, there remained a surplus balance of £853 2s. 8d. for transfer to the suspense account. The deficit balance on the suspense account now stands at £5,935 4s. 11d. The deficit balance on the destructor account at the beginning of the year was £4,374 7s., and the payments during the year for working expenses amounted to £1,035 1s. 6d.

LIGHTING AND GENERAL—Overseas.

SYDNEY (Australia).—The City Electrical Engineer (Mr. Forbes Mackay) has prepared a report giving a comparison of the cost of electric and gas lighting. He says that put shortly, the relative costs of electric light with the new metal filament lamps and gas, with the average modern mantle and burner, are in Sydney as 38 is to 81 in favour of electric light. In the above figures, no account has been taken of the amount of gas used in the by-pass. This is sometimes considerable, and if taken account of would, of course, improve the relative position of the electric light.

TRACTION—Home.

LONDON.—The London County Council Highways Committee passed the proposal for the construction of electric tramways from Streatham High-road to Mitcham-road, and in Wimbledon-road. The estimated cost of the construction and equipment of the lines on the underground conduit system is £69,990 in the case of the Streatham High-road scheme and £9,335 for the Wimbledon-road route. The expenditure in respect of special rails, etc., has already been provided for, and the Committee now recommend that sanction be given to the expenditure of £41,950 for trackwork, etc., and £2,120 for sub-station plant, in addition to £5,700 for trackwork, etc., on the Wimbledon-road scheme. The estimates of the financial results of working the Streatham High-road scheme, based on a four-minute service, show an adverse balance for the first few years, after providing for debt charges and renewals, without allowing for any proportion of the debt charges in respect of the cost of street widenings, which will amount to about £604 in the first year, decreasing by about £7 a year as the debt is paid off. On the other hand, no allowance is made for the increase of receipts which the Highways Committee consider will result on the existing routes, to which it is expected that the new line will induce additional traffic. The Committee also propose that authority be sought in the session of Parliament for construction of new tramways from Maida-vale *via* Kilburn-priory, Alexandra-road, Hilgrove-road, and Adelaide-road to Upper Avenue-road, 1·025 miles, on the overhead system, at a cost of £30,855; and from Canonbury-road *via* St. Paul's road to Essex-road, ·70 mile, on conduit system, £28,820. Also for the reconstruction of existing tramways on the conduit system, Highgate-road, 1·59 miles' £35,030; from City-road *via* East-road, New North-road, and Canonbury-road to Highbury-corner, 3·35 miles, £63,380; from Baring-street *via* Southgate-road, Mildmay-park, Newington-green, and Green-lanes to Seven Sisters'-road, 4·92 miles, £99,630; diversion line *via* a new street between New North-road and Southgate-road, ·38 miles, £7,750; and from Essex-road *via* Ball's Pond-road, Dalston-lane, and Graham-road to Mare-street, 2·74 miles, £63,230. Totals, 14·705 miles; expenditure, £328,695. They also approved of expenditure on capital account, not exceeding £200, in respect of the provision of 14 car body trucks required for use at the central car depôt, the work to be carried out by the employment of direct labour.

SOUTH SHIELDS.—The Tramways Committee instructed Mr. Harvey, the tramways manager, to report on the question of a reduction in the price of electric current.

WOOLWICH.—A resolution has been passed by the Highways Committee, London County Council, in favour of the reconstruction of a further portion of the Woolwich and South-east London tramways. The length of the route now proposed to be electrified (from Rainton-road *via* Woolwich-road, Albion-road, and George-street to Chapel-street) is about 1½ miles, and the estimated cost of the reconstruction and equipment of the lines is £68,020. Provision for some of the expenditure has already been made. The Committee passed estimates involving the capital outlay of £40,550. The cars required for the lines will be kept at existing depôts, and the Woolwich sub-station, now in course of erection, will be used for supplying part of the electric power necessary for working the lines. It is proposed to transfer to this sub-station from the Elephant and Castle sub-station part of the machinery to be fitted up at the former sub-station. It is proposed that the lines should be reconstructed on the underground conduit system, having regard to the proximity of the Greenwich Observatory. This system obtains on the tramways in Woolwich-road, and which the lines now in question form part. The estimated cost of the trackwork rails and special work amounts to about £16,750 a mile of single track, which is below the cost of other lines recently reconstructed on the conduit system. By the execution of this work the Committee point out that a better traffic terminus will be secured for the working of the tramways, while it will be possible to maintain the horse car service on the remainder of the lines until such time as the whole of the route to Woolwich can be dealt with. The effect will be to shorten materially the time occupied in making the journey from Greenwich to Woolwich by tramway.

TRACTION—Overseas.

AUSTRIA-HUNGARY.—Permission has been granted to the Abbazianer Elektrizitäts-und-Kleinbahngesellschaft, Vienna, for the extension of the Abbazia-Mattuglie electric railway to Lovrana, *viâ* Volosca and Abbazia.

BRAZIL.—A correspondent reports that President Peçanha has asked authority from Congress to make the contracts and issue the necessary bonds for the electrification of the Central of Brazil Railway in and near Rio de Janeiro, for the reason that the number of passengers carried increased from 13,423,779 in 1903 to 20,128,387 in 1908, while the means of giving service have not been proportionate, resulting in failure to meet unsual demands, as on Sundays and holidays. It is understood that the preliminary estimates and surveys of the Government engineers provide for the third-rail system, and that the work without materially interfering with traffic, can be finished within two years, at an estimated cost of $2,500,000.

FRANCE.—The new electric line from Chezery to Bellegarde, on the Geneva-Lyons route of the P. L. M. Railway Co., will shortly be opened.

JAPAN.—The British Commercial Attaché at Yokohama reports that, according to a local newspaper, a company is to be floated, with a capital of 2,000,000 yen (about £204,000), to construct and work an electric railway. The railway is to run for a distance of some nine miles in the suburbs of Tokio, and is to be connected with the Tokio Railway at Otsuka.

SWITZERLAND.—The Federal Railways directors decided to abandon electric traction on the Seebach-Wettington line.

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EDUCATIONAL.

UNIVERSITY OF LONDON.

In the University College Calendar for 1909-10, the Electrical Engineering Department is described in detail. The department is provided with all the necessary apparatus for teaching the subject in the ordinary course work to undergraduate students and also with certain special appliances for particular departments of advanced and post graduate work, used by advanced students. The admirably equipped laboratories are open to students every day in the week except Saturday. The courses of instruction are arranged to cover ordinary and special training for the profession of electrical engineering by lecture and laboratory courses, undergraduate lecture and laboratory courses covering the range of study required in preparation for graduation (B.Sc. in Engineering) in the University, and special advanced research and post graduate work.

PERSONAL.

Mr. Cuthbert W. Bentley, resident engineer and manager of the Alderley Edge and Wilmslow Electric Supply Co., has been appointed manager of the Cromer Electricity Works in succession to Mr. Hesketh.

Mr. Charles Henry Gott, M.I.C.E., a member of the old-established Bradford firm of Messrs. Charles Gott & Sons, civil engineers, electrical engineers, and surveyors, has been appointed by the Treasury to the position of valuer in the Estate Duty Department. The appointment will involve the departure of Mr. Gott from Bradford in order to take up his duties at Somerset House. The practice of the firm of Messrs. Charles Gott & Sons will be carried on as usual by the remaining partner, Mr. Ralph E. Gott.

Mr. George Mallet, formerly of the Bolton Electricity Works, has accepted a position as electrical engineer to the Afghan Government at Kabul.

CATALOGUES AND LISTS.

The Economic Electric Co., Twickenham, London, have issued a new edition of their comprehensive catalogue of electrical apparatus.

The Electrical Trades Supply Co., Ltd., are sending out a new catalogue of porcelain and stoneware insulators, iron-work, electricians' tools, etc.

The British, Irish and Colonial Department of the Maschinenfabrik Oerlikon, Norfolk-street, Strand, are sending out an illustrated list of machinery and apparatus, together with a pamphlet on five and six-speed three-phase motors.

From Messrs. J. H. Holmes & Co., Newcastle-on-Tyne, we have received copies of price lists of electrical switchgear and continuous current "Castle" motors and dynamos manufactured by them. The firm are also issuing an illustrated pamphlet containing particulars of some of the plans they have supplied for mining work.

The Lahmeyer Electrical Co., Ltd., are sending out a pamphlet describing their turbo-generators, both for alternating and continuous current. The firm are the agents in this country for the "Zoelly" steam turbine, as manufactured at Escher Wyss & Co.'s Works, Zurich. They are also issuing a list of automatic high-tensional switches, suitable for working under the severest conditions, such as in fiery mines, atmospheres containing acids, and dangerous gases, etc.

SOME CONTRACTS.

Messrs. J. H. Holmes & Co., of Newcastle-on-Tyne, are supplying the *Glasgow Herald* with a Holmes-Clatworthy patent duplex motor for driving printing machinery. It consists of a small auxiliary motor set in operation by a push-button, and connected by a worm gear with a large motor, made from 25 to 100 h.p. When the small motor has attained full speed the large motor is running, and automatically the claw clutch governing the two is released, and the small motor ceases. But the latter has by then done its work, and has saved 90% of the energy which would be necessary to start a single big motor, and has put the big motor in work in the most gradual possible manner and without the slightest jerk. The controller meets every emergency in the way of working the machinery.

TENDERS ACCEPTED.

KEIGHLEY.—The tender of the Tudor Accumulator Co., Ltd., for supplying and fixing new calls to the storage battery at the Electricity Station was accepted by the Town Council.

LONDON.—County Council.—The following tenders have been dealt with in Committee:—

Manufacture, Delivery and Laying of High-tension Cables.—Western Electric Co., North Woolwich, E. (accepted), £4,757 5s.; W. T. Henley's Telegraph Works Co., Ltd., Blomfield-street, E.C., £4,818 5s.; British Insulated and Helsby Cables, Ltd., Prescot, £4,872 17s. 6d.; Siemens Bros. & Co., Ltd., Westminster, S.W., £4,888 6s. 8d.; Johnson & Phillips, Ltd., Old Charlton, £4,937 1s. 2d.; Callender's Cable and Construction Co., Ltd., Victoria-embankment, E.C., £4,957 15s. 10d.; W. T. Glover & Co., Ltd., Manchester, £4,976 7s. 1d.; Robert W. Blackwell & Co., Ltd., Westminster, S.W., £5,072 13s. 10d.; the Yorkshire Cable Co., Ltd., Bradford, £5,437 12s. 6d.; and Edward Le Bas & Co., Billiter-street, E.C. (incomplete tender), £7,031.

Manufacture, Delivery and Laying of Low-tension Cables.—British Insulated and Helsby Cables, Ltd., Prescot, (accepted) £31,999 12s. 2d.; Union Cable Co., Ltd., Islington, N., £31,996 12s.; W. T. Henley's Telegraph Works Co., Ltd., Blomfield-street, E.C., £32,402 15s.; Western Electric Co., North Woolwich, E., £32,417 15s.; Callender's Cable and Construction Co., Ltd., Victoria Embankment, E.C., £32,768 16s. 8d.; Johnson & Phillips, Ltd., Old Charlton, £32,990 10s.; W. T. Glover & Co., Ltd., Manchester, £33,456 15s. 10d.; Siemens Bros. & Co., Ltd., Westminster, S.W., £34,326 15s. 10d.; Robert W. Blackwell & Co., Ltd., Westminster, S.W., £34,568 13s. 4d.; and the Yorkshire Cable Co., Ltd., Bradford, £37,710 11s.

Tramway Feeder Pillars.—British Insulated and Helsby Cables, Ltd., Prescot (accepted), £1,116 10s. 3d.; W. Boydell & Sons, Ltd., Leigh, £1,198 6s.; J. H. Tucker & Co., Birmingham, £1,229 13s.; Johnson & Phillips, Ltd., Old Charlton, £1,239 8s. 10d.; Edison & Swan United Electric Light Co., Ltd., Cheapside, E.C., £1,273 19s. 8d.; Ferranti, Ltd., Hollinwood, £1,275 7s.; Robert W. Blackwell & Co., Ltd., Westminster, S.W., £1,288 11s. 10d.; British Westinghouse Electric and Manufacturing Co., Ltd., Manchester, £1,295 7s.; Universal Electrical Manufacturing Co., Ltd., Peckham, S.E., £1,312 13s. 6d.; Whipp & Bourne, Castleton, £1,321 12s.; W. Lucy & Co., Ltd., Oxford, £1,344 12s. 6d.; Spagnoletti, Ltd., Goldhawk-road, W., £1,356 13s.; Western Electric Co., North Woolwich, E., £1,384 13s.; Siemens Bros. & Co., Ltd., Westminster, S.W., £1,395 4s. 4d.; Estler Bros., Victoria Docks, E., £1,414 4s.; Tetley & Co., Salford, £1,416 5s.; W. T. Glover & Co., Ltd., Manchester, £1,446 17s. 8d.; the Electric Construction Co., Ltd., Wolverhampton, £1,471 4s.; Tramway Supplies, Leeds, £1,602 16s. 6d.; Société Anonyme (Jones & Co.), Brussels, £1,675 6s. 8d.; Callender's Cable and Construction Co., Ltd., Victoria-embankment, E.C., £1,698 4s. 4d.; Alfred Wiseman, Ltd., Birmingham, £1,742 16s.; Veritys, Ltd., Covent-garden, W.C., £1,962 3s.; and General Electric Co., Ltd., Witton, £2,047 9s. 4d.

Special Work for Reconstruction of the Tramways from Beresford-square to Nile-street.—Hadfield's Steel Foundry Co., Ltd., Sheffield (accepted), £502 9s. 11d.

Special Slot Rails for Reconstruction of Highgate-hill Tramways.—Frodingham Iron and Steel Co., Ltd., Middlesbrough (accepted), £2,036 7s. 6d.

Reconstruction of Bridges for London, Deptford, and Greenwich Tramways.—Rowlingsons & Co., Quality-court, E.C. (accepted), £12,872 13s. 6d.

Steam, etc., Piping, Valves, Water Tanks, etc., for Greenwich Generating Station (Final Portion).—Staveley Coal and Iron Co., Ltd., Chesterfield (accepted), £7,344 18s. 5d.; Edward Le Bas & Co., Billiter-street, E.C., £7,642 6s. 5d.; John Spencer, Ltd., Wednesbury, £7,746 8s. 7d.; Foster Bros., Ltd., Wednesbury, £7,760 6s. 5d.; Babcock & Wilcox, Ltd., Farringdon-street, E.C., £7,768 4s. 5d.; the Railway and General Engineering Co., Ltd., Nottingham, £7,999 12s. 6d.; Stewarts & Lloyds, Ltd., Glasgow, £8,010 13s. 6d.; James Oakes & Co., Alfreton, £8,151 10s. 9d.; E. Bennett & Son., Ltd, Aldgate, E., £8,173 17s. 9d.; John Wilson & Co., Lime-street, E.C., £8,440 2s. 10d.; Shelby Manufacturing Co., Peckham, S.E., £9,268 0s. 9d.; and Westwood & Wrights, Brierley-hill (incomplete tender), £6,872 18s.

Choke Coils, etc., for Motor Generators at Sub-stations.—Electric Construction Co., Ltd., Wolverhampton (accepted), £1,098 9s. 5d.; Johnson & Phillips, Ltd., Charlton, Kent, £1,437 8s. 5d.; Spagnoletti, Ltd., Goldhawk Works, W., £1,605 4s. 6d.; Ferranti, Ltd., Hollinwood, £1,761 10s. 8d.; (alternative tender), £1,768 10s. 8d.; Dick, Kerr & Co., Ltd., Abchurch-yard, E.C., £1,923 3s. 9d. (alternative tender), £1,298 3s. 9d.; British Westinghouse Electric & Manufacturing Co., Ltd., Manchester, £2,706 4s., (1st alternative tender) £2,511 4s., (2nd alternative tender) £1,821 4s. (3rd alternative tender), £1,726 4s.

Erection of Woolwich Tramways Sub-station.—Kirk & Randall, Woolwich (accepted), £4,747, and an additional £33 16s. 11d. for teak framing.

Reconstruction of Highgate-hill Tramways.—A. N. Coles, Paddington (accepted), £16,654 13s. 7d. for tramway work, and 2,446 15s. for paving works for street widening.

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High and Low Tension Switchgear.—The Switchgear Co., Ltd., Manchester (accepted), £3,517 4s. 2d.; Johnson & Phillips, Ltd., Charlton, £3,625; Spagnoletti, Ltd., Shepherd's-bush, W., £3,669 18s.; Ferranti, Ltd., Hollinwood, £4,111 11s. 3d.; Electric Construction Co., Ltd., Wolverhampton, £4,175 12s.; General Electric Co., Ltd., Witton, £4,225 1s. 3d.; British Westinghouse Electric and Manufacturing Co., Ltd. Manchester, £4,864 4s. 8d. Estimate of the chief officer of tramways, was £3,550. Switchgear Co. permitted to sub-let portions of work to undermentioned firms (or such other firms as may be approved), (1), to Ferranti, Ltd., high tension switches; (2), to Everett, Edgcumbe, Ltd., instruments; and (3), to W. T. Glover & Co., Ltd., cables.

Motor Generators.—Dick Kerr & Co., who previously supplied large number of machines (accepted), £4,206; Lancashire Dynamo Motor Co., Ltd., Manchester (not to specification), £3,457 10s.; General Electric Co., Ltd., Witton, £3,821 10s.; Bruce, Peebles & Co., Ltd., Edinburgh (not to specification), £3,939; British Electric Plant Co., Ltd., Alloa, £4,231; British Westinghouse Electric and Manufacturing Co., Ltd., Manchester, £4,291; Brush Electrical Engineering Co., Ltd., Loughborough, £4,997; Electric Construction Co., Ltd., Wolverhampton, £5,428. Estimate of the chief officer of tramways was £4,750. Dick, Kerr & Co. allowed to sub-let the rheostats to E. F. Moy, Ltd., and portions of work to other firms.

PADDINGTON.—A Committee of the London County Council has been deliberating on a letter from the Paddington Metropolitan Borough Council, stating that it has for some time had under consideration a proposal for transferring the Paddington generating station of the Metropolitan Electric Supply Co. from Amberley-road to Willesden, and for effecting a reduction in the price of electrical current. The Borough Council asked whether the County Council is prepared to assist it in this latter object, having regard to the fact that by the London Electric Supply Act, 1908, the purchasing powers of the company's undertaking, hitherto vested in the Borough Council, were transferred to the Council. The charge made by the company for ordinary house lighting in their central London area is 5d. a unit, while in Paddington the charge is 5½d., and the charges for ordinary trade lighting in the company's central London area are from 4d. to 4½d. and in Paddington from 3d. to 5d. The Committee report that they do not consider it desirable to take any action in the matter.

JUNIOR INSTITUTION OF ENGINEERS.

At the annual general meeting of the Junior Institution of Engineers, held at the Royal United Service Institution, Whitehall, the Council's report was presented, showing that the membership has increased to 1,063, 85 elections and transferences having taken place during the past year. The election of officers, etc., resulted as follows: Chairman, Mr. Geo. T. Bullock; Vice-Chairmen, Mr. J. Wylie Nisbet, Mr. F. D. G. Napier; Hon. Librarian, Mr. S. V. Cooke; Hon. Auditors, Messrs. H. Norman Gray and Henry Cook; Members of Council, Messrs. G. D. Harrison, Jas. Oswald, C. H. Smith, and Percy L. Young; Provincial Members of Council, Messrs. C. T. Briggs (Newcastle-on-Tyne), Ernest King (Sheffield), R. H. Parsons (Peterborough), Eustace W. Porter (Southampton), T. P. Hosegood (Bristol), Adam Hunter (Glasgow), W. E. Lilly (Dublin), H. F. Hunt (Pembroke). The annual meeting of the Benevolent Fund afterwards took place, the statement of accounts showing that the amount standing to its credit is £188 19s. 9d. A paper was then read by Mr. T. A. Watson, Assoc.M.Inst.C.E., on "The Reinforced Concrete Construction of the new General Post Office Buidings, London."

CHICAGO ELECTRICAL SHOW.

The Electrical Trades Exposition Co. announces that the 1910 Electrical Show will be held in the Coliseum, Chicago, January 15 to 29 inclusive. This show will be under the same management as the four previous annual successes.

ART EXHIBITION.—There is being held now an exhibition of photographs by Mr. Arthur Marshall, A.R.I.B.A., at the new premises of the Royal Photographic Society of Great Britain 35, Russell-square. The exhibition will be open to the public till Saturday, December 18. Photographic visitors to the exhibition may obtain permission to view the newly fitted up premises of the Royal Photographic Society on application made to the Secretary, Mr. J. McIntosh.

GLASGOW.—It is reported that the North British Locomotive Co., Glasgow, has under construction the first steam turbine railway engine. The experiment is regarded with great interest in view of the various proposals for electrifying steam railways. The steam turbine locomotive is for express trains on main lines.

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Aberdeen.—Aberdeen Electrical Engineering Co., 17, Belmont-street.
Ayr.—Reid and Co., 108, High-street.
Auld, Wm., and Sons, 70, Sandgate.
Bedford.—Bacchus, Hy., 36, High-street.
Belfast.—Stanley Johnston, 7-9, Queen-street.
Lowden, J., and Co., Ann-street.
Patterson and Co., 57-59, High-street.
Aston Bros., Limited, 38, Donegal-street.
Scott, Hugh J., and Co., Ravenhill-avenue.
Birkenhead.—Heaney and Co., 327, Borough-road.
Stafford and Co., 117, Oxton-road.
Birmingham.—Ellis and Ward, 75, Edmund's-street.
Blackburn.—Thompson, W., Victoria-street.
Blackpool—Fylde Electrical Engineering and Plating Co., 50b, Abingdon-street.
Bolton.—Hart, James O., and Co., Limited, Bank-street.
Townson, Chadwick, and Co., 118, Bark-street.
Bootle.—Scott, J.
Bradford.—Pullan, C., 52, King's-arcade.
Smith and Croft, Providence-street, Westgate.
Bush, E., and Co., 26, Sunbridge-road.
Seaman, J. E., 1, Tanfield-buildings, Hustlergate.
Bridlington.—Bailey and Sons, Quay-road.
Brighton.—Page and Miles, 60, Western-road.
Smith, J., and Son, 33 and 34, North-road.
Adams Bros., 11 and 12, Trafalgar-street.
Bristol.—Parfitt Webber, Denmark-street.
Edwards and Armstrong, 4, Colston-street.
Brecknell Munro, and Rogers, Limited, Thrissel-street.
Burnley.—Thornton and Co., 6, Howe-street.
Simpson Bros., Hapton, near Burnley.
Coates, J. F., 18, Hebrew-road.
Bursiem.—Evans, E. M., and Son, Swan-square.
Bury St. Edmunds.—Pudney, C. C., Guildhall-street.
Canterbury.—Philpot, E. J., 34, St. George-street.
Cardiff.—Price, Friend, and Co., 6 and 7, St. John's-square.
Cheltenham.—Steel, H. E., Limited, High-street.
Chester.—Brook, Hirst, and Co., Northgate Electrical Works.
Clapham.—Stegmann and Co., St. John's-hill.
Coatbridge.—King, Jno., and Co., 8, Dunbeth-road.
Colchester.—Kuner, J. A., 103, Greenstead-road.
Joslins Limited, 107, High-street.
Colwyn Bay.—Bevan, G., and Co., Conway-road:
Cork.—Porte, F. C., and Co., 27, Marlborough-street.
Fielding, C. F., and Co., 57, Grand-parade.
Coventry.—Burbury and Co., 2, Earl-street.
Marson, G. R., 3, Hales-street.
Cricklewood.—Harrison and Co., 35, Cricklewood-broadway, N.W.
Dalkeith.—Falconer, W., and Son, Buccleuch-street.
Darlington.—Cox-Walkers, Limited, Feethams.
Devonport.—Devonport Brough Electrical Department.
Dewsbury.—Hirst and Son, Limited, Victoria-road.
Dublin.—Dockrell, Thos., Sons, and Co., South Great George's-street.
Davy, Arthur E., Riversdale, Donnybrook.
Cummins and Sons, 12, Lower Abbey-street.
Dudley.—Whittaker Bros., Limited, 204, Wolverhampton-street.
Theedham Limited, High-street.
Dunfermline.—Fife Electric Power Co., 23, Guildhall-street.
Durham.—Laidler and Sons, 83, New Elvet.
Eastbourne.—Dunn, C. T., 11, Tideswell-road.
Pearson, R. H. and J., Limited, 102, Terminus-road.
Prevette, E. A., Station-street.
East Ham.—Stokes, J., and Sons, High-street.
Edinburgh.—Anderson and Munro, 63, Queen-street.
Foggo, J. and Sons, 7, South Back Canongate.
Millar and Stewart, 7, Hanover-street.
Cole and Co., Victoria-chambers, 42, Frederick-street.
Epsom.—Dorset and Co., High-street.
Erith.—Jarvis, J. J., and Sons, Pier-road.
Forest Gate, E.—Woodward W. R., Boleyn-road.
Frinton-on-Sea.—Drake, L. W., Croydon House, Connaught-avenue.
Glasgow.—Lindsay, A., 8, Bothwell-street.
Johnston, Park, and Co., 15, Oswald-street.
Hutcheson, Andrew, 97, Waterloo-street.
Gloucester.—Beaven and Sons, Westgate-street.
Govan.—Somerville, Jas., 27, Harmony-row.
Grimsby.—Beckett and Co., Chantry-lane.
Northern Electrical Co., 117, Cleethorpe-road.

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PATENTS.

Control of Electric Motors.

20721—1908.—J. G. V. Lang, Southall. The motor operates as an ordinary series motor during acceleration, and a part only of the series windings are connected to an auxiliary source of electro-motive force during retardation, the remaining series windings being left in series connection with the motor armature to serve as a check upon undue rush of current. Fig. 1 comprises two diagrams illustrating diagramatically the electrical connections for acceleration and retardation respectively of a single motor. Fig. 2 is a diagram illustrating a modified arrangement. Figs. 3 and 4 are diagrams illustrating the invention as applied to two motors. In Fig. 1 it will be seen from diagram (*a*) of this figure that during acceleration the main motor armature A and the series field windings F^1 F^2 are connected across the mains with the result that the motor runs as a series

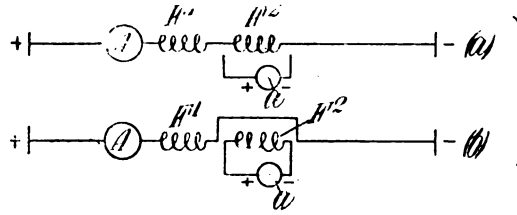

Fig. 1.

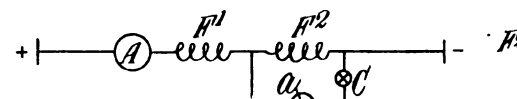

Fig. 2

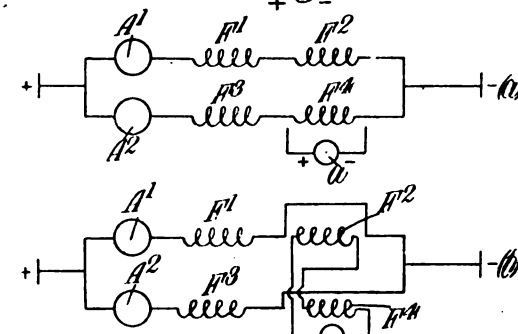

Fig. 3.

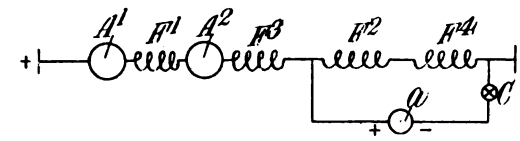

Fig. 4.

motor: *a* is the separate or independent source of electric supply and is represented in the drawings as being the generator armature of a motor generator. Diagram (*b*) of Fig. 1 represents the connections that are made for retardation of the vehicle or lift and it will be seen that only part F^2 of the series field windings is disconnected from the mains and connected to the generator armature *a*, the other part of the series field windings F^1 remaining in series with the main motor armature A. The invention is also applicable to cases where the equivalent of compound motors is obtained by keeping a series field energised not only by the current through the main motors, but also by current from an independent source of supply which determines the maximum value of the independent field excitation. In applying the invention to such a system the separate source of supply is disconnected from the series field windings while propulsion is taking place and is rendered active only during retardation. This change of connection may be made by means of a changing switch, the result being that the motors have a series characteristic during propulsion and a compound characteristic during retardation. Fig. 2 diagramatically illustrates the system involving the use of a single motor. The generator armature *a* is connected in shunt across the part F^2 of the series field windings and a switch indicated at C is provided in the shunt path. During acceleration this switch is open, and the motors run as plain series motors, but during retardation the switch is closed, thereby imparting to the motor during retardation the characteristic of a compound motor. Figs. 3 and 4 represent the connections for two motors. Fig. 3 represents the connections for operating the two motors when in parallel, and when entirely disconnecting part of the series field windings from the mains during retardation. F^1 F^2 are the series field windings of the main motor armature A^1, and F^3 F^4 are the series field windings of the main motor armature A^2. In diagram (*a*) which illustrates the connections during acceleration the motors are operating as plain series motors. Diagram (*b*) illustrates the connections during acceleration, the motors are operating as plain series motors. Diagram (*b*) illustrates the connections that are made during retardation and regenerative braking of the motors. It will be seen that the series field windings F^1 and F^3 are left in series with their respective armatures, and that the windings F^2 and F^4, which have to be made independent of the load, are disconnected from the mains and are connected in series across the generator armature *a*. Fig. 4 represents the connections for operating the two motors when in series and when leaving the whole of the series field windings in circuit across the mains during retardation as well as during acceleration. It will be seen that the generator armature is connected in shunt across the series field windings F^2 and F^4, and it will be understood that during acceleration the switch C will be open and that during retardation it will be closed, thereby causing the motors to have a series characteristic during propulsion, and a compound characteristic during retardation.

Electrical Indicating and Recording Instruments.

28522—1908.—W. Smith, Lewisham. At the present time electrical recording instruments, such as volt meters, ammeters and watt meters, are commonly made with the indicating arm swinging on a pivot near its upper end, and carrying a pen at its lower end bearing lightly against a travelling strip of paper on which the record is to be made. The indicating arm at its upper end has also been formed with an arm extending side-wise from it coupled at its extremity by a link to a piston immersed in a thick oil contained in a cylinder within which the piston is very loosely fitted, small holes being also sometimes formed through the piston. The dashpot thus formed steadies more or less the movements of the indicating arm, but if in order to increase the lag in the movements of the arm by making the piston a tighter fit in the cylinder or by

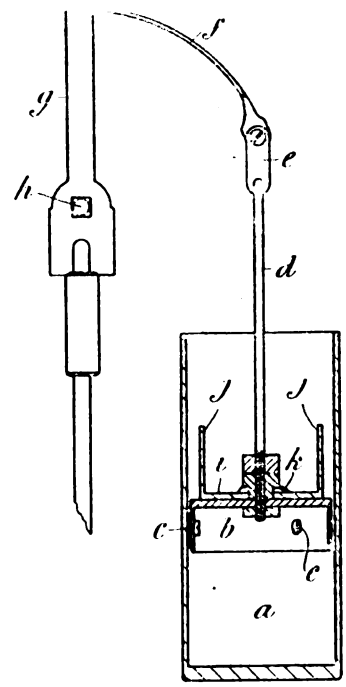

FIG. 1

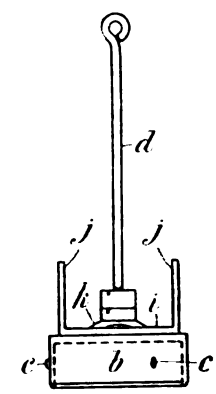

FIG. 2

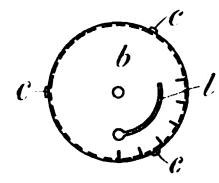

FIG. 3

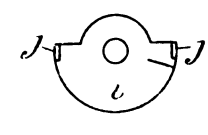

FIG. 4

decreasing the size of the holes through the piston, the piston is not only liable to stick fast within the cylinder and then give no indication, but will not return to zero when no current is passing. For many purposes it is desirable that fluctuations in the current which do not long continue, shall not be recorded and that the recording line marked by the pen should show only the average condition of the passing current. The object of this invention is to provide a dashpot by which the time lag can be increased to any desired extent and yet, by the use of comparatively thin oil, allow of the indicating arm showing small variations and always returning to zero when the instrument is dis-

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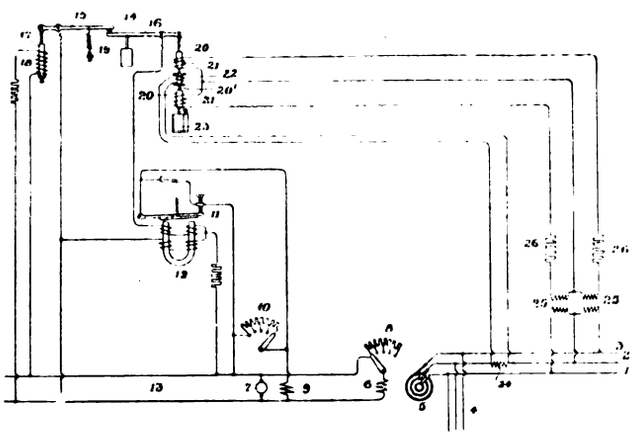
connected. Fig. 1 is a vertical section of a dashpot. Fig. 2 is a side elevation of the piston and its rod. Fig. 3 is a plan view of the piston with its regulating disc removed, and Fig. 4 is a plan of this disc: *a* is the dashpot cylinder, *b* its piston, and *cc* small studs projecting out from the sides of the piston. For the sake of lightness the piston is made hollow and the studs are screwed through its sides from the interior. *d* is the piston rod formed at its upper end with a small eye, by which it is jointed to one end of a link *e*, which at its opposite end is jointed to an arm *f* extending from the recording arm *g* of a recording instrument. The arm *g* is as usual arranged to swing about a pivot *h*. Above the upper flat face of the piston is a disc *i* which has projections *j* standing up from it by which it can be turned; *k* is a spring washer by which the disc is held down against the top of the piston, but allows of the disc being turned; *l* is a slot formed through the flat upper face of the piston through which the oil in the dashpot can pass. A portion of the circumference of the disc *i* is cut away so as not to cover the slot *l*. By giving a partial turn to the disc more or less of the slot can be covered over to decrease or increase the size of the opening through which liquid can pass and so increase or decrease the damping of the instrument so that the time lag may be adjusted to, say, one minute or part of a minute, or to 10 or other number of minutes as may be desired. As indicated in Fig. 3 indicator lines may be marked upon the piston by which the time lag which will be given when the cut off disc *i* is turned into any one or other position can be at once seen.

Regulation of the Power Factor in Systems of Alternating Electric Current Distribution.

25556—1908.—The British Thomson-Houston Co., Ltd., London. In alternating current systems of distribution, in which the phase relation between the current and potential is regulated by a synchronous motor, the power factor of the system can be maintained constant. The object of this invention is to provide an improved means for automatically regulating the field excitation of the synchronous machine in response to a change in the power factor of the circuit, for the purpose of maintaining the power factor constant. The diagram illustrates an alternating current system of distribution embodying the invention. The supply mains 1, 2, 3, of a three-phase line furnish current to a load circuit 4, and also to a synchronous motor 5, whose field coil 6 is energised by an exciter 7. A rheostat 8 in series with the field coil 6 enables the magnetisation of the synchronous motor field to be adjusted. The circuit of the exciter field coil 9 also contains an adjustable resistance 10, which is shunted by the contacts 11, controlled by the differentially wound relay 12, taking current from the exciter busbars 13. The relay is controlled by a pair



of floating contacts 14, carried on levers 15, 16, the former being attached to the movable core 17 of a direct current control magnet 18, which is connected across the mains of the exciter. The pull of the magnet is opposed by a spring 19. The other lever 16 is attached to cores 20 which are attached to a stem 20¹ and move freely up and down through fixed coils 21. The stem 20¹ carries a floating coil 22. A dashpot 23 is connected with the cores to retard their movements. The coil 22 is in circuit with a current transformer 24 on one of the line conductors. Potential transformers 25 are connected across the line, each being in series with one of the coils 21. Non-inductive resistances 26 reduce the current in the coils 21. The operation is as follows: Suppose that the synchronous motor is running without load, and the floating control contacts and other parts are adjusted so that the synchronous motor is excited to such a value as to give neither leading or lagging currents; in other words, let the power factor of the system be unity. Under these conditions the two potential coils exert an attractive force upon the floating coil, and the latter does not affect the position of the cores 2 and contact 14. But if the supply system becomes unbalanced, so, for instance, that the current in the floating coil becomes lagging, then the pull of one of the coils 21 becomes greater than that of the other and the floating coil moves down, raising the contact 14 on the lever 16 and causing it to close sooner and remain closed longer than in the rapid opening and closing action of the Tirrill regulator. This causes an over excitation of the field winding 6 of the synchronous motor which generates a leading current to counteract the lag in the system and restore the power factor to unity, providing the motor is of sufficient capacity and the inherent regulation is sufficiently close. For a leading current on the system, a reverse action will take place.

Starting and Cutting Out Electric Motors.

12258—1909.—Zucker Fabrik Frankenthal, Germany. A spring is introduced between the driving device and switching apparatus to operate with a pawl controlled by the armature current for starting the motor, and a second spring is provided to operate with a pawl and other contrivances to stop the motor.

Aerial Electric Cut Outs.

9803—1909.—E. Weckmar, Stuttgart. The electrical cut outs consist of an insulating member which is suspended between the conductors. Two metal bolts situated in the insulating block and formed at one end as contact bolts, and at the other end as clamps, are arranged in such a manner that they are unable to turn in the insulating body. The middle member, which serves as a cut out, is so constructed that it can be removed and replaced while the installation is under current without loosening screws and without contact with current conducting parts.

Electrical Heating.

12562—1909.—G. Cooper, F. C. Sharp & T. A. Stevens, Birmingham. This is an electrical heater of the immersion type in which the heating part consists of one or more pairs of Prometheus elements. Each pair is enclosed in the straight legs of a U-shaped water-tight metal casing, the curved part of which contains a connecting strip. The legs are enclosed in clamping plates mounted in slots in a casing attached to the handle.

Regulation of Alternators Running in Parallel.

17199—1909.—Allgemeine Elektricitats Gesellschaft, Berlin. The alternator regulators are influenced by the potential and also by a force, the value of which is dependent upon load differences, and the value of the corresponding currents. The force operates in such a way that the potential of an under excited generator is raised and the potential of an over-excited generator is reduced.

Electric Contact Breakers.

14117—1909.—R. W. Grant, S. Farnborough. In electric contact breakers particularly adaptable for induction or sparking coils for explosion engines, the armature is mounted on one end of a rod co-axial with and located between the core of the coil and the contact screw. The rod is carried in a bearing so as to be capable of reciprocating in the direction of its axis. A coiled spring encircles the rod which carries the armature and acts between a stationary base and a collar on the rod to carry the rod into contact with the contact screw.

Suspension Devices for Supplying Electric Current from Over-Head Wires.

13661—1909.—A. Schweiger, Ilzling-Salzburg. Two electrically conducting arms are suspended from the two current supplying conductors so as to be in electrical connection with them. An insulator is carried on two upwardly extending projections integral with the conducting arms and receives the free ends of the overhead wires which are electrically joined to the arms.

Electrically-driven Rotary Brushes.

26283.—1908. Light Electric Motor Co. & F. Higgins, Ilford. The brush is supported by a stirrup which has a handle. The stirrup is specially constructed, so as to enable the brush stock to be removed when desired without detaching the stirrup.

Fixing Electric Fittings.

25461.—1908. J. J. Rawlings, H. W. Handcock, & A. H. Dykes, Westminster, S.W. This comprises a backing plate of metal, which acts as an electrical connection, and a wooden base, secured by screws to the plate, to carry the fitting. The fitting is readily fixed, and of convenient construction.

Electrical Ignition Devices.

24759.—1908. L. H. Hounsfield, Clapham, S.W. This is an improvement in electrical ignition devices of the low tension type. The object is the production of a make and break device, in which the moving rod that passes through the cylinder wall shall move with a reciprocating movement in the direction of its axis, and not move to and fro about its axis as hitherto.

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Sheathing Electric Wires.

24348—1908.—J. J. Rawlings, H. W. Handcock & A. H Dykes, London. The sheath is formed from a strip of hard tinned or soldered metal lapped closely round the wi e in two or more longitudinal layers. The metal covering is soldered in such a manner as to obtain a homogeneous sheathing of even cross section.

Lightning Arresters.

22134—1908.—General Electric Co., Schenectady, U.S.A. Certain of the conglomerate materials used in making non-inductive resistance rods have the property of offering a high resistance up to a certain voltage, but above this point the resistance suddenly drops. A mass of these conglomerate materials are arranged in a dry powdered state in series with a spark gap and a magnet is secured with its poles transverse to the gap. In this manner an arrester is produced in which the point of the drop in resistance is brought to a voltage a little above the normal line voltage, thereby producing an arrester which will permit a comparatively free discharge of potentials above the critical point.

Electrically Driven Trains.

21490—1908.—F. Wagner, Gr. Lichterfelde, Germany. Each of the driving axles has two equal electric motors, each actuating a wheel separately. The armature windings of these two motors on one axle as well as the field windings of the motors are always connected in series.

Electric Clocks.

26239—1908.—T. J. Murray; Hounslow. The chief feature of the invention is in the application of a cam on the arbor of a rotary or centrally pivoted armature, as a means of giving motion to the main wheel of a secondary dial movement either directly or indirectly.

Electro-Magnetic Call Boards.

24618—1908.—J. Appleby and A. E. Drew, Bolton. Mounted on a switchboard are arms or levers, each of which is fixed at one end in a socket or by a swivel. This end is connected with a bell in the room where the call is to be given. The other end of the arm moves over contact points which are in connection with the respective times on the clockwork. When it is desired to complete an electrical circuit from the clockwork to any room the movable end of the arm corresponding with the room is moved until it is in the right position with the contact point connected with the desired time of the clock.

Induction Coils and Transformer Apparatus.

19885—1908 H. F. Bigg, F. B. Butt & J. H. Webb, London. This is an improvement in induction coils used in connection with electric therapy, and provided with an additional winding for the purpose of producing unidirectional current. The additional winding is short circuited by mechanical means during the time of make only, and is left on open circuit during the time of break. In other words the additional coil acts as a protective winding for the secondary coil at the times of make of the primary.

Electrical Batteries.

28285—1908.—T. McNaughton, New York, U.S.A. This is a dry cell electric battery in which the metal casing forms one element and a carbon or other electro negative element centrally disposed therein forms the other element. A moisture absorbent filler is interposed between the casing and carbon and holds the excitant.

Electric Self-Winding Clocks.

28286—1908.—H. O. Jackson & T. McNaughton, New York. The clock movement is provided with a barrel mounted on a support in the clock train frame and containing the clock spring and carrying the driving gear for the train and a pawl. One end of the spring is secured to the barrel. A pair of levers in the electric circuit carries the co-operating cricuit closing contact fingers. A circuit closing racket on the support engages with one of the levers and carries a smaller ratchet engaged by the pawl. A circuit opening ratchet on the support has the opposite end of the spring fastened to it.

Electric Secondary Clocks.

28287—1908.—H. O. Jackson & T. McNaughton, New York. The hand shaft is turned through the medium of a worm gear actuated by an electro-magnet, provided with means of including it in an electric circuit. One or more spring retracted armatures are attracted by the magnet in opposition to the spring and gear of the worm shaft to turn without moving the worm gear under the magnet attraction.

Electrical Control of Railway Signals.

5565—1909.—F. Cumont & Compaigne de Signaux Electriques pour Chemins de Fer Paris. The motor dynamo is placed at the top of the signal post and the counterweight for bringing the signal back to its original position is attached to an arm which is vertical when the signal is at danger, and horizontal when the signal is at line clear.

Locking Device for Electric Switch Boxes.

4561—1909.—C. Wust & Co., Seebach. A spring controlled lever works in conjunction with a projection on the inside of the door of the switch box. The lever also works in conjunction with a curved member placed on the switch pivot and causes the movable switch contacts to spring back into their end positions by means of a spring which has been tensioned by the switch pivot during the first part of its rotation.

Electric Furnace.

4553—1909.—Aktiebolaget Elektrometall, Ltd., Stockholm. The smelting chamber of the furnace is covered by a cupola. The electrodes are arranged obliquely inside a shaft within the cupola in such a manner that they do not come near the bottom of the furnace. In this way the heat is developed within the mass of the material and not in the proximity of the walls.

Thermo Dynamic Motors.

1997—1909.—L. A. Haines, Columbus, U.S.A. This is an improvement in thermo dynamic motors of the kind in which the motive agent is successively supplied to and cut off from different power generating elements comprised in the motor to render them alternately active and inactive. The improvement consists in providing means for positively controlling the supply of the motive agent and for cooling the driving elements of the power transmitting shafts and also to provide reduction gearing whereby the relative speeds of the driving and power transmitting shafts may be varied.

Protective Devices for Alternating Current Systems.

5717—1909.—Allgemeine, Elecktricitats Gesellschaft, Berlin. This is an excess current time limit device for alternating current systems, and comprises a releasing magnet having a primary winding carrying the working current, and a secondary winding in inductive relation to the primary winding and short circuited through a thermostatic device in such a manner that on the occurrence of excess current the short circuit is broken and the releasing magnet operates the cut out.

HIGH TENSION SWITCHGEAR.

At a meeting of the Glasgow Scientific Society on Saturday evening, Mr. A. G. Collis, A.M.I.E.E., read a very interesting paper on "High Tension Switchgear." The lecturer began by stating the important practical points to be considered in the design of any type of high tension switchgear, and spoke of the means adopted to satisfy the many conditions specified. A comparison between the two types of remote control switchgear—the mechanical type and the electrically operated—was then made to the great advantage of the latter. The lecturer showed a number of diagrams giving the connections of such boards, and described the manys witches, time relays, and instruments employed. Mr. Collis favoured the use of overload relays on outgoing feeders and reverse relays on generators. Some considerations relative to instrument design were next gone into, and the effects of change of frequency and temperature error were specified. In concluding his paper, which was illustrated with many lantern slides, Mr. Collis spoke of the indifference to danger shown in many switch board designs, and referred to the strange ideas of economy prevalent in some stations, where the cost of the switch board was cut to the lowest possible amount; although such extravagances as oak panelling and mosaic floors were considered necessary.

Electrical Engineers (London Div.). Territorials Orders for the week ending November 13:—Monday November 8, "A" Co., Technical Drill, 7 to 9.30 p.m.; Tuesday, November 9, "B" Co., Technical Drill, 7 to 9.30 p.m.; Wednesday, November 10, Gymnasium, 6.30 to 9.30 p.m.; Thursday, November 11, "C" Co., Technical Drill, 7 to 9.30 p.m.; Friday, November 12, "D" Co., Technical Drill, 7 to 9.30 p.m.; Saturday, November 13, "A" Week end run at Coalhouse Fort. Parade at Fenchurch-street station at 3 p.m. Dress: Khaki with haversack and great-coat, knife, fork and toilet requisites to be carried in haversack. Tickets will be issued at the station before entraining.—Officer Commanding, Col. R. E. B. Crompton, C.B.—(Signed) P. H. Campbell, Capt. R. E., Adj. for O. C., E.E., L. D.

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COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last prices. £
British Insulated and Helsby Cables, Ord. 1-100,000	5	7¼-7⅜
—— 6 p.c. Cum. Pref., 1-100,000	5	6⅛-6½
—— 4½ p.c. Mortgage Debentures	100	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100	89-94
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 1-200,000 and 275,001-475,000	3	1-1⅛
—— 4 p.c. Mortgage Debenture Stock	100	44-47
Callender's Cable, Debentures	100	105-107
—— Ordinary	5	10¼-10⅜ xd
—— 5 p.c. Pref.	5	5⅛-5¼
Consolidated Electrical Co., Ordinary, 1-110,000	1	⅞-1
Dick, Kerr, and Co., Ordinary, 1,260,000	1	1-1⅛
—— 6 p.c. Cum. Pref., 1-305,000	1	1-1⅛
—— 4½ p.c. Debenture Stock.	100	100-103
Edison and Swan United, "A" Shares, 1-99,261	3	⅝-⅝
—— "A" Shares, 01-017,139	5	1-1⅛
—— 4 p.c. Deb. Stock, Red.	100	68-73
—— 5 p.c. 2nd Debentures	100	82-85
Electric Construction, Nos. 1 to 112,100	2	7/16-11/16
—— 7 p.c. Cumulative Pref.	2	1 3/16-1 7/16
—— 4 p.c. Perp. 1st Mort. Deb.	100	63-68
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100	68½-74½
General Electric Company (1900) 5 p.c. Cum. Pref.	10	8¼-8⅜
—— 4 p.c. 1st Mort. Deb. Stock	100	83-87
W. T. Henley's Telegraph Works, Ordinary	5	12½-13¼
—— 4½ p.c. Preference	5	5⅛-5⅜
—— 4½ p.c. Debentures	100	106-108
National Electric Construction Co., 1-170,000	1	⅛-⅜
Telegraph Construction and Maintenance	12	34½-36
—— 4 p.c. Bonds	100	101-103

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Bournemouth and Poole, Ordinary	10	9½-10¼
Brompton and Kensington, Ordinary	5	6¼-7¼
—— 7 p.c. Preference	5	6¼-7¼
Canadian General Electric Co., Common Shares	$100	117-122
—— 7 p.c. Cum. Pref. Stock	$100	116-121
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5	3¾-4⅛
—— 4½ p.c. Cum.. Pref., 1-80,000	5	4⅛-4¼
—— 4 p.c. Debenture Stock, Red.	100	98-101
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5	3¾-4⅛
City of London, Ordinary	10	10⅜ 10⅞
—— 6 p.c. Cumulative Pref.	10	11¾-12½
—— 5 p.c. Debenture Stock	100	121-124
—— 4½ p.c. 2nd Deb. Stk. Red.	100	100-103
County of Durham Electrical Power Distribution Co., Ordinary, 1-50,000	5	1½-2
—— 5 p.c. Preference, 1-50,000	5	2¾-3⅛
County of London Elec. Supply, Ordinary	10	7⅛-8⅛
—— 6 p.c. Cum. Pref.	10	10⅜-11⅛
—— 4½ p.c. Debentures Prov. Certs. All pd., Rd.	100	105-108
—— 4½ p.c. 2nd Debentures, Red	100	98-101 xd
Edmundson's Electricity Corporation, Ord., 1-80,000	5	⅛-5/16
—— 6 p.c. Cum. Pref.	5	⅛-¼
—— 4½ p.c. First Mort. Deb.	100	57-60
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100	91-94
Kalgoorlie Electric Power and Lighting, 6 p.c. Non. Cum. Pref., 1-150,000	1	7/16-9/16
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000.	5	7-7½
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100	95-98
London Electric Ordinary	3	1¾-2⅛
—— 6 p.c. Pref.	5	4¾ 5¼
—— 4 p.c. 1st Mortgage Debenture Stock, Red.	100	93-97
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	73¼-77½
Metropolitan Ordinary, 100,001-300,000	5	4-4⅛
—— 4½ p.c. First Mortgage Debenture Stock	100	105-108
—— 4½ p.c. Cum. Pref.	5	4⅝-5
—— 3½ p.c. Mortgage Debenture, Red.	100	83¼-86½
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,050 ($500) M 1-4,400 ($1,000)	—	80-82%
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb. Red	—	98-100
Newcastle-upon-Tyne Electric Supply, Ord., 1-50,000 and 57,010 to 137,500	5	4-4⅛
—— do. 50,001 to 57,009	5	4-4⅛
—— do., 5 p.c. Pref., 1-137,500 Non. Cum.	5	4¾-5⅛
Notting Hill Electric Lighting	10	12¼-13¼
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	6-6¼
—— 4 p.c. Debenture Stock	100	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1	1⅛-1⅛
—— 6 p.c. Non-Cum. Pref., 1-100,000	1	1⅛-1⅛
—— 5 p.c. Debenture Stock, Red.	100	105-106
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5	5⅛-5⅛
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5	6⅛-6¼
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	—	105½-107½%
Smithfield Markets Electric Supply, Ord., 1-12,000	5	⅛-⅛
South London, Ordinary	4	2⅝-3
South Metropolitan Electric Light and Power Ord.	1	5/16-9/16
—— 7 p.c. Cum. Pref.	1	1 1/16-1 3/16
—— 4½ p.c. 1st Mort. Deb.	100	100-103
St. James's and Pall Mall, Ordinary, 101-20,080 and 40,081 to 60,100	5	8½-9
—— 7 p.c. Pref. Non. Cum.	5	7-7⅛
—— 3½ p.c. Deb.	100	84-88
Urban Electric Supply Co., Ordinary	5	⅝-¾
—— 5 p.c. Cumulative Preference, 50,001-100,000	5	1¼-1⅜
—— 4½ p.c. First Mort. Debenture Stock, Red.	100	78½-78¾
Westminster, Ordinary	5	8⅛- 8⅜
—— 4½ p.c. Cum. Pref., 110,101-191,379	5	4⅛-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 5 p.c. Cum. 1st Pref., 1-640,000	5	4⅛-4⅜
—— Debenture Stock, Red	100	91-92½
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1	⅛-¼
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1	⅛-¼
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	87-90
British Columbia Electric Railway Co., Ord. Def.	100	150-155
—— Ord. Pref.	100	123-128
—— 5 p.c. Cum. Perpetual Pref. Stock	100	109-112
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	100-102
—— 4½ p.c. Vancouver Power Deb.	100	102-105
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10	⅜-1
—— 6 p.c. Cm. Pf., 30,001-60,000	10	2⅛-2⅜
—— 5 p.c. Perpetual Debenture Stock	100	82½-85½
—— 4½ p.c. 2nd Deb. Stock	100	58-62 xd
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100	97-99
Calcutta Tramways, Ord., No. 1 137,610	5	4¼-5
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5	4⅜-5
—— 4½ p.c. 1st Deb. Stock, Red.	100	101-104
Cape Electric Tramways, Nos. 1-491,222	1	3/16-7/16
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5	4⅜-5⅛
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100	96-100
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5⅛-6
—— 4 p.c. Deb. Stock, Red. (1985)	100	98-101
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12½-13¾
London United Trys (1901) 5 p.c. Cum. Pref.	10	2⅜-2⅞
—— 4 p.c. 1st Mt. Db. Stock, Red.	100	67-70
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	1/32-5/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1	1/16-1/8
—— 4½ p.c. Deb. Stock, Red.	100	93¼-96½
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100	100½-103½
Provincial Tramways Co., Ordinary, 1-24,912	10	4-4⅛
—— 6 p.c. Cum. Pref., 1-10,000	10	9½-10½
San Paulo Tramway, Light, and Power Co.	$100	148-151
—— 5 p.c. 1st Mort Deb., Red. (1929) 1-12,000	$500	102-104½%
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅜-½
—— 4 p.c. Deb. Stock, Red. (1940)	100	69-73
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5	¼-⅜
—— 6 p.c. Cum. Pref., 1-46,261	5	1⅜-2⅛
—— 4½ p.c. 1st Deb. Stock, Red.	100	81-85

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100	60-62
—— 4 p.c. Pref.	100	85-87
—— " " deferred	100	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	101-103
City and South London, Consolidated Ordinary	100	30-31
—— 4 p.c. Debenture Stock	100	100-102
—— 5 p.c. Pref. Stock '91	100	108-110
—— " " " '96	100	104-107
—— " " " '01	100	100-103
—— " " " '03	100	96-100
Underground Electric Railways of London, 5 p.c. Prior Ln. Bds.	—	100-101 xd

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10	3-3⅛
—— 5 p.c. Debs., Red., within 1-1,609 Red	100	96-99
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000	96-98
Anglo-American Telegraph Co., Ordinary	100	61-63
—— 6 p.c. Preferred Ordinary	100	101½-102½
—— Deferred Ordinary	100	22⅛-22⅞
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100	87½-89⅛
Direct Spanish Telegraph Co., Ordinary	5	3-3⅛
—— 10 p.c. Cum. Preference	5	8-8⅛
—— 4½ p.c. Debs., 1-600	50	100½-102½
Direct United States Cable Co.	20	13-13½
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 p.c. Mort. Debs., within 1-8,000 (1913,	25	99-101 xd
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	—	—
Eastern Extension, Australasia and China, 1-300,000	10	11⅛-12¼
—— 4 p.c. Mort. Deb. Stock, Perp.	100	102-104
Eastern Telegraph Co., Ordinary Stock	100	126-129
—— 3½ p.c. Preference Stock	100	83½-85¼
—— 4 p.c. Mortgage Debenture Stock	100	102½-104½
Great Northern Telegraph Co. (of Copenhagen)	10	28½-29½
Marconi's Wireless Telegraph Co., Nos. 1-394,190	1	⅜-½
National Telephone, Preferred	100	107-108½
—— Deferred Stock	100	120-122
—— 6 p.c. Cum. First Pref.	10	10¼-11
—— 6 p.c. Cum. Second Pref.	10	10¼-10⅞
—— 5 p.c. Non. Cum. Third Pref.	5	5 7/16-5 11/16
—— 3½ p.c. Deb. Stock, Red.	100	98-100
—— 4 p.c. Deb. Stock, Red.	100	100-102
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100	100-102
West Coast of America, 1-30,000 and 53,001-53,008	2½	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	100-102
West India and Panama Telegraph Co., Ordinary	10	11/1613/16
—— 6 p.c. Cum. 1st Preference	10	8⅛-9⅛
—— 6 p.c. Cum. 2nd Preference	10	8½-9⅛
—— 5 p.c. Debs., Red., 1-800	100	101½-103½
Western Telegraph Co., 1-207,930	10	13⅛-14
—— 4 p.c. Debenture Stock, Red.	100	103-105

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1909.	1908.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Oct. 20	1,243	1,313	— 69	— 677	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940.	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Sept.	6,538	7,241	— 703	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Oct. 24	1,044	1,021	+ 23	— 374	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Oct. 23	6,775	6,385	+ 390	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Oct. 23	4,780	4,505	+ 275	+ 4,275	98	98	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	Oct. 31	834	831	+ 3	+ 1,527	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Oct. 29	5,303	4,875	+ 428	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Oct. 30	1,213	1,110	+ 103	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Oct. 31	246	222	+ 24	— 214	10	10	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Oct. 30	5,792	8,013	— 2,221	— 42,896	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·760	55,404	30·27*a*
Charing X, Euston, & Hamp. Ry.	Sept.	6,678	5,642	+ 1,036	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Oct. 31	3,366	3,131	— 235	+ 1,578	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Oct. 21	496	480	+ 16	—	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Oct. 8	1,793	1,552	+ 241	+ 2,906	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Oct. 29	119	127	— 8	+ 75	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Oct. 29	4,996	4,893	+ 103	+ 1,929	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Oct. 30	948	891	+ 57	+ 4,219	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Oct. 23	17,766	17,338	+ 428	— 4,761	180	181	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Sept.	9,693	9,264	+ 429	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Oct. 23	1,606	1,550	+ 56	+ 1,640	28½	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	Oct 30	2,537	2,517	+ 19	+ 2,790	26	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Oct. 23	468	424	+ 44	+ 950	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Oct. 20	139	134	+ 5	— 238	4	4	„ 31	7,214	1,908,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Oct. 27	1,163	1,183	— 20	— 763	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Oct. 16	11,105	10,959	+ 146	— 2,081	106	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Oct. 24	1,325	1,334	— 9	+ 12	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Oct. 9	39,757	37,840	+ 1,917	+ 38,069	126	122½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	„ 17	216	258	— 42	— 743	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Oct. 23	194	173	+ 21	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Oct. 30	10,474	9,899	+ 575	+ 6,327	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Oct. 31	16,160	16,749	— 589	— 6,565	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,710	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Oct. 23	4,248	4,187	+ 61	— 1,336	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Oct 28	586	576	+ 10	— 106	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,596	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Oct. 24	5,721	5,361	+ 360	+ 151	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Oct. 20	1,089	1,033	+ 55	— 380	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Sept. 22	169	156	+ 13	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 17	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Oct. 30	834	841	— 6	+ 731	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Oct. 14	2,377	2,250	+ 126	+ 4,104	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Sept. 22	879	804	+ 75	— 784	22½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train miles. *h* Half-year's figures.

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NOTES.

ELECTRICITY, CUTLERY AND ECONOMY.

At Sheffield, where tenement workshops—used by a single artisan, or by an artisan and one or more assistants, who carry on their trade on behalf of some large manufacturer or merchant—largely prevail, a quiet revolution is taking place. Many of these tenement workshops are run for grinding and polishing purposes, and formerly steam was used for power; but now it is found that electricity is far more economical than central steam power. It is found far more convenient, being more perfectly under control. So far the change has given complete satisfaction, and is gaining converts. Seeing that a group of tenements may range in rental value from 5s. per week to £120 a year or upwards, and that these groups are numerous, this adoption of electricity is an important move, which may afford practical object lessons for other industrial centres.

REDUCING WASTE.

In connection with Professor Charnock's report to the Bradford Engineering Society on electric driving in textile factories, it has been pointed out that apparently the experiments were only made with large motors driving long shafting. What the Committee should do is to study the use of small motors for driving individual machines, or small groups. This would give different results. Again, it is shown by critics that electricity cannot altogether banish steam from textile factories, because steam is required for heating, humidifying, sizing, and many other processes. But it is not, of course, seriously supposed that all boilers could be scrapped, merely that the horse-power of boilers could be materially reduced and engines largely discarded. Indeed, the far-seeing among electrical engineers deliberately calculate upon the extensive generation of steam in industrial districts for the supply of cheap electrical power, the idea being that much waste steam could be taken from individual factories and used by central or sub-stations for the generation of electricity, in which case the factories would gain an outlet for what was unprofitable to them, and would also profit by reason of the electricity concerns being able to sell cheap power. The idea is already being systematically exploited in the North-Eastern Counties, and is making many converts.

"RUN ON COMMERCIAL LINES."

We are often told that when a municipality instals a department for production or supplying of any commodity, such department ought to be run on purely commercial lines. The main idea underlying this proposition is right enough; there should be proper business management, but, after all, the commercial spirit cannot, and should not, altogether rule a corporation department. The difficulties facing friends and critics of municipalisation have been giving pause to two councils. At Bath the Corporation use both gas, supplied by a private company, and electricity, derived from their own undertaking, for lighting the public thoroughfares. Recently, being dissatisfied with the lighting of certain streets, the Surveying Committee decided to discard gas and instal new electric lamps. Naturally, and rightly enough, the gas company kicked, desiring to be permitted to put up new gas lamps. Then the question arose as to policy. It was argued that as the electricity works belonged to the Corporation, it should be supported through thick and thin, but others argued that this support should be subject to economic considerations. And there the matter rested. It must be remembered, however, that, as a rule, when electricity is installed, the community secure a more efficient and certainly a safer system. This is often overlooked when questions of cost are being considered. Then, again, if the municipal department light the streets, the greater output enables a better domestic service to be supplied, so that the community gains. The "strictly commercial" idea must be modified by common sense.

COLWYN BAY'S PROFIT AND LOSS.

There has been a searching of hearts, as well as an overhauling of the Electricity Works at Colwyn Bay, as the result of the fact that the department has lapsed from a profitable to a losing concern. Mr. Hill, from Rhyl, was called in to report on the whole position. Unfortunately, there seems to have been a comparison between the two municipal concerns, hence the report has called forth a good deal of recrimination and is scarcely likely to improve matters. Among the points coming in for criticism are the following: High rate for repairs of public lamps, amounting to £3 14s. per lamp; low rate charged for current supplied for public services; discrepancy between amount of current generated and that used at works or sold, there appearing to be a loss of 64,000 units, or 20% on the amount generated. Mr. Hill also suggests re-arrangement of staff and duties. Another proposal is that as the Electricity Department in former years earned £1,250, which went in reduction of rates, the loss should also be paid out of the rates. Of course, in effect this is done, but it is well that profit and loss should be shown, as it must be taken into consideration when income-tax has to be calculated. Mr. Tudman, Colwyn Bay's electrical engineer, has replied to some of the criticisms. He shows that part of the loss is due to obligatory, and at present unremunerative capital outlay, to a falling off in revenue owing to adoption of metal filament lamps, and to the low rate paid for current by the municipality. As regards the apparent amount of current unaccounted for, which compares with Rhyl's 18,947 units, this discrepancy is merely a matter of different methods of organisation and accounting. It does seem, however, that the municipality is debited at too low a rate for the current used by it.

FALSE ECONOMY.

One patent fact is that the Colwyn Bay concern is severely handicapped by false economy. There is ample proof that the lamps used for street lighting ought to be discarded, for they are outworn, consequently requiring too much attention from the staff, and costing an absurd amount for keeping in repair. This clinging to appliances that are no longer much good is a prevailing fault, but one from which public bodies should be free. It is clear enough that these lamps, while entailing heavy expense and loss of time, cannot give averagely good results, and, consequently, there must be a waste of current. Public bodies ought certainly to understand by now that to postpone replacing inefficient appliances is a penny wise and pound foolish policy. Surely we have in the metallic filament lamps for indoor use a striking enough example, and one which should come home to everyone concerned with central station administration. By using these latest of scientific developments customers not only secure better illumination, but save on their bills as well. It is always true economy to keep up efficiency at the highest pitch practicable, and that cannot be done by retaining old, time-worn appliances.

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CONSULTING ENGINEERS.

As regards Colwyn Bay, a misunderstanding seems to have arisen over the question of salaries. Mr. Hill considers that the second in command should not be called assistant engineer, regarding him as little more than an artisan. Mr. Tudman replies that he is a fully qualified engineer, and all that we can say, under the circumstances, is that the municipality is greatly to blame in expecting its assistant engineer to carry out certain of the duties which now fall to his lot. It is like using a fine steel razor to cut a millstone. Some discussion has arisen over Mr. Tudman's salary, which is said to be higher than paid elsewhere. In this case, the salary was fixed when Mr. Tudman undertook the duties of chief engineer and consulting engineer. It appears that since the services of a consulting engineer were dispensed with capital expenditure had been undertaken to the extent of £15,000, thus showing a saving of £750 commission to the Council. While in no way desiring to criticise this particular case, we think the principle bad. Apart from the fact that a chief engineer should have his time pretty well occupied with current work and planning for future developments, there is no doubt that the services of independent consulting engineers cannot wisely be dispensed with. A consulting engineer views a scheme with greater independence of mind, and should be in closer touch with new developments than is possible in the case of a local man. It is false economy, in nine cases out of ten, to save the consultant's fees.

AMERICAN GOVERNMENT'S ELECTRIC TRADING.

Some criticism has been raised owing to the United States Government going in for electric power supply. Mr. R. A. Ballinger has approved of two contracts whereby the Federal Reclamation Service undertakes to supply respectively Spanish Fork City, Utah, with electricity for lighting purposes, and the supply of electricity to the Pacific Gas and Electric Co., for the lighting of Phœnix City. In the one case the current is supplied (to the extent of not more than 65,000 kw.h. per month, at eight-tenths of a cent per kw.h.), from the surplus power generated on the Strawberry Valley irrigation scheme. In the other case, the power is supplied from the Salt River Reclamation Scheme. Much the same policy is being pursued in India, and, indirectly, in Canada.

MERCURY LAMPS AND EYESIGHT.

One of the leading German medical papers declares that the rays from mercury vapour lamps are injurious to the eyesight. Five cases are reported where either conjunctivitis or paralysis of the retina was caused by the use of mercury vapour lamps for therapeutic purposes or as illuminants in factories. This extremely powerful lamp, with its chemically active coloured rays, is comparatively new, and as yet scarcely understood. It is probable enough that the lamps should be so placed as to avoid the direct rays falling on the eyes. It is a point requiring further investigation.

DEHYDRISATION OF TRANSFORMER OIL.

A new method of removing water from oils intended to be used for insulation purposes in transformers is reported from France. The dehydrising agent used is sodium. This metal is added in small quantities to the oil, when hydrogen is formed, the soda falling to the bottom. About three-quarters of an ounce of sodium is added to 20 gallons of oil, more being added gradually until no more gas is disengaged. The oil should be shaken up for a minute for a period of three or four days, but it is found that the longer the oil is allowed to mature over the deposit of soda, the stronger will be its insulating powers. Oil, it is said, can be treated in the transformers themselves, the sodium being melted and moulded into sticks, which are attached to wires and plunged into the liquid. Dehydrisation in bulk, however, is naturally preferable.

CELLOLINE.

It will be remembered that in our issue of September 3 we gave some particulars of "Celloline," a really marvellous substitute for celluloid in all the uses to which the latter can be put, as well as possessing other distinct advantages. In one form it is a viscous body, which can be used as a varnish, and in this way proves a splendid insulating medium for wires, thus doing away with cotton binding. We are reminded of this when we read of the new system of wire insulation now being adopted at Woolwich, as described in another column. We understand that good progress is being made with "Celloline." It will undoubtedly prove an immense boon when it is on the market, not only owing to its commercial advantages, but because of its safety. With "Celloline" there would be no danger of such a terrible accident as happened at Brooklyn, New York, on Monday, when Messrs. William Morrison & Son's Celluloid Factory was burned down as the result of an explosion, causing the death of nine persons and the injury of many others. "Celloline" is not only not explosive, but practically non-inflammable.

THE RAYS AND PRODUCT OF URANIUM X.*

By FREDERICK SODDY, M.A.

Experiments have been made with the uranium X. preparations separated with the help of Mr. A. S. Russell from 50 kilograms of pure uranyl nitrate. There occurred the growth of a feeble α-radiation as the intense B-radiation decayed. Such a growth of α-rays, concomitant with the decay of B-rays, is to be expected if the parent of radium is the direct product of uranium X. From the period of the parent of radium given in another paper, the uranium X in equilibrium with 1 kilogram of uranium should give by its complete disintegration a product having the α-activity of 2 milligrams of uranium, if no new intermediate bodies intervened.

The preparations of uranium X were examined in a magnetic field sufficient to deviate all rays having a value for Hp less than 8640, but the still undeviated B-radiation produced a leak in the electroscope several times greater than that due to the γ-rays. So far as can be seen, these difficultly deviable B-rays are similar in general character and in the value of their absorption co-efficient, to ordinary B-rays. The first measurements were made in an electroscope filled with air, by covering the preparation with a thin screen, sufficient to absorb α-rays and measuring the difference between the leaks with and without the screen. The results of these experiments are believed now to be untrustworthy, and they are rejected provisionally. In later experiments the electroscope was filled with hydrogen, which constituted an enormous advance, and these experiments have shown that the α-radiation of the preparation remains sensibly constant as the B-radiation decays. Anomalies have been encountered with the difficultly deviable B-radiation, which appears to vary in intensity according to the conditions in an unexplained way. But throughout, the "difference leak" between the preparation bare and covered, due to α-rays, has remained constant in all the preparations examined. These measurements of the α-rays, for different preparations, cover a period from immediately after preparation to nearly a year in the case of the main preparation, and longer periods in the case of weaker preparations. The two most recent preparations each contained the uranium X in equilibrium with about 5 kilograms of uranium, and the growth of α-rays if the change of uranium X into the parent of radium were direct, should be equal to the α-radiation of 10 milligrams of uranium. This should have been easily detectable under the conditions of the experiment. It is concluded that the parent of radium cannot be the direct product of uranium X. The experiments, taken in conjunction with those given in the preceding paper, indicate that it is not a product of uranium X at all, but the subsequent history of the uranium X preparations must be awaited before this can be decided.

* Paper read before Physical Society of London, Oct. 22.

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A SURVEY OF THE ELECTRICAL INDUSTRY.*

By R. K. MORCOM, A.M.Inst.C.E., M.I.E.E.

There appears to be no doubt that at present the electrical industry is passing through difficult times. There is a great deal of severe competition both home and foreign, and the market itself is not expanding as satisfactorily as in the past. I think that having as I have a keen interest in the progress of electricity, but being, as it were, on its border-land, I may be able to survey the position from a somewhat special point of view. More particularly I wish to consider the state of the primary branch of the industry—namely, large electrical engineering—which will be referred to as "the industry" in many places. With the object of getting into closer touch with internal opinion I referred to the reports of annual meetings and to the balance-sheets of the leading companies, and was surprised to note that at least one or two companies in every year since the beginning of the century complained of general industrial depression, although in the same years others might state that trade was satisfactory. Opinions being so conflicting I thought it advisable to analyse figures to discover to what extent depression or the reverse existed by an examination of figures published or otherwise obtainable for the past few years.

In some respects the state of the electrical industry is difficult to analyse. Its development depends upon the development of a practically new science, and its progress is affected not only by the general progress of trade, but also by the success of its competition with older methods of attaining particular ends. If electricity were unknown oil and gas could still give light and heat; ropes, belts, and shafting would transmit our power, and locomotives or horses propel our trains and trams. But the convenience of the electrical method is such as to make comparatively rapid headway in these fields.

In studying the period from 1900 to the present day from available statistics, it at once becomes apparent that immediately the disturbance caused by the South African War had subsided, the trend of trade was upwards on a very steep curve, except that 1904 and 1908 were noticeably periods of depression. So far as the Board of Trade returns for total imports and exports are concerned, the 1904 depression is masked by the demands of the Russo-Japanese War, whereas that of 1908 is obvious. To find the signs of the former depression we must go to other figures. Among the chief users of electrical power are the textile, the iron and steel, engineering, shipbuilding, chemical, and mining industries. A study of the Board of Trade returns for these industries reveals the signs of depression not in the textile industry, which shows a steady increase up to 1907, but in the others. In the iron and steel industry there was a decided falling off in exports during 1904. The chemical exports instead of increasing were almost steady, the machinery exports showed an increase less than that shown in either 1903 or 1905. Also there was a falling off in shipbuilding in 1903-4 for vessels for our mercantile marine. There was likewise a fall in the rates of increase of coal and pig-iron production.

The depression of 1908 is much more marked, and statistics show a retrograde movement all round—a very serious one in the textile trade, and actual decreases in all the other above-mentioned industries. As further indicating that these were years of depression, the returns of unemployment show a peak in both. It is to be hoped that the coming winter will show some alleviation of the unemployed position compared to last year when it assumed such serious proportions.

Another important consideration bearing on the progress of the industry is to be found in the expansion of public supply, my authority for which I take from the latest edition of Garcke's Manual. The figures show that whereas there was an increase from 1906 to 1907 of 179 million units, the increase from 1907 to 1908 was only 104 million units. The increases of plant installed for supply undertakings have likewise fallen off considerably in the last year or two.

The traction figures for municipal trams extended but slowly during 1908. The expenditure of tramway companies was very considerable, but Mr. Garcke points out that the rate of growth of increase is not maintained, and a considerable portion was accounted for by railway companies' electrical expenditure. The Board of Trade returns treating of the electrical industry itself are incomplete and unsatisfactory. Roughly they reveal that whereas our imports of electrical machinery have since 1903 maintained a fairly constant level of, say, £600,000, our exports have risen from just under half a million to about one and one-third million. Figures of electrical exports and imports, excluding machinery, have been subject to various adjustments and classifications which obscure them, but the position may be summed up by saying that the imports have shown an almost steady rise, while exports fell severely in 1904 and again in 1908. The exact value of our home market for electrical machinery is one that is difficult to estimate. The census of production figures for the industry are not available, and unlike some of our foreign competitors, we do not seem anxious to publish particulars of our sales. Occasionally some indication is offered in prospectuses, but incomplete and sometimes over-optimistic. I endeavoured to get at it in a roundabout way as follows: I obtained, after considerable inquiry, particulars of the number of employees of leading firms. I also got from some of them the proportion existing between the export and home trade in a sufficient number of cases to suggest an average figure. The average was taken, the percentage from each firm being properly weighted by multiplying it by the number of employees. As the figures given were confidential I can only give my results as follows: This rate for 1908 works out at 31½% foreign and 68½% home. The figures are necessarily approximate only, but indicate that our home consumption is in the neighbourhood of £3,000,000, our exports one and one-third million, and imports half a million. In comparison with previous years our exports appear to have increased faster than the home consumption.

Another noticeable point has been the falling off in the ratio, in our home consumption, between work for public service to that for private service. A recent estimate of the municipal demand was about 1½ million per annum. To-day's figure is probably a good bit less than this. Estimates of the output of other branches of the industry, which I glean from evidence collected in the Tariff Commission's report, are that the home consumption of electrical fittings is between £300,000 and £400,000 per annum, of which about half is imported. For lamps the home consumption is about 20 million lamps, of which about 7 millions are imported.

So far the analysis has been chiefly confined to the consideration of the market for finished goods. The prices of raw materials will next be taken. The most noticeable feature of the century was the rise in price of copper in 1906-7 to a value double that prevailing in 1894-5. This rise, it will be seen, occurred on a falling market for electrical machinery, and was a factor in producing considerable distress to manufacturing concerns. The price of pig iron from a very low figure in 1901 has risen steadily, and was in 1908 nearly 70% above the former figure. Under these conditions of output and prices of raw materials what has been the progress of selling prices? As an indication I propose to take instances which represent the general trend, selecting the branch for which the figures are most easily accessible to me—namely, generating sets for coupling to high-speed engines. I propose to give the price per kilowatt of alternating and direct current machines of about 250 kw. and about 1,000 kw. The averages thus obtained for 1901-2 were £3·6, £3·4, £2·6, £3·0 per kilowatt. These started at once to fall, first slowly, then rapidly in 1904, and then again gradually, till to-day the corresponding figures are £1·9, £1·85, £1·5, £1·55. The trend of prices has been similar in practically all branches of the trade, and in the allied industries of stationary engine building and steam turbine building. The increased price of raw materials in 1906-7 made no difference to the rate of fall.

The causes assigned for the fall are three-fold. Some put it down to foreign competition either real or feared, others to over-productiveness in the industry, others, again, to depression of general trade. A satisfactory feature is that up-to-date machines are better designed and more reliable than the older; they are better manufactured and much better standardised. A few years ago to

* Chairman's Inaugural Address to Birmingham Local Section, Institute of Electrical Engineers, Nov. 3.

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meet the cut prices, some machinery was turned out of inferior design, but the mistake of such a policy has been clearly shown, and my own experience is that our manufacturers now turn out the finest machines in the world at prices far below their true value.

A further point that needs consideration is the distribution of capital in the industry. The figures for this capitalisation are given in Garcke's Manual, but unfortunately they are very disguised by the inclusion of a large number of companies whose staple product is not electrical, or who are merely agents for foreign manufacturers. I have taken out revised figures which will, I think, put the position more clearly. Mr. Garcke states that from 1896 to 1906 the capitalisation grew from £6,500,000 to £40,000,000. I have attempted a closer analysis of the figures for the three years 1896, 1902, and 1908, which I tabulate as follows :—

Year.	Large Engineering.	Cables.	Lamps, Fitting, and Wiring.	Traction Accessories.	Instrum'ts and Accumulators.	Foreign Agencies.
1896	1,700,000	1,400,000	880,000	—	450,000	130,000
1902	5,000,000	2,500,000	2,200,000	600,000	900,000	500,000
1908	9,000,000	3,200,000	4,300,000	500,000	1,400,000	500,000

It will be seen that much the largest rise in capital has been in the industry I am specially considering, and this branch is the one which accordingly will suffer most from internal competition. The stress in other branches is more likely to occur from foreign competition or that due to the large engineering factories taking up accessories as a sort of by-product.

The tendency nowadays is towards wholesale manufacture and the accumulation of subsidiary manufactures into the hands of large firms whose business is of such a nature as to be akin to the particular subsidiary. It is generally a mistake to endeavour to link up two industries which require staffs of absolutely different training. For instance engine-building pursued by electrical firms has not on the whole been a great success, and probably always leads to waste in staff expenses. The heavy capitalisation which has been noted in the engineering section is one particularly worth note, and its effect may be usefully illustrated by a wider review than has been hitherto adopted.

In a way it is a young industry, but past its infancy. In its infancy it suffered from one very bad slump in the early and middle '80's, similar to that which recently hit the infant motor-car industry. This slump was undoubtedly due to the great rush of capital into an industry, based on a mistaken idea as to its immediate future. In the year 1882 alone nearly £9,000,000 of capital was raised for electrical enterprises. As a result competition was so keen as to reduce profits to vanishing point. Improved methods of manufacture and gradual realisation of the over-eager anticipations of the companies gradually steadied the industry into one of increasing prosperity.

The progress of electric lighting, which came with the improved design and cheapness of lamps, continued steadily. Electric traction found more and more application, and up-to-date manufacturers, by adopting electric drive because of its convenience, cleanliness, and economy, all brought grist to the mill, and a remunerative business was done during the closing years of the last century by a number of concerns whose names are household words with us.

The beginning of the twentieth century seems to have heralded harder times. The older companies, led on by their excellent trade, increased their capital, and new enterprise was tempted in by the evident prosperity of the business, till to-day we are again in the position that if all our works were full, the demands of our home and export trade would not be enough to take their output.

I find that, generally speaking, the summary of figures which I have so far given throw considerable light on the published remarks made at the various company meetings, which, as I previously mentioned, I had found somewhat conflicting. It is obvious that the sore straits in which some of them found themselves, blinded them to the actual course of events.

The evidence all points to considerable increase in the volume of trade in 1906 and 1907 in spite of a marked reduction in the increases of municipal expenditure. Reports show that improvements in organisation and design were having their effect in coping with the reduced scale of prices, but towards the end of 1907 the cheerful tone disappeared and a severe depression set in, the reasons for which as well as its character will be quite clear from what has been said about the very obvious slump of 1908.

It is certain that had it not been for increased productivity, the first seven years of this century, excepting 1904, would have been progressively profitable. In fact, 1906-7 were remarkably good years. The introduction of the metallic filament lamp has undoubtedly reduced the requirements in machinery, and it remains for the increased cheapness and efficiency of electric light to stimulate the demand to a pitch when plant requirements shall again assume an upward grade. Cheap electrical power is encouraging further industrial application, and if experience of heavy traction, at present on its trial, is satisfactory, it is only a matter of time before this application is extended. Tramway work is bound to extend with increasing urban population.

In shipbuilding more and more work is being done electrically, and the electrical requirements of the ships are growing, while at present the air is full of rumours of the close approach of electro marine propulsion. All these things give hope that, as the capitalisation which caused the slump in the early '80's was justified in the '90's, that of the first decade of this century may be justified in the second.

But to cause such a demand capital and enterprise are required. I use the word capital in the usually understood sense of capital in bulk. While freedom of captial may not so much affect the sale of an article which can be bought in penny lots, when it comes to an industry whose output comprises units costing hundreds or thousands, free capital is its life blood. Without it we must look to great restriction of our home market which is at present our chief one, with the likelihood of foreign competition such as occurred in 1904. The other great markets of the world are practically closed to us. Our Colonial industries though growing rapidly are not yet large enough to make up the deficit, and the same may be said of various non-manufacturing countries. The industry is so large and important that in foreign countries it receives special support from the Governments, and it is estimated that in Germany the number of employees increased from 1904 to 1906 from 72,500 to 95,000. According to Garcke, the comparative British figures for 1907 would be 45,000. It is estimated that the whole of the electrical industry in this country employs 300,000 persons, so that its prosperity may seriously affect the question of unemployment. In the large engineering branch capital must play a great part. Contracts are severe, and payments for the finished article are often held up for long periods. All the while the wages of labour must be promptly and fully paid. Capital is the flywheel of industry, which keeps things going steadily under the fluctuating impulses of demand, and enables the machinery to grind out at an even rate the current of wages. It is, therefore, the business of capital to keep wages secure. But it cannot perform this function rightly unless it is secure itself. Such security requires a large enough market. It is serious to note in Garcke's Manual that almost £7,000,000 of capital in the industry earns no dividend at all, and to observe the serious fall which has occurred in the Stock Exchange quotations for electrical securities. In an industry so specialised, and which requires a great amount of brain work, a great deal of expensive machinery, and large purchases of raw material, the capitalisation must be high. I find from figures of numbers of employees, and of the capital of a number of our leading companies that on the average £300 of capital must be found to provide workshop, tools, security, and trade for every single workman.

The average capital expended on buildings and plant is nearly £200 per man employed. Careful organisation, with increasing trade, will enable this figure to be reduced. The staff expenses for technical and clerical work are necessarily very high, and add considerably to the dead charges. In many instances their total is as high as the wages bill; while, taking an average for the clerical staff of a number of the large firms, it will be found that one clerk is required for every three to four workmen. The

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importance of this clerical element is often overlooked when discussing the relation of capital to labour. I would like to enlarge upon the internal relations of manufacturing, but the information is very hard to obtain. In this connection the annual report of the American G.E.C. is most interesting. From the 1907 report I glean the following: Area, 4,770,000 sq. ft.; employees, 28,000; cost, $1.12 per sq. ft.; orders, $60,000,000; capital, $64,000,000.

I have touched a little upon the great subject of the relations between capital and labour, but will refrain from discussing it at all in its political aspect, as I have refrained from remarking upon the tariff controversy. We are not a political institution, but one thing upon which we all are intent is to do our bit for the welfare of our great industry, and thus for our country. Our bit is for the manufacturer, designer, and consultant to see that our products, designs, and schemes for 1910 are so superior to what we have done before that our older works will be discarded, and their substitution bring in such a crop of orders as to give plenty of business and full employment to our engineers and factories alike. But not only must our 1910 goods be better than our previous ones, they must be better than any one else's 1910 goods.

We are now so well equipped with fine technical schools and universities, and they have such splendid men on their staff as professors, that we may rest assured that engineers are being turned out, equipped with the highest training, and able to hold their own in any competition. This, above all, will ensure our industry showing progressive improvement, which will keep the market alive.

A noticeable feature in the addresses of Chairmen of Local Sections of late years has been the stress laid on the education problem, and very rightly, but we must see that the thing is done properly and not overdone. Education can narrow as well as broaden.

That a man in his time must play many parts has never applied to anyone, I think, as much as to the modern engineer. It has been pointed out that he may have to be a physicist, mechanic, accountant, salesman, organiser of labour, and judge, and you cannot be educated to all that. All that our teachers can do is to lay the right foundation of knowledge and leave experience to do the rest. So much has been said and written by able men on this point that I can but refer you to their writings and words for guidance in forming your own opinions, but there is one point on which I feel strongly, and that is that there is rather a tendency to discourage pure is favour of applied science. The value of mathematics, in particular as a training, should never be overlooked. Given zeal, I believe that mathematics, and plenty of it, will take a man further than any other training. It will give him that most valuable commodity, a well-ordered mind. A common experience is that if a student experienced difficulty, in say, advanced arithmetic, he would go back to it as child's play after a bout with algebra, and when algebra begins to get vague a dose of differential will send him back to scoff at the former difficulty, and so on into higher fields. A sound mathematician can always more readily specialise on a physical subject than another man—he is trained to reason.

Take a mathematician, give him a workshop training, and let him read the technical papers instead of the sporting columns of the daily press, and he will make an engineer. If he also has the gift of common sense and zeal for his profession he will make a good engineer. An engineer whose knowledge of mathematics and pure science is rudimentary is to his truly educated *confrère* much what a pianola player is to a pianist.

And this brings me to my conclusion on a point at which manufacturers, educationalists, and this Institution are on common ground. For it is only by keeping in the forefront of scientific production that we can hope to secure for ourselves a prosperous industry and a respected profession.

"PAY-AS-YOU-ENTER" CARS.

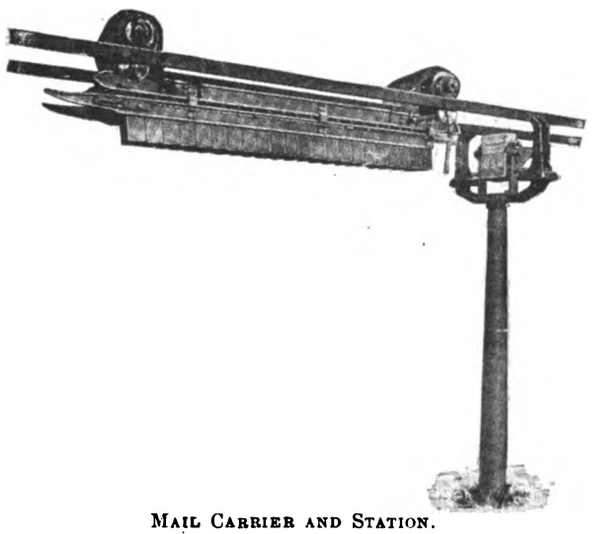
The "pay-as-you-enter" cars, the invention of Messrs. Ross & McDonald, of the Montreal Street Railway, are used now very extensively in Canada and the States. In the latter country these cars are in use in no fewer than 40 cities.

AUTOMATIC ELECTRIC TRANSPORTATION.

NOVEL AMERICAN SCHEME.

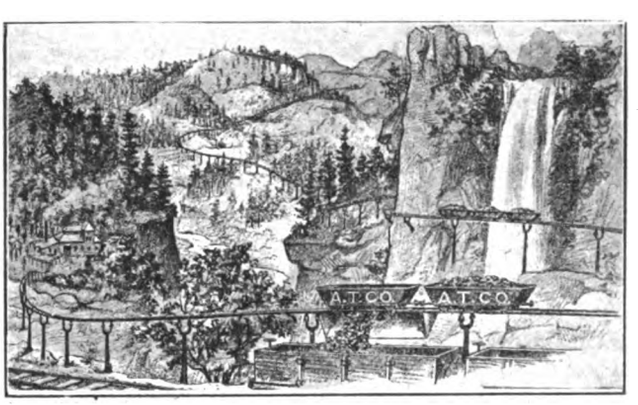
An automatic electric transportation system is in the course of development in the United States, which, owing to its great flexibility and consequent adaptability to all kinds of conditions, seems destined to attract the closest interest in the electrical world. The main principle of the new system is the taking of electric energy directly into the carrier from the rails on which it travels, thus doing away with the third rail and overhead trolley. If the claims of the inventor, Mr. Carr, of Buffalo, are substantiated, the adoption of the new system will greatly facilitate means of transport in the suburbs and country for the delivery of packages, mails, and like matter.

We gather from the prospectus of the American company formed for the exploitation of the invention, that the electric automatic device which has already reached a



MAIL CARRIER AND STATION.

practical stage of completion, will deliver automatically, as frequently as desired, mail or packages of merchandise to every house within a given radius. The installation of this electric automatic device will, it is claimed, supplant the present slow Government rural mail delivery system and provide the much needed parcel post. Delivery is made by means of carriers, which travel from 8 to 20 ft. above the ground, starting from a given point and travelling at a rate of 20 to 25 miles an hour, and depositing, while *en route*, mail or packages at any or all of the stations on the line. The carriers also automatically collect mail or merchandise deposited by the farmers, and return with it immediately to the starting point or central station. It is said that one man can operate at least 12 rural lines.



AUTOMATIC ELECTRIC ORE CARRIER FOR USE IN MINING DISTRICTS.

This being so, the rural resident may send his butter, eggs, and all other farm produce to the central station at a rapid speed, while goods of any kind may be distributed to any of the stations located at the various farmhouses on the line accurately and quickly. By thus facilitating the transporting of goods to and fro, and at the same time furnishing complete telephone connection for communication, will afford the farmer practically the same advantages he would enjoy if a resident of a city.

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It will be possible under this system to afford the rural districts two or more distributions a day. The electric carrier can cover a route of 25 miles in less than an hour.

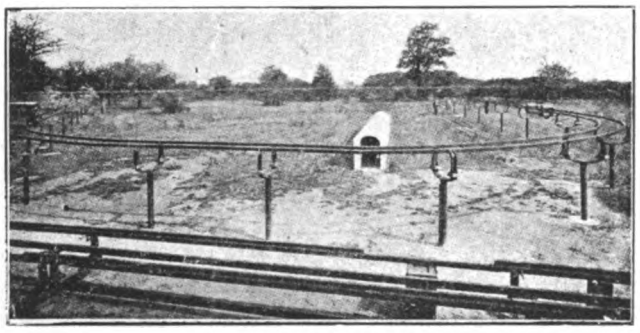
An underground tube system will be constructed in cities for the rapid delivery of mail from railroad stations to central and sub-post offices. This underground system in centres of congested population will also greatly facilitate the delivery of merchandise. Lines will radiate from central points to various outlying districts of the city. By the use of this system the great stores of the various big cities of the country may send parcels to central stations from which they will be sent through underground tubes to the various precincts of the cities and thence distributed by wagons or messengers. In this way shoppers from the outlying districts will find their purchases delivered at their homes before they return from their shopping tours.

It is also intended that the system installed in concrete tubes shall be used to transport mail and merchandise between cities at a rate of speed hitherto impossible of attainment.

Each rural resident will be informed when his mail box or parcel is deposited at his station by the ringing of an electric alarm; and the progress of the electric carrier over its route will be noted at each stage in the central office by an electric indicator. In connection with the automatic transportation line, telephones will be installed on the line at an unprecedented low rate.

The period of experiment has already been successfully passed. A complete full size line has been installed at the testing station, Main-street, Buffalo, where, as our illustration shows, visitors may see the ore cars, rural mail carriers and automatic switch in actual operation.

The inventor asserts that mail can be transported through the underground system, from Buffalo to New York, at the rate of 150 miles per hour.



PANORAMIC VIEW OF FULL SIZE TESTING LINE.

Another feature urged in behalf of the system is that it will make electric lights, heat and power possible in every farmhouse along its route through the rural sections. Tapping the rails, a farmer can enjoy electric lighting in his house, electric heat for his cookstove and electric power to operate his threshing machine. In short, Mr. Carr claims that the farmer can enjoy every electrical convenience that his city brother now enjoys.

Moreover, by the use of this system, specially constructed carriers will take ore over mountains, through valleys—where the cost of constructing railroads would be almost prohibitive—and deliver the ore at a high rate of speed direct to the smelters, or dump it in freight cars. In the great wheat belts of the West and in the plantations of the South, this same means of transportation might also be adopted.

We understand that the invention has already attracted a large number of capitalists, both American and foreign, from countries where the inventor now has patents pending.

INDUSTRIAL PROGRESS IN SOUTH CHINA.

The South China Government has placed in America an order for a complete shoe factory. They have also placed in England an order for a complete tannery and belt, harness and saddle factory, the equipment of which is being purchased through Messrs. Sanders, Rehders and Co., Ltd., London.

DETERMINATION OF TRAIN RESISTANCE.*

By E. I. WENGER, B.Sc., Stud. Can. Soc. C.E.

The rapid development of the use of electricity as a motive power for railway trains has forced the engineer of to-day to the consideration of problems which were relatively unimportant a few years ago.

The tractive resistance of electric cars being the foundation upon which is based the calculations leading to the selection of motive power, equipment has of late claimed considerable attention. Numerous formulæ have been developed, and a number of tests have been made to determine the train resistance of electric cars and trains. Amongst these may be mentioned the Buffalo and Lockport Railway tests in 1900 by Mr. W. J. Davis, the Zossen high-speed tests in 1902–3, tests made by the Electric Railway Test Commission on the test car, "Louisiana," in 1904–5, the New York Subway tests in 1905, and tests on the New York Central locomotives in 1905–6. The majority of these tests were made under somewhat unusual conditions of track and equipment, and consequently the results obtained are not generally applicable to traction problems met with in the ordinary inter-urban railway. It was, therefore, with the object in view of obtaining information which would be useful in the selection of motive power equipment for inter-urban railways operating single car trains that a series of experiments was undertaken by the Railway Engineering Department of the University of Illinois.

The car used in making the tests to determine train resistance was a standard inter-urban car and formed part of the laboratory equipment of the Railway Engineering Department. It was built by the Jewett Car Co., and the principal dimensions are as follows:

Length over all	45 feet
Width over all	8 feet 4 inches
Distance between truck centres ..	22 feet 4 inches
Height from under side of sill to top of roof	9 feet 6 inches

The car is divided into two compartments, the smaller of which contains the recording instruments as well as part of the motor control apparatus. In the larger compartment are a motor generator set for supplying low voltage current for bond testing, a water rheostat for regulating the voltage on the motors, and several other pieces of apparatus for work of a special nature.

The trucks are of the C60 type of the Standard Steel Motor Truck Co. The wheels on one truck are rolled steel and on the other chilled iron. The wheel base is 6 ft. 4 in., and the wheels are 33 in. in diameter and have the M.C.B. tread and flange. The motive power equipment consists of four No. 101D Westinghouse motors, with a nominal rating of 50 h.p. The gear ratio is 22:62, thus giving the car a maximum speed of 45 miles per hour, with a pressure of 500 volts on the trolley-wire. The motor control is the Westinghouse unit switch system of multiple unit control. The switch group, circuit breaker, reverser, limit switch, and line relay are installed in the interior of the car for the purpose of inspection under operating conditions and instruction of students.

The straight air brake system was used, hand brakes being installed for use in emergencies.

The instrument equipment consists of two integrating wattmeters, a recording ammeter, a recording voltmeter, two speed-recorders, an air pressure recorder, and a portable wind vane and anemometer. One integrating wattmeter was used to measure the total power supplied to the motors, and the other one measured the power supplied to the air compressor motor. The recording ammeter and voltmeter were of the general electric graphic recording type, and gave continuous records of the current supplied to the motors and the voltage across the motor terminals. The speed recorders were of two different types, the first one installed consisting of a recording ammeter of low range connected to a small generator, which was driven from the axle and separately excited from a storage battery carried on the car. The other speed recorder was the well-known Boyer recorder, which was installed for the purpose of checking the speed record obtained by means of the electric speed recorder. The air pressure recorder was connected

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with the brake cylinder, and was used in making braking tests, as well as serving to show whether or not the brakes were fully released during any tests. The portable anemometer and wind vane were mounted on a tripod and set up in the field adjacent to the track, and were used to determine the direction and velocity of the wind for each individual test. The record sheet or chart was 40 in. wide, and was arranged to be operated on either a time base or a distance base. In operating on a time base the paper rolls were driven by a small electric motor, while for operation on a distance base the rolls were driven from the axle by means of a system of gears. A record of distance was obtained by means of a magnetically operated pin, which made an offset in the distance line every 50 ft. The magnet circuit was completed by a contact-maker driven from the axle. The location of the car at any instant was obtained by a pen operated by a magnet, the circuit of which was closed by means of a telegraph key operated manually as the car passed the poles. The time record consisted of two lines operated by magnets, which had their circuits closed every 5 sec. by a time-marker clock, thus producing offsets in the time lines at 5 sec. intervals. In addition to these recording instruments, indicating instruments were also connected in the circuits, and the records were frequently checked with the readings on the indicating instruments. Attempts have been made from time to time to develop an instrument for recording acceleration. The best results have been obtained by using a one-kw. transformer having the low tension winding connected in series with the ammeter used for recording speed and the high tension winding connected to a millivoltmeter. The jump spark method of recording was used with partial success, but, owing to the pressure of more important work, this accelerometer was never fully developed.

In making the tests the car was operated on the track of the Illinois Traction System between Champaign and Danville. This track was of the ordinary inter-urban construction, the rails 30 ft. in length and 70 lbs. to the yard, being supported by sleepers spaced 2 ft., centre to centre, and the ballast was mostly gravel. A very accurate survey of the track was made and the exact location of each pole determined.

The scheme of operation followed in making the tests was to select a section of track free from grades and curves and of as great a length as possible. Owing to the fact that the kinetic energy of the car at high speeds was relatively large, and reading the speed record to the second decimal place rather difficult, no sections under 1,000 ft. in length were used, and as this division of the railway system contained a large number of curves, it was impossible to obtain suitable sections much more than 2,000 ft. long. A certain section of track was selected as the scene of operations for a certain day, and the car was run in both directions over this section as many times as possible. The regular service on this division being frequent, it was unusual to obtain more than 40 individual tests in any one day, and the number of tests fell on some days to 10 or 12. The car was run to a point about 1,000 ft. from the end of the selected section, and brought up to the required speed some time before entering this section. While making the tests to determine the increase of train resistance due to curves, various curves of different radii, ranging from one degree to 15 degrees, were selected, and accurate surveys made of the curves and sections of tangent track at both ends of the curves. The car was operated at a uniform speed over the section of tangent track before entering the curve, the curve, and the section of tangent track after leaving the curve.

The method followed in working up the data. At each end of the sections selected a perpendicular to the base lines was drawn across the chart, and, using a templet to correct for the arc described by the recording pens, the exact locations of each of the pens at the times of entering and leaving the section were obtained. Perpendiculars were then drawn from these points to the various base lines, and the area enclosed by the base line, the record, and the two perpendiculars were obtained by using a planimeter. The mean height was then obtained by dividing the area by the distance between the perpendiculars, and the mean values of current voltage and speed were read on the calibration curves. The time taken to pass over the section was obtained by measuring the time line from the last five second offsets to the perpendiculars at the ends of the section. Knowing the current, voltage, and time, the energy delivered to the motors was calculated. From the speed record the speeds at the entrance and exit of the section were obtained, and the kinetic energy of these speeds calculated. From the profile the elevations were obtained, and the energy input or output due to grade was calculated. Thus energy delivered to the motors plus or minus the change in kinetic energy plus or minus the energy due to grade divided by the length of the section gave the tractive effort over the section. This divided by the weight of the car in tons gave the true train resistance in pounds per ton, the various values of which were then plotted against speed and an average curve drawn which showed the value of train resistance for all of the various speeds. In determining the increase of resistance due to curves the same method was followed, except that the tangential section at each end of the curve section was worked up to avoid any possible error due to change in the relative direction of the wind with respect to the car. The superelevations of all curves were carefully ascertained and made a part of the records.

A total of about 400 tests were made in the determination of train resistance for straight, level track, and the values obtained in these tests were plotted. As is to be expected in work of this nature, all of the points did not lie on a curve, so an average curve was drawn such that the sum of the moments of the points lying on one side of the curve was equal to the sum of the moments of the points on the other side of the curve. In this way a curve was obtained which was held to represent the average values of train resistance for ordinary inter-urban cars on a track of this type. At the same time the fact that a considerable number of points lay further from the curve than any possible error could account for would indicate that the train resistance varies over a considerable range, and shows the necessity of experiments to determine the values of the individual elements of train resistance.

The results of the tests to determine the increase of train resistance due to curvature were plotted in a series of curves showing the increase for curvature of one, two, three, five, eight, ten, and fifteen degrees.

Owing to the fact that these results are to be published shortly by the University of Illinois, it has been found impracticable to reproduce the curves at this time.

ELECTRICAL DEVELOPMENTS AT BRADFORD.

We note that a feature in the development of the Bradford Electricity Works, under the direction of the City Engineer (Mr. Thomas Roles) will be the installation of three turbo-generators of the Curtis vertical type, two of which the British Thomson-Houston Co., Ltd., of Rugby, have already partly laid down. In the extension that was made some few years ago room was provided for five sets of slow speed reciprocating engines and generators of 1,600 h.p. each. Four of these sets are laid down. But in the space which had been reserved for the fifth it was decided to put in these turbo-generators. The three of them will take up much less than half the space required for a slow-speed engine and generator, yet the output in kilowatrs of the turbo-generator compared with the other type is 3,000 as against 1,000, and the horse-power exerted is 5,000 as against 1,600. The flywheel alone of the slow-speed generating engine of 1,000 kw. capacity is heavier by eight tons than the combined weight of the turbine engine and generator, which have a capactiy three times as great. The turbines being supplied to the Corporation are said to be the largest of the vertical type that have been built in this country. The whole of the rotating portion, consisting of turbine wheels, shaft, and the rotor of the electric generator, is supported vertically by a foot-step bearing, and this total weight of 15 tons is carried by a mere film of water supplied at a pressure of nearly 500 lb. to the sq. in. by a three-throw pump. The friction is so slight that a turbine will rotate for nearly one hour and a half after all power has been completely shut off. Pending the completion of the above machines, a 1,000 kw. (1,600 h.p.) horizontal turbine made by the British Thomson-Houston Co., Ltd., has been installed, and is now working. It runs at a speed of 3,000 r.p.m., and occupies a floor space of 85 sq. ft., which compares very favourably with the existing slow-speed engines and generators of the same output, and which take up a space of 683·2 sq. ft.

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1,200-VOLT D. C. CAR EQUIPMENT.*

By F. E. CASE, Engineer of Railway Equipment, General Electric Company, U.S.A.

Direct current of 1,200 volts has been adopted in preference to 600 volts as the trolley potential of a number of interurban and other railways on account of lower first cost and lower cost of operation. That 1,200-volt current can be more economically delivered to the car requires little argument. On a railway having a given size and length of feeder, a car equipped with 1,200-volt apparatus will entail a line loss of only one-quarter that of a 600-volt car of the same size operating at a similar speed. With dense traffic, where cars are required to run on a very close headway, consequently giving practically a uniformly distributed load, the sub-stations at 1,200 volts can be located twice as far apart as at 600 volts for the same maximum per cent. line loss.

Under the other extreme condition of two cars or trains only between sub-stations and passing midway the sub-stations can be located four times as far apart as at 600 volts with the same maximum per cent. line loss. The latter condition, however, is rarely practical for interurban operation on account of the great headway between cars. Under the usual prevailing conditions of interurban service it will be found that the substations at 1,200 volts can be located from 2½ to 3 times the distance apart as at 600 volts to give the same percentage line loss.

The adoption of commutating poles has made the operation of 1,200-volt generators entirely practicable. Where alternating current is better adapted to long-distance distribution, rotary converters in sub-stations are also well designed to translate the alternating current to 1,200 volts direct. No more complicated or less reliable pieces of switchboard apparatus are required in the power house or substation than for the ordinary voltages.

Either the third rail or trolley wire can be used for carrying current to the car. One road is now successfully using the former, and there are several others using the latter. The third rail is of the under-running type, and is installed in a similar manner to a 600-volt practice, but the insulators are of somewhat increased dimensions.

No radical departure from standard 600-volt practice is required in the line construction to ensure a safe insulation. Cross suspension, side bracket, or catenary method of trolley wire support can be used, but additional insulation over that used for 600 volts is, of course, required. The catenary form of suspension is usually recommended, as not only does it require a minimum number of poles and insulators, but it provides the most flexible support, which is a great advantage for high-speed operation.

The standard trolley base, pole and wheel give better results than with 600 volts, as the current to be collected for a given weight and speed of car is only half, which increases the life of the wheel especially.

The motors are similar electrically to ordinary 600-volt commutating pole motors, with increased insulation, and there is no departure in mechanical features from other direct current motors for lower voltage. The brush holders are located in a similar manner, and there are no more of them, so that inspection is just as readily made as in other direct current motors. The commutation of the motors is so good that no more attention to the brushes and commutator is required than with low voltage motors of similar capacity. As the motors have the same electrical characteristics as other direct current motors, the armature speeds are no greater, and in consequence the bearings are equally long lived.

Some motors have been furnished by the General Electric Co. for operating directly on 1,200 volts and others two in series. With the former it is possible to operate at only half speed on 600-volt portions of the line, but the latter motors can be connected in multiple so as to give the same speed on the low voltage as the high, which in many cases is a great advantage.

The car equipment consists of apparatus similar to that used for 600 volts, many of the parts being identical. Cylinder platform controllers have not been used in any instance, however, as they require the motor current to be carried above the floor, and we have considered it advisable for obvious reasons to keep the apparatus that breaks the main circuit under the car, where it can be suitably isolated.

Sprague-General Electric Type M control, comprising electrically operated contactors, a reverser and a circuit breaker is used. These parts are practically the same as for 600 volts, with additional insulation where required. Both automatic control as described in my paper of last year for 600-volt operation, and hand, or non-automatic, control have been furnished. The circuit connections are identical, for both the master control and the motors, to that used for 600 volts.

Standard 600-volt contactors, operated by means of electro-magnets, are employed for making the motor and resistance circuits in the contactor box, a few extra contactors being used to provide the necessary breaks in series to safely open the circuit. Practice has shown that a 1,200-volt current can be very satisfactorily interrupted by the contactors, and that the burning is not excessive.

Proper insulation of the reverser contacts is easily secured, owing to the motor fields being reversed, instead of the armatures when the direction of car movement is to be changed, and also because the fields are connected to the ground side of the armatures. This connection of the motors has been adopted both in new cylinder controllers and type M control for 600 volts. For commutating pole motors, it is desirable, in order that the commutating field winding, which is permanently connected to one side of the armature, may always be on the ground side of the armature. The connection has also the advantage that fewer of the contacts have a high potential between them, as the drop across the exciting field to be reversed is only about 15 volts.

A magnetic blow-out circuit breaker, located under the car, similar to the one generally furnished with type M control, is used for an overload protective device. It is, however, provided with a more powerful magnetic blow-out and has an increased opening and insulation. The circuit breaker is set and tripped from the motorman's cab by means of the ordinary double-movement switch, which connects to the proper train wires.

A magnetic blow-out copper ribbon fuse-box is provided as an additional protective feature for the main circuit. Standard 600-volt cast-grid rheostats are used for providing the necessary resistance steps in starting the motors. These rheostats are effectually insulated from the angle-irons to which they are attached by means of large collars and tubes surrounding the supporting bolts. A new design of cast-grid rheostat has recently been brought out.

When a car equipped with four motors is required to operate at the same speed on both 600 and 1,200-volt sections, it is necessary to use a commutating switch for changing the connections of the motors. For 1,200-volt operation this switch connects the motors in two groups with the motors in each group in series, each group being handled as a single motor. This commutating switch is arranged for operating either by hand or with air controlled by a valve located near the motorman. An interlock device is provided, which prevents operation of the contactors if the motors are not properly connected for 1,200-volt running.

On some roads the operating conditions are such that only on the interurban sections is it desirable to obtain the maximum speed. To meet these requirements the commutating switch is, therefore, not necessary, and having 1,200 volts on the high-speed section and 600 volts on the city division gives relative speeds of about 2 to 1.

Six hundred-volt current is used for operating the control, and also for the car lighting. With the earlier equipments, the air compressors are also operated at this voltage. This current is obtained from a dynamotor, or motor generator, of waterproof design for mounting under the car.

The new feature of the dynamotor is a series field winding, which is connected between the two halves of the armature, and is provided with a tap at its centre. In starting up, line current passes through the first half of armature, series field, and second half of armature to ground, thereby strengthening the normal field, and the machine operates as a compound motor. When current is being taken from the tap in the centre of the series winding for the control of lights, the two halves oppose each other, and there is no effect on the field strength. When the

* Abstract of paper presented before the Committee on Equipment of the American Street and Interurban Railway Engineering Association, Denver, Col., October, 1909.

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trolley leaves the wire with the dynamotor running, and the controller on, there is an immediate tendency of the dynamotor to deliver current to the motors, due to the momentum of the armature and the shunt field. The series winding now comes into play by demagnetising, or beating down the field, since the direction of the current has been reversed in the first half of the series field, and the two parts, therefore, no longer oppose each other. This action prevents an amount of current sufficient to blow the dynamotor fuse being taken by the motors.

The dynamotor is a very simple device, both electrically and mechanically. No mechanical load being driven by the armature, the strains on the bearings are negligible and the parts are long-lived. On recent equipments the dynamotor is started up automatically, when the car runs on to a 1,200-volt section, by means of a selector relay. The light and control circuits are disconnected from both the trolley and dynamotor, when the relay is not energised, the proper connections being made to correspond with the voltage applied. To insure correct operation of this relay, a short, grounded section of trolley wire is interposed between the 1,200 and 600-volt portions.

The electric heaters can be operated either from the dynamotor or directly from the 1,200-volt circuit. As the conductors in the heater are insulated from the frame by porcelain, the requisite insulation is easily secured for 1,200-volt operation.

The air compressors on some recent equipments are wound for operating at 1,200 volts, as there is no difficulty in obtaining good commutation and insulation for this voltage. When the car is running on the 600-volt section the compressor will, of course, be required to operate for a longer period if air is used to the some extent as on the 1,200-volt portion, but this is easily taken care of in selecting the proper capacity of compressor.

TRANSFORMER NOTES AND CALCULATIONS.—III.

BY "ELECTRON."

(9) Determine approximately the dimensions, sizes of wire and the weights of the core and the windings of a 100 kw. 50-cycle single-phase transformer, given the following particulars :—

E_1 = 5,000 volts ; E_2 = 250 volts.
B_{max} = 10,000 C.G.S. per sq. cm.
Current density = 250 amperes per sq. cm.
Core loss = 2·5 watts per kilogramme of iron.
Power-factor of external load = 0·8.
Space-factor, s, of the windings = 0·4.
Thickness of transformer iron = 14 mils.
Molecular co-efficient constant $\eta = 0{\cdot}0012$.
Specific resistance of copper = 1·6 microhms per cm. cube.
Also estimate the full-load efficiency.

As some mutually conflicting conditions have to be satisfied when designing a static transformer, it is obivous that the design of a transformer is a complicated problem, and considerable experience is necessary before an engineer can fix upon the best values to give to the dimensions of the core and the windings, so as to secure the essential conditions of high efficiency and low cost. From first

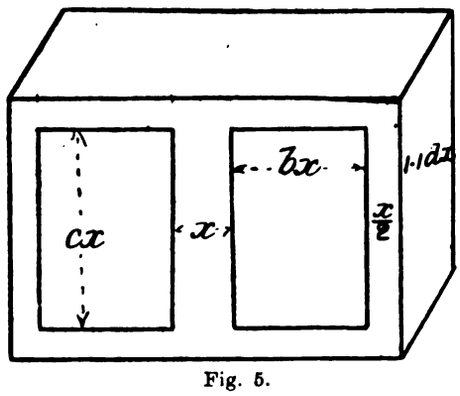

Fig. 5.

principles, it is obvious that the factors which have to be taken into account are the maximum value of the flux-density, the permissible iron and copper losses, and the nature of the external load. As this example is given to show how to apply the fundamental principles of the transformer, the following scheme is suggested more from the educational, than from the designer's, point of view. It is assumed, for instance, that a definite relationship exists between the various dimensions of the core to the breadth of the core, which in Figs. 5 and 6 is denoted by the symbol x, the other dimensions being given as bx, cx and dx, as indicated in the figures.

Static transformers may be divided into two classes, *i.e.*, the shell (Fig. 5) and the core (Fig. 6) types, and as

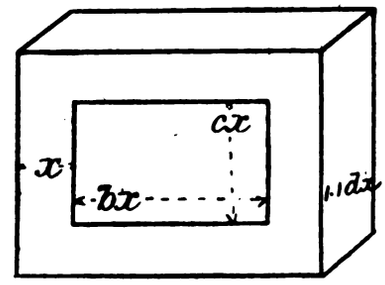

Fig. 6.

the shell type may be recommended for high voltage work, the shell type will be selected for the example under consideration. As a general rule the actual volume of the iron used may be taken as 90% of the space occupied by the iron, the remaining portion consisting of the insulation between the plates, or, in other words, the volume occupied by the iron and its insulation is 1·1 times the actual volume of the iron. There are, of course, several methods of disposing the primary and secondary windings, and to simplify matters it will be assumed that the two windings are sub-divided and interlaced, and that the same amount of space is required for the primary and secondary windings and their insulation.

Then, if C_d denotes the current density adopted, *i.e.*, 250 amperes per sq. cm., we have

$$\text{area of winding space} = 2S_2 \frac{I_2}{C_d} \times \frac{1}{s} \quad \ldots\ldots(1)$$

$$= bcx^2 \quad \ldots\ldots(2)$$

$$\therefore I_2 = \frac{C_d\, sbcx^2}{2\,S_2} = \frac{\text{Output}}{P_2\,E_2} \quad \ldots(3)$$

where P_2 denotes Cos θ or the power-factor of the external load, and s denotes the space-factor, or ratio between the actual space occupied by the copper to the space occupied by the winding. Consequently

$$S_2 = \frac{P_2\, C_d\, sbcx^2 E_2}{2 \times \text{output.}} \quad \ldots\ldots(4)$$

We also have from first principles

$$E_2 = \sqrt{2}\,\pi f\,(A\,B_{max})\,S_2\,10^{-8} \text{ volts}$$

and $A = dx^2$ (from Figs. 5 and 6)

$$\therefore S_2 = \frac{E_2\,10^8}{\sqrt{2}\,\pi f dx^2\,B_{max}} \quad \ldots\ldots(5)$$

$$\text{and } \frac{P_2 C_d sbcx^2 E_2}{2 \times \text{outp}} = \frac{E_2\,10^8}{\sqrt{2}\pi f dx^2 B_{max}}$$

$$\therefore x^4 = \frac{\sqrt{2} \times \text{output} \times 10^8}{\pi P_2 C_d sbcf\, B_{max}} \quad \ldots\ldots(6)$$

For a transformer of 100 kw. capacity and a space-factor, s = 0·4, the following values are appropriate : *i.e.* $b = \frac{8}{9}$, c = 1·5, and d = 2·25 for the shell type of transformer ; whilst b = 2, c = 3, and d = 1 for the core type. Therefore, by substitution for the above example, we have

$$x^4 = \frac{\sqrt{2} \times 100{,}000 \times 10^8}{\pi \times 0{\cdot}8 \times 250 \times 0{\cdot}4 \times \frac{8}{9} \times 1{\cdot}5 \times 2{\cdot}5 \times 50 \times 10{,}000}$$

$$= 45020$$

and x = 14·57 cms. = 15 cms. (say)

We consequently have as the approximate dimensions :

Breadth of coil space = $\frac{2}{3} \times 15$ = 10 cms.
Depth of coil space = 1·5 × 15 = 22·5 cms.
Length of core (iron) = 2·25 × 15 = 33·75 cms.

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With respect to the secondary winding we have

$$S_2 = \frac{E_2 \times 10^8}{\sqrt{2}\pi f (d x^2) B_{max}}$$
$$= \frac{250 \times 10^8}{\sqrt{2}\pi \times 50 \times 2{\cdot}25 \times 15^2 \times 10{,}000}$$
$$= 22{\cdot}22 \text{ or } 23 \text{ turns}$$

And since $\frac{S_1}{S_2} = \frac{E_1}{E_2}$, we have

$$S_1 = 23 \times \frac{5{,}000}{250} = 460 \text{ turns}$$

And since the primary and secondary coils are assumed to be interlaced, both the coils will have the same mean length, l_m, of a turn, which from Fig. 7 is determined as follows :—

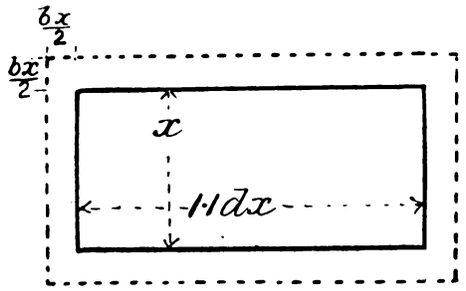

Fig. 7.

$l_m = x(2 + 2{\cdot}2d + 4b)$ cms. for shell type
$l_m = x(2 + 2{\cdot}2d + 2b)$ cms. for core type

In the example given

$l_m = 15(2 + 4{\cdot}95 + 2\frac{2}{3})$
$= 144{\cdot}25$ cms.

Consequently the total length of wire required for the primary winding is

$L_1 = 460 \times 144{\cdot}25$
$= 663{\cdot}55$ metres

and for the secondary winding

$L_2 = 23 \times 144{\cdot}25$
$= 33{\cdot}1775$ metres.

The size of the wire to use is decided by the permissible current-density, and the secondary current is

$$I_2 = \frac{100{,}000}{0{\cdot}8 \times 250} = 500 \text{ amperes}$$

and the area of cross-section

$$a_2 = \frac{500}{250} = 2 \text{ sq. cms.}$$

For the primary winding, we have

$$I_1 = \frac{S_2}{S_1} \times I_2 = \frac{23}{460} \times 500$$
$$= 25 \text{ amperes}$$

and the area of cross-section

$$a_1 = \frac{25}{250} = \frac{1}{10} \text{ sq. cm.}$$

Assuming that the specific-gravity of the copper is 8·9, *i.e.*, one cubic centimetre of copper weighs, 8·9 grammes, the total weight of the primary winding is given by

$Wt_1 = 8{\cdot}9 \times a_1 \times L_1$ (in centimetres)
$= 8{\cdot}9 \times \frac{1}{10} \times 66{,}355$
$= 59{\cdot}056$ kilogrammes

and for the secondary winding

$Wt_2 = 8{\cdot}9 \times a_2 \times L_2$
$= 8{\cdot}9 \times 2 \times 3317{\cdot}75$
$= 59{\cdot}056$ kilogrammes

and the total weight of copper required will be 118·112 kg.

The weight of the core is readily obtained from the volume of the iron forming the core by taking the specific gravity of iron as 7·8. From the geometry of the core (Figs. 5 and 6) the volume of the iron is obviously given by

$V_i = dx[(2x + 2bx)(x + cx) - 2bx \times cx]$
$= 2dx^3[1 + b + c]$ cu. cms. (shell type)

and $V_i = dx[(2x + bx)(2x + cx) - bx \times cx]$
$= 2dx^3[2 + b + c]$ cu. cms. (core type)

The volume of the iron in the example is, therefore,

$V_i = 2 \times 2{\cdot}25 \times 15^3[1 + \frac{2}{3} + 1{\cdot}5]$
$= 48{,}100$ cu. cms.

and the weight of the core is

$Wt_i = 48{,}100 \times 7{\cdot}8 = 375{\cdot}18$ kg.

To obtain the efficiency at full load it will be necessary to determine the iron losses and copper losses separately, and, as previously shown, the iron losses are given by

$$W_i = \text{Vol}[\eta f B_{max}^{1{\cdot}6} \times 10^{-7} + t^2 f^2 B^2_{max} \times 10^{-16}] \text{ watts}$$
$$= 48{,}100\left[\left(\frac{0{\cdot}0012 \times 50 \times 10{,}000^{1{\cdot}6}}{10^7}\right) + \left(\frac{14^2 \times 50^2 \times 10{,}000^2}{10^{16}}\right)\right]$$
$$= 48{,}100 \times [0{\cdot}01507 + 0{\cdot}0049]$$
$$= 960{\cdot}6 \text{ watts}$$

This corresponds to $\frac{960{\cdot}6}{375{\cdot}18}$ or 2·56 watts per kilogramem, which is approximately the value specified.

The copper losses are given by

$$W_c = I_1^2 R_1 + I_2^2 R_2$$
$$= \left[\left(25^2 \times \frac{1{\cdot}6}{10^3} \times \frac{66{,}355}{0{\cdot}1}\right) + \left(500^2 \times \frac{1{\cdot}6}{10^6} \times \frac{3317{\cdot}75}{2}\right)\right]$$
$$= 1326{\cdot}7 \text{ watts.}$$

The total losses are

$$W = W_i + W_c$$
$$= 960{\cdot}6 + 1326{\cdot}7$$
$$= 2287{\cdot}3 \text{ watts.}$$

Therefore the efficiency is given by

$$\eta = \frac{100{,}000}{100{,}000 + 2287{\cdot}3} = 0{\cdot}9775$$
$$= 97{\cdot}75\%.$$

ELECTRICITY IN BOILER CONSTRUCTION.

At a meeting of the North-East Coast Institution of Engineers and Shipbuilders, held at Newcastle-upon-Tyne, on the 29th ult., Mr. D. Myles (Vice-President) read a paper on "Marine Boiler Design, Construction, and Economy." Mr. Myles observed that, along with the improvement in workmanship, there had been vast improvements made in machines used in the manufacture of boilers. The holes for stay tubes, which a few years ago were tapped by hand, were now almost universally accurately tapped by machine, and this applied also to stay holes between combustion chambers, boiler backs, etc., and a hole tapped by machines was more likely to be true and fair than one tapped by a man pulling at the end of a long single-ended lever, as was frequently the case in former years, and if the hole was truer, the screwed stay would necessarily be a better fit. The same remark applied to the greatly increased use of electric or pneumatic drills instead of the hand ratchet brace, and although this improvement might be also in the direction of economy in costs, the more accurate workmanship was undoubtedly in the direction of improvement in the manufacture of boilers. With regard to future development, it appeared to him that while water-tube boilers were absolutely essential for certain classes of work, they, like everything else, had their limitations, and while they had overcome troubles arising from quick raising of steam, forced evaporation, etc., they brought with them defects and troubles to which the ordinary type of marine boiler was not subject, and which would restrict them to vessels for special service, and the ordinary return tube type of marine boiler had still a long and useful career before it. He had always considered caulking as rather a barbarous method of making seams of boilers tight, but it was very difficult to propose a satisfactory substitute. The electric arc, oxy-acetylene, or any other method of welding had disadvantages, which at present appeared fatal, but from the advances that had already been made in this direction, he hoped that some further improvement would be made in the near future, and that a more satisfactory method of making boiler seams tight, without interfering with the movement due to expansion, would yet be discovered. Mechanical stokers for marine purposes did not appear to have made any great advance. Several systems had been tried with fluctuating success, but he thought it would be a long time before the properly trained fireman was superseded.

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THE

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CONTENTS.

	PAGE
Notes	679
The Rays and Product of Uranium X.	680
A Survey of the Electrical Industry	681
Automatic Electric Transportation	683
Determination of Train Resistance	684
Electrical Developments at Bradford	685
1,200-Volt D. C. Car Equipment	686
Transformer Notes and Calculations	687
Electricity in Boiler Construction	688
Electricity and the Countryside	689
Correspondence	690
Central Station Economics	691
Institution of Civil Engineers	692
The "Entz" Booster	693
Wilkinson's Thermal Column	694
Electrical Signalling for Trains	694
Harnessing our Streams	695
Diary	696
Technical Problems, with Solutions by Practical Men	697
Hydro-Electric Plant for Mexico	698
Tyneside Notes	699
Midland Notes	699
Lancashire Notes	700
American Notes	700
German Notes	702
Lincoln Electrical Engineer's Failure	702
Sale of a Traction Company	702
Lighting & General Notes	703
Traction Notes	704
Personal	705
The Metal Filament Lamp Case	705
Companies' Meetings and Reports	705
Contracts Open	706
Tenders Open	706
Cable and Wire Novelties	706
Patents	707

ELECTRICITY AND THE COUNTRYSIDE.

Quite recently we dealt in this column with French and Italian enterprise in bringing the enormous advantages of electric lighting and power within the reach of semi-rural communities and agriculturists. We have also repeatedly pointed out that the many streams that intersect our country should enable our own rural districts to secure the benefits of cheap electricity. A most apt illustration of this policy is seen in the enterprise of Grassington, which, with its sparse population of 500 inhabitants, has succeeded in providing itself with a most serviceable hydro-generating station. Another instance is seen in the new system of automatic traction which is being brought forward at Buffalo, and of which we give a brief description elsewhere. This movement to bring electricity into the country is an eminently satisfactory one in every way. Viewed from the broad economic point of view, it will tend to make country life more easy, enjoyable and profitable; from our own particular stand, the movement deserves encouragement as a healthy development of the industry. In this country we are somewhat slow in adopting methods which amount to a revolution when applied to a calling which is peculiarly conservative, not to say stagnant. But, with the example set us by our French and Italian friends and our kin over the seas, what has taken place at Grassington should prove merely a forerunner of a steady spread of the beneficial influence of electricity. Another aspect of the popularising of electricity should receive close attention. In America, for some time past, telephones have radiated from a vast number of towns, not only for the purposes of inter-communication between the towns themselves, but so as to link up outlying farms through their nearest villages with the city exchanges. It is extraordinary how this service has "caught on" in the States, where soon the farms using telephones will form a no mean percentage of the exchanges' customers. The

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idea has, to a large extent, spread to Canada, and it is being adopted in Australia and, to some degree, in New Zealand. As for South Africa, the question of a farm telephone service has occupied the attention of the various Governments for many months. It was seriously discussed at the Congress of the South African Union sitting at Kimberley, and has been endorsed by the Inter-Colonial Agricultural Union. The Governments of Cape Colony, Natal and Rhodesia have already expressed their intentions to further the scheme, while the Transvaal and the Orange River Colony have the matter still under consideration. It is felt that a widespread telephone service such as proposed would be of incalculable value not only to agriculture, but to the Colonies generally. We may ask what is being done here, seeing that the telephone service generally is so soon to be taken up by the Post Office? With our denser population and shorter distances, farm telephone service is, perhaps, not so greatly needed as it is in the Colonies; on the other hand, it should be easier and more remunerative. Not only does the telephone place a farm in a better position for social purposes, and for the convenience of selling and purchasing, but it reduces the hardships of isolation, rendering a call for help in case of illness or other immediate need easy, and should be of service in helping to stamp out the spread of disease, as the precautions incumbent when disaster threatens could be made more efficient. For all these reasons, our farmers deserve some consideration on the part of the Post Office. Meanwhile, the fact that electricity is destined to quicken life in the countryside is too patent to be ignored. It is a movement fraught with great possibilities, which it behoves electricians and manufacturers to recognise and foster. Abroad, in our own colonies, and notably in the countries of South America, the use of electricity and telephones on farm will mean a steadily increasing demand for electrical machinery, wire and appliances generally, and also opportunities for young engineers, and there is no reason why we should not participate in this coming boom. But while we should carefully study colonial and foreign markets, it should not be forgotten that our home market only requires a little judicious stimulus to bring about a healthy revival. In this connection the countryside should receive closer attention, for its potential influence on electrical engineering prosperity is far greater than the casual observer is inclined to allow.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "THE EDITOR, *149, Fleet Street, London, E.C.*" *Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.*

LIGHTNING CONDUCTORS.

Sir,—I beg leave to thank Professor Dalby for his remark in your issue of the 22nd ult., though he might perhaps have expressed himself differently. I admit I am a mere tyro in this matter, but it is one that I am called upon to deal with occasionally and am anxious to learn something definite about. If he would be so good as to give some information as to really reliable works on the subject I should be grateful.

When I asked my bookseller to get me the latest monograph, he supplied Hedge's "Modern Lightning Conductors," which I presumed was a reliable scientific work, as it professes to be "a supplement to the Report of the Lightning Research Committee of 1905." This Committee I supposed was a highly authoritative body, but a reference to your columns of 1905 has caused me to modify my opinion, and a comparison of its real report with the version in Hedge's book has shown me that, as stated by Mr. Hands, there are additions in the latter. I have been hoping to see in your columns an explanation by the author as to his reasons for inserting them, or a disclaimer from some other member of the committee. In the absence of these, I can only presume that the report itself is not more valuable than the book.

There are, doubtless, many electrical engineers who, like myself, are required to deal with lightning conductors, and who are anxious to do rightly in trying to prevent buildings being damaged by lightning. What are we to do, and who are we to believe in?

Yours faithfully,
A. W. P.

CONTINUOUS CURRENT MACHINES.

Sir,—In your current number Mr. Rennie criticises the answers given to Question 1,204 (published in issue of October 29), and considers that in the first answer, by H. K. W., an important item was forgotten.

I did not "ignore the fact" that the generator was to supply a three-wire system; but I did read the question carefully, more than once. The question mentioned that the generator was "by means of a balance to supply a three-wire system."

This I took to mean a balance set—balancers. Also, a change in the armature winding was required "by altering several connections," and was given by the first answer.

With two similar separate windings on one armature and two commutators, the generated voltage will be the same in both windings, and for a three-wire supply the regulation will be bad for unbalanced loads. A three-wire system demands *either* separate generators between middle and outers, having good constant potential characteristics or good control; *or else* a generator between outer lines, and balancers.

Mr. Rennie mentions the second method as more expensive, more of a makeshift, and able to be done more rapidly. I do not agree as regards the makeshift. The whole change from two-wire to three-wire working does not want to be a makeshift, and is certainly not going to be done with a rush.

Yours, etc.,
H. K. W.

Hornsey, N., November 8, 1909.

INCOME TAX ASSESSMENTS.

Sir,—By the time this letter appears the Notices of First Assessment under Schedule D will probably have been scattered broadcast. Should the assessment be in excess of the amount stated in the return form sent in nearly six months ago, the taxpayer should appeal *immediately*. It is essential that instant objection to the assessment be sent, otherwise it will be confirmed.

For the information of taxpayers, I beg to state that it is only necessary to write a letter to the Surveyor of Taxes somewhat similar to the following:—"I beg to give notice of objection to the assessment of (say) £350 levied on me for the year 1909/10."

If it be found subsequently that it is not desired to appeal, no harm will have been done; but in any case the way must thus be left open for a subsequent appeal. Without some such notice any and every rectification would be statute-barred.

Yours faithfully,
F. LODGE ROSSER, Secretary.

The Income Tax Reclamation Association, Ltd., 14, Queen Victoria-street, E.C.

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CENTRAL STATION ECONOMIES.*

By W. L. ABBOTT, Operating Engineer, Commonwealth Edison Co., Chicago.

The selling price of electricity in large quantities is now about one-tenth of what it was 20 years ago, and as the business of selling electrical energy 20 years ago was a precarious one, whereas stock quotations indicate that this same business at the present time is on a safe commercial basis, despite the greatly reduced prices, which are tending steadily lower, it is apparent that radical changes have been and are still being made in central-station economies.

With the improvement in the general scheme of generation and distribution has come a much more wonderful and unprecedented increase in the volume of business, permitting and necessitating more elaborate organisation and a minutely detailed analysis of all the elements contributing to the cost of the energy sold, so that it is possible for the wholesale manufacturers of electrical energy to tell with as great exactness the cost of each element entering into the grand total of the expenses of conducting the business as it is for a manufacturer of any other staple article to tell the cost of each piece which his shop turns out.

The items which go to make up the total cost of central-station operating may be generally classified as fixed charges, general expenses, and operating costs, of which fixed charges equal the other two combined. Fixed charges comprise interest or dividends on investment, sinking fund or depreciation, taxes and insurance, and are the severest burden on the business. An extravagance or error of judgment in design and construction becomes a tax on the business until that investment is wiped out through the operation of the sinking fund.

Most of the earlier plants were of such irrational design and cheap construction that the depreciation ate up the margin between revenue and operating costs. Under early designs of central-station distribution, the fixed charges, instead of being 50% of the total costs of the business must have been as high as 70 or 80%, or in cases where the system broke down under excessive fixed charges, they may have been as high as 90%.

Fortunately, now that the day of high prices formerly obtained for electrical energy is past, the business has gotten upon a conservative basis, the different components of the costs are better understood, and the engineering is done by experienced engineers. With the increasing investment in these properties, the capitalisation of former errors and of old-time apparatus, now obsolete and discarded, is becoming a smaller component of the entire capitalisation, so that the effect in time will be to lessen materially the relative importance of the item of fixed charges. It is by the reduction of fixed charges, rather than by reductions in the amount of general expense or operating costs, that the decrease in the cost of electrical energy in the immediate future will be obtained.

On the other hand, because it is not feasible to construct a pole line for a single wire nor a conduit line for a single duct, and because all installations of whatever nature must have some provision for future growth, as well as for reserve capacity to guarantee the service in case of accident, it is evident that the investment must always be far in advance of the minimum requirements, and to that extent be unprofitable.

The number of power houses which will most economically serve a given market depends on several factors—extent of territory, amount and density of business, overhead or underground transmission, and the amount of permissible voltage.

At the beginning of the era of consolidation of smaller lighting companies and power houses, great economy was realised in operating costs by shutting down the smaller scattered plants and supplying the entire territory from one large central station. This saving was due partly to the higher efficiency of the larger apparatus and partly to the smaller operating force required for the larger units. Such savings, however, occur relatively less and less with the size of the plants, and in plants having a capacity of 50,000 kw. are practically negligible, providing the power houses are ideally located.

Unfortunately, however, it is seldom feasible to scatter power houses about through the territory served in the way which will result in a minimum of investment and of operating costs. To provide for the inevitable future extension, for coal storage piles, and for necessary track space, requires a tract of land equal in extent to several city blocks. It must, of course, be located where it can obtain an abundance of free water for condensing purposes. It must also have direct connection to at least one, and preferably two, coal railroads, meaning roads along whose lines coal is mined, so that the freight charges will not be increased by switching charges, as would be the case if the coal originated on some other road and had to reach the power house over the rails of the road upon which the power house is situated.

Next to the fixed charges, the largest single item of expense is that of fuel, and as central-station systems increase in size, and as the business on their ramified circuits builds up, the fixed charges will relatively decrease and the fixed costs will become correspondingly greater. One of the keys to cheap electrical energy in future years, therefore, will be an abundant supply of cheap fuel.

Having acquired a power-house site of ample dimensions, conveniently located to the centre of gravity of the load, adjacent to free water and accessible to the rails of two or more coal-producing railroads, the subject of power house design is next in order. It should be borne in mind that a power house is primarily an establishment where coal is to be received and burned in enormous quantities, and the refuse to be quickly and conveniently removed, and, moreover, that of all of the money sent to the power station in pay envelopes, one-half is placed in the grimy hands of those honest sons of toil who handle and burn the coal. The controlling feature, therefore, in power house design should be to handle cheaply and to burn efficiently the great tonnage of coal which must go through the boiler room every day. A car of fine coal, when standing over the receiving hopper, may be unloaded by hand for five cents a ton, and it may appear to some that this is cheap enough, but if this cost can be reduced to two cents or less by the use of unloading machinery, the resulting saving on a consumption of 1,000 tons a day is not negligible, even in a large power house.

A vigorous fireman, with nothing else to do, may be able to fire 10 tons of coal a day on a plain grate, and this, on a consumption of 1,000 tons daily, with some allowance for the load being irregular, and with some further allowance for a few additional men to take the place of those who might not show up when their shifts begin, would require, say, 125 firemen—a small army of a class of help which it would be difficult to subject to that degree of discipline which would be necessary for the efficiency required and for the security of the service.

The advent of the chain-grate stoker, with its perfect adaptability to Illinois screenings, makes it possible for one man to burn 10 times as much coal as is possible with hand-shovel stoking, and, not only that, but the fires are run much more evenly and at a higher efficiency. Smokelessness now is considered feasible and necessary in all new boiler installations. Such combustion can be readily obtained by the use of chain-grate stokers, but is absolutely out of the question with hand firing.

Formerly boilers were rated on the basis of 12 sq. ft. per boiler horse-power, and it was supposed that the engineer who ran his boilers at a higher rate to some extent took his life in his hands in doing so. Later, with the general introduction of the water-tube boiler, the boiler rating was changed to 1 h.p. for 10 sq. ft. of heating surface. Recent tests and recent practice have shown that not only is a boiler not injured by working it harder, but the efficiency of the boiler and furnace is almost always improved thereby. Therefore, we now find our boilers equipped with tall stacks or with forced-draft apparatus, or with both, to increase the consumption of coal to make a fire over the entire furnace grate of the intensity of that in a blacksmith's forge. To work a boiler 50% above rating is a normal condition, and to work it 100% above rating is not unusual.

* Abstract of paper read before Chicago Section of the American Institute of Electrical Engineers and the Electrical Section of the Western Society of Engineers, Oct. 22.

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With all the refinements and improvements known to steam engineering and adopted in power house work, we must admit that in our best practice 86% of the heat of the coal is wasted and only 14% converted into useful work under best test conditions; in fact, only 12% is saved under best operating conditions. The greater part of this loss is unavoidable, and it is, therefore, all the more necessary that all possible minor leaks be stopped.

The loss at the bunghole is unavoidable, but some of the spigot losses may be avoided in whole or in part, and as the net amount saved is small, any additional savings effected will add a respectable increment thereto. To this end the fires are run at the highest temperature that the furnace brickwork will stand. All possible precautions are taken to prevent the infiltration of air through leaks in the setting. The steam is superheated to prevent its condensing during its discharge through the turbine blades. The steam pipes are protected with the best of non-conducting covering, to prevent radiation from the high temperature, the latent heat in the exhaust from the auxiliaries is all returned to the boilers through the feed water by being condensed in the feed-water heater, and the vacuum is kept at the highest possible point by the use of large condensers and unlimited volumes of cooling water. *(To be continued.)*

INSTITUTION OF CIVIL ENGINEERS.

Three papers of electrical interest were included in the proceedings at the meeting of the Institution of Civil Engineers, held in London on Tuesday evening. We give below summaries of the respective papers:—

SINGLE-PHASE ELECTRIFICATION OF THE HEYSHAM-MORECAMBE LANCASTER BRANCH OF THE MIDLAND RAILWAY.

By J. DALZIEL and J. SAYERS.

The authors contended that electric working in this country had hitherto been confined to the handling of dense suburban traffic, although the belief was often expressed that electric working showed to least advantage in fast passenger service, and that in this country its application to such service would follow its adoption in the far wider field of heavy mineral and goods traffic, particularly on lines and sections with large traffic or having steep gradients. The adoption of the single-phase system for the Heysham-Morecambe-Lancaster section of the Midland Railway showed the conviction of the authors that that system was more probably applicable to future requirements than the direct current system hitherto used in England. The choice of that particular section of line for experimental electrification was partly due to the fact that it could be worked from an existing power station at Heysham. The traffic, though light, was of a long-hour character throughout the year, and being expensive to work by steam, there was scope for saving in working expenses. The power station at Heysham had direct current generating machinery supplying alternating current for the frequent service, the peak load being met by means of a battery. The motor cars were required to work very similarly to locomotives, and to take over daily from steam locomotives trains up to a weight of 190 tons. The authors dealt with the alleged disabilities of single-phase apparatus in respect to its asserted unsuitability for high schedule speed, frequent stops, and high acceleration, and it was shown, as the result of tests made to ascertain the accelerating capabilities of the Heysahm equipment, that single-phase apparatus was not only equally capable of working such services as direct current apparatus, but that the weight of the single-phase train was only a small percentage greater than that of corresponding direct current trains, the energy consumption being appreciably less. The *maximum* attained accelerations were 1·1, 1·3 and 1·4 per hour in a second, and energy consumptions of only 88·7, 99·3, and 100·76 watt hours per ton mile were obtained, as against figures of the direct current equipment which would be in the neighbourhood of 110 watt hours.

EQUIPMENT AND WORKING RESULTS OF THE MERSEY RAILWAY.

By J. SHAW, M.Inst.C.E.

This paper dealt with a different aspect of electrification. In this case the revenue under steam traction being insufficient to make a commercial success of the undertaking, the electric service was inaugurated in May, 1903. The traffic conditions required a train service of 19½ hours per day, with morning and evening peak loads. For the power house the company was fortunate in having a site practically at the electrical centre of gravity of the system, which permitted of a distribution system being adopted which depended entirely on the conductor rail, without the assistance of any copper feeders, except the short lengths connecting the rails with the power station. This method of distribution was probably the only one of its kind that had been adopted for heavy traction. The large steam-driven ventilation plant, necessary to the railway when operated by steam, had been superseded by three small electrically driven fans, which cost very little for maintenance. In order to make a comparison between the working results of the railway when operated by steam and electricity, three years' working results under both systems had been analysed, and for each system an average year of steam and electricity taken. The departments of a railway most directly affected in the substitution of electricity for steam were the locomotive and carriage departments, and the tabulated results showed that under electric working these costs had been reduced from 0·117d. to 0·089d. per ton mile. With electric traction 1 lb. of fuel, costing 8s. 9d. per ton, moved one ton of load 2·29 miles at an average speed of 22¼ miles per hour; whereas with steam the same weight of fuel, costing 16s. per ton, moved the same load 2·21 miles at an average speed of 17¾ miles per hour. The effect of electric traction on the maintenance of the permanent way had been to reduce the cost of maintenance per ton mile from 0·0208d. to 0·0089d. per ton mile. As regards the life of rails under the two systems, the average rolling load over the track before the rails required renewal had been increased from 32 million ton to 47½ million tons. The substitution of electrically-driven pumps for working the hydraulic lifts had decreased the cost per lift mile from 85·2d. to 30·1d. Electric working decreased the total cost of working and maintaining the whole of the locomotive and engineering departments from 0·238d. to 0·152d. per ton mile. The total costs of the railway, including general charges, but exclusive of interest on additional capital for electrification, had been reduced from 0·344d. to 0·24d. per ton mile. The average speed of the trains, including stops, had been increased from 15·6 to 19·9 miles per hour, and the number of ton miles per annum from 43 to 67 millions, while the total expenses per ton mile, after allowing interest on additional capital for electric work, had been reduced from 0·344d. to 0·2928d. In the half-year ended June 30, 1908, the number of passengers carried was more than twice as many as in the last half-year of steam working. The seat miles run per passenger showed a decrease of 30%, and the passenger receipts per seat mile an increase of 26·5%, while the ratio of expenses to receipts decreased from 95·3% to 69·8%.

EFFECT OF ELECTRICAL OPERATION AND PERMANENT WAY MAINTENANCE OF RAILWAYS.

By C. A HARRISON, D.Sc., M.Inst.C.E.

Discussing the effect of electrical operation on permanent way maintenance, as illustrated on the Tynemouth branches of the North-Eastern Railway, the author showed that, while there was some increase in the cost of permanent way maintenance, following the introduction of electrical working, with its improved traffic facilities, substantial economies in track work had been rendered possible in other directions. There had been a steady increase of the passenger load, and the present volume of traffic could not be dealt with by any other method without substantial increase of terminal accommodation. In any case the additional cost of maintenance had not proved to be a heavy one. Instances had occurred of crossings, which under steam conditions had lasted nine years, requiring renewal at the end of five years. To meet the conditions of wear, especially on curves and crossings, Sandberg and manganese rails had been installed. It remained to be proved whether the additional cost involved would be justified by the increase in life obtained. With regard to the maintenance of the electrical equipment of the track, he was of opinion that £50 per annum per mile of single track should cover all ordinary contingencies.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

THE "ENTZ" BOOSTER.

A speciality for which the Chloride Electrical Storage Co. is finding a large and constantly increasing demand is the "Entz" booster. This type of booster is undoubtedly one of the finest on the market, and it is being taken up with enthusiasm, not only at home, but in the Colonies and foreign countries. We might mention that installations of this reliable booster may be found working with singular success at the electric power works at Maidstone, Halifax, and other important centres, as well as in connection with electric railways and industrial undertakings in different parts of the world.

The chief feature in connection with the "Entz" booster (Fig, 1) is a special apparatus known as the carbon regulator, shown also in Fig. 2. This is neat and compact and occupies about the same space on the switchboard as an ordinary watt hour meter. The carbon regulator consists of two sets of piles of carbon discs. Between the two sets is pivoted a lever, from one end of which is freely suspended a soft iron core surrounded by a solenoid carrying the entire generator load. To the other end of the lever is attached a spiral spring, the tension of which is regulated to counterbalance the pull of the solenoid. This enables any predetermined load to be allotted to the generator. Variations in the total load above or below this fixed generator load will cause changes in the pressure on the carbon piles, resulting in wide variation in their contact resistance. Advantage is taken of this resistance variation to control the field excitation of the booster through the intermediary of a small exciter, the field of which is in the middle wire of a three-wire system (Fig. 3). In explanation of the diagram (Fig. 3), if the pull exerted by the solenoid, S.1, on the lever of the carbon regulator overcomes the spring, S.2, the carbon piles, C.P.2, will be compressed and C.P.1 released, the effect being that the direction of the current through the exciter field will be as shown by the arrow. If the spring S2 overcomes the pull of the solenoid, then the direction of excitation will be reversed. When the desired average load is on the generator the pull of the solenoid and the spring counterbalance each other, and as then the resistance of the carbon piles is equal, the booster field coil is not excited. Should, however, the line load rise above the average, and the load on the generator tends to increase, the pull due to the increase in current flowing round the solenoid overcomes the tension of the spring at the other end of the lever; this compresses the carbon piles on one side and allows current to flow in the field of the exciter in a direction to which will energise the booster field coil in such a manner as to add to the voltage of the battery and cause it to discharge.

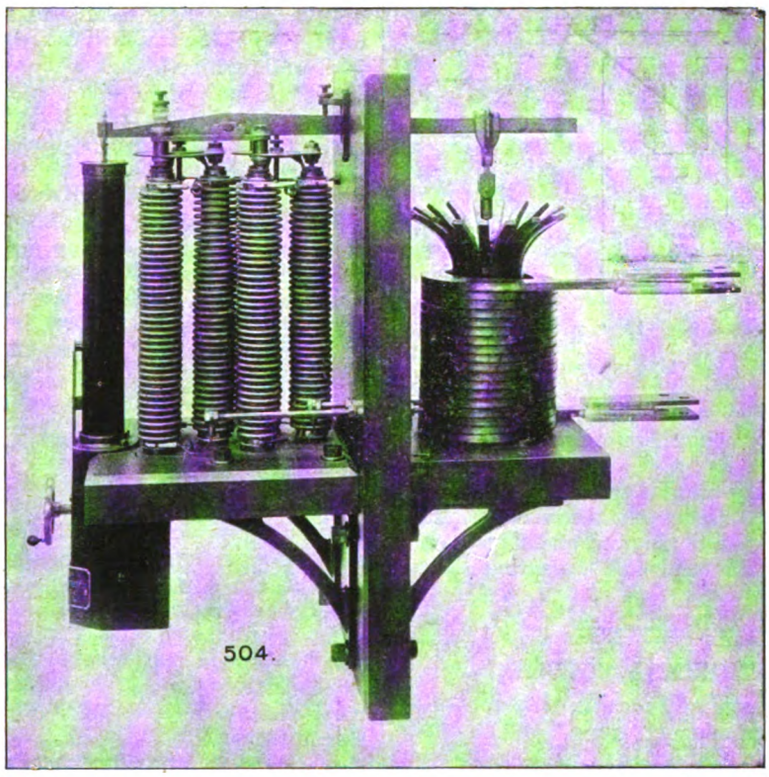

FIG. 1. "ENTZ" CARBON REGULATOR.

The carbon regulator will so adjust the booster voltage

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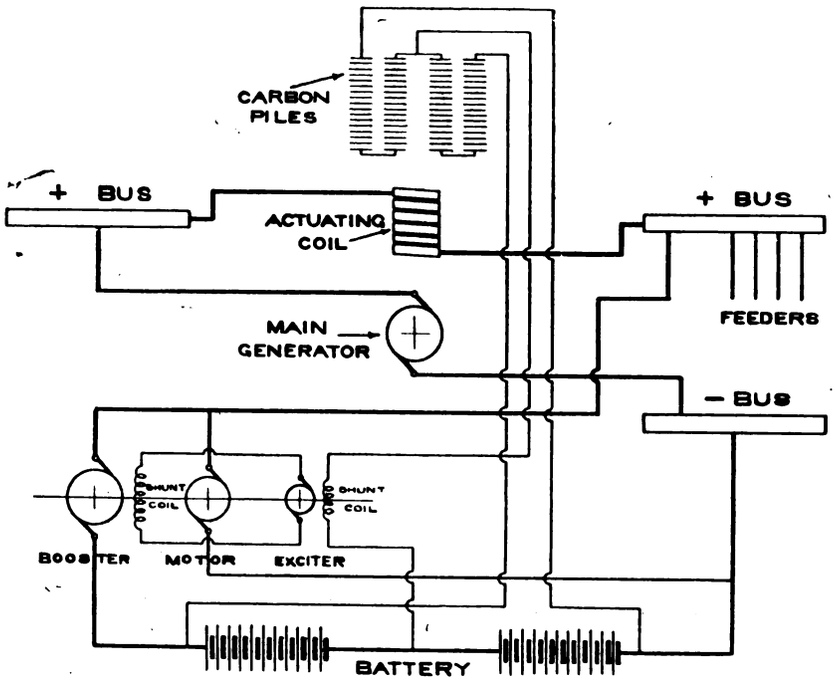

FIG. 2. DIAGRAM OF "ENTZ" BOOSTER.

that the discharge from the battery plus the average load (on the generator) will equal the line load. If the load should fall below the average the generator output would tend to drop, and the spring at one end of the lever of the carbon regulator will overcome the pull of the solenoid. The carbon piles of the regulator (on the other side to those which were compressed when the battery was discharged) will then be

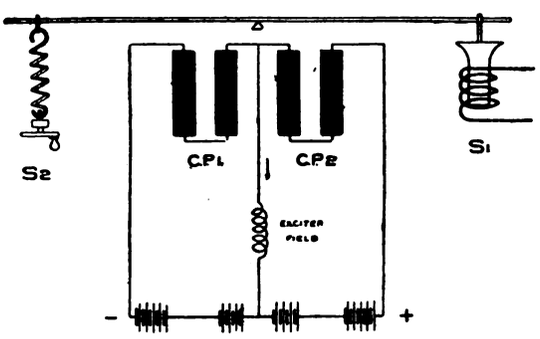

FIG. 3. CONNECTIONS OF CARBON REGULATOR.

compressed and the battery receive a charge equal to the difference between the average generator load and the line load.

The following points may also be noted: There is only one full winding booster, consequently the watts required for excitation are reduced to a minimum; and there is only one adjustment, namely, the tension of the spring against which the solenoid pulls.

WILKINSON'S THERMAL COLUMN.

This invention, which essentially consists of an apparatus with two chambers, a lower one, or "sump," and an upper one, or "receiver," is intended for the drainage of steam pipes, and the automatic return of condensed steam direct to the boiler. In other words, it frees the pipes of all water of condensation, and returns it at a high temperature to the boiler, thus doing away with ordinary steam traps and also effecting an appreciable economy in steam raising. The principle on which the apparatus is constructed is this: as soon as a body of steam is cut off from the source of supply it cools rapidly and the pressure drops. Thus steam at 366° Fahr. has a pressure of 150 lbs., but at 361° Fahr. temperature it has a pressure of 10 lbs. less, which is sufficient to lift a column of water (in round figures) 20 ft. Now, when there is no water of condensation in the lower chamber, or "sump," of the apparatus, the steam has free access up through a rising pipe into the top chamber, or "receiver." Directly sufficient water of condensation drains into the sump from the steam range through inlets, and the bottom of the rising pipe becomes immersed in water, then the rising pipe and the receiver are cut off from the source of steam supply. The steam already impounded quickly drops in pressure and, therefore, the water rises up the pipe into the upper chamber. When, as the result of this, the sump has been drained into the receiver, steam follows up the rising pipe, establishing equilibrium of pressure on the top of the water in the receiver, the water being set free to gravitate through a pipe and check valve into the boiler, or boilers, to which it may be connected. The receiver is of such capacity that notwithstanding the periods during which it is discharging its contents to the boiler, or boilers, the maximum amount of condensation water formed in the system during each cycle is incapable of filling this upper chamber; that is, the amount of water collected in the sump and entraining pipes during the period of time when the receiver is discharging to the boiler and being refilled, is less than the receiving chamber will hold. By way of safety, it is so arranged that should at any time the top receiver and rising pipe become full of water, owing to some such abnormal cause as the priming of a boiler, opening out of a length of cold steam pipe, or other unforeseen accident, an automatic relief pipe on the receiver comes into action, which allows this excess of water to escape, until the rising pipe becomes again charged with steam, when the apparatus resumes its normal work. Of course, such flooding should not occur under normal working conditions. Mr. George Wilkinson, M.I.Mech.E., M.I.E.E., tells us that his apparatus is to be seen at work in the Harrogate Corporation Electricity Works, where it has been in successful operation for nearly 12 months, and has proved itself to be a thoroughly reliable and very economical device. It certainly appears to be one of the most notable recent contributions to the economics of steam raising.

ELECTRICAL SIGNALLING FOR TRAINS.

The introduction of the electrical system of signalling at London-road station, Manchester, is reported to have caused some disorganisation of the London and North Western traffic. The older methods were superseded a few months ago at one of the boxes a distance outside the station, and until the apparatus got in working order the trains were delayed. The effect was seen to a greater extent by the extension of the system to two of the signal boxes at the station. To a correspondent one of the officials stated that the electrification had still to be extended to another singal box, and when the apparatus worked smoothly, the new system would be found to be a great advantage. Another improvement was a rearrangement of the rails consequent upon the widening of the line.

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HARNESSING OUR STREAMS.

THE ELECTRIC LIGHTING OF SMALL TOWNS AND VILLAGES.

To us, who have consistently advocated the harnessing of our streams for the cheap production of electricity, the formal inauguration, on October 30, of the Grassington (Yorks) Electric Light and Power Station, appears of special importance. As we have already mentioned, Grassington is not a busy commercial or manufacturing town, but is, in fact, a village possessing a population of only 500, though legally a town, having a Charter granted as far back as 1286, and was a market town of some importance up to some 50 or 60 years ago. It is situated on the river Wharfe, in the Upper Wharfedale district.

The originator of the scheme which has just been brought to a head, is Mr. John Crowther, an old and respected resident. In the early part of 1907 enquiries were made to see if the present water-wheel at Linton Mill was large enough to drive the machinery there, and also a dynamo suitable for a general lighting scheme. This was found to be inadequate for the work in view, and expert advice was sought, with the result that an adverse report was given as regards the utilisation of water power, a suction gas plant being recommended in its place, while it was also suggested to shut down at 10 or 11 o'clock each night, as it would not have been commercially practicable to run the plant all night. As no accumulators were proposed to be adopted, this scheme was received favourably by those who had the matter up for consideration. A few months later Mr. Chas. Pullan, electrical engineer, of Bradford, heard that a proposal was on foot for the lighting of Grassington, and his able manager, Mr. Moss, at once went to investigate and obtained the fullest particulars. He, at this time, took a canvass of the village, inspected sites, and examined the recourses of the river. Having obtained these particulars, two complete schemes were drawn up, one for suction gas as prime mover and one for water power, together with estimates of the complete initial costs of each individual scheme, the working costs, estimated revenue, etc., etc.

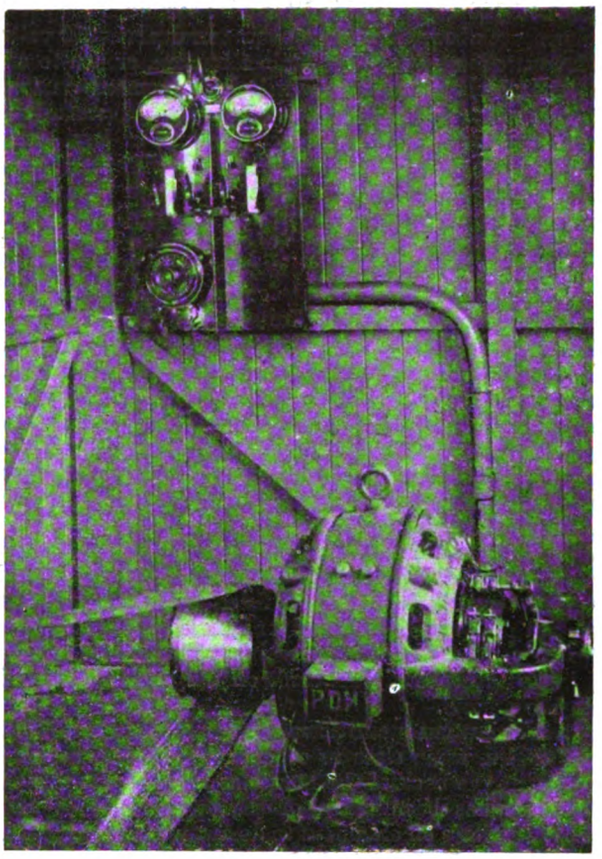
These two schemes were then submitted to the interested parties with a strong recommendation to adopt the water power scheme. This advice was eventually taken, and Mr.

THE POWER STATION, GRASSINGTON.

Pullan's scheme accepted. The next move was to get a company floated, and this work was also left in Mr. Pullan's hands, with the result that the company was registered this year, the first meeting being held on June 23, when the official contract for the whole equipment was signed and let to Mr. Pullan.

From that date onward matters progressed surely and steadily, and although difficulties were met in the shape of very heavy rains and floods, the contractor forged ahead, with the result that the whole of the plant was in running order and a trial run was made on Friday, October 15. On October 30 the official opening ceremony was performed by Mr. S. Lee, J.P., chairman of the company. With one stride Grassington has gone from "candles and oil lamps" to electric light, the coal gas epoch being entirely overstepped.

From an electrical point of view the plant would be uninteresting but for the fact that it is such a small one for a public lighting undertaking.



DYNAMO HOUSE.

The prime mover consists of a 26 in. vertical shaft Samson water turbine, capable of developing 30·9 b.h.p. under a working head of 8 ft. of water. For the reception of this machine a good deal of masonry work was necessary to form a turbine pit, a description of which would not be of an interesting nature, suffice to say that this work was carried out, under difficulties, by a local mason to plans by and under the superintendence of the principal contractor, Mr. Pullan. The turbine is of the mixed flow type, and with an 8 ft. fall will pass 2,523 cubic ft. of water per minute and run at 175 r.p.m. It is a standard machine of its type, having buckets of heavy flanged mild steel. The centre boss and ring is of cast iron, the whole being turned and balanced and securely keyed to a heavy steel vertical shaft. The guide casing and discharge cylinder is of cast iron with all flanges and joints machined and fixed together with mild steel bolts. The guide vanes are of cast iron hung on trunnions at the centre. Each vane is fitted with a steel pin and connected by sliding blocks and heavy steel arms to a cast iron centre yoke swinging on a boss formed on the top plate of the casing. The centre yoke is provided with a spur arm, pinion and shaft for adjusting the position of the vanes. The bottom end of turbine shaft runs in a footstep bearing fixed inside the discharge cylinder, the footstep being formed on a lignum vitæ block running in a cup formed in the lower end of turbine shaft.

The shaft of the turbine is extended with a length of steel shafting 3 in. diameter, on the top of which is a cast iron pinion wheel fitted with selected beech cogs, machine cut and dressed. Geared with this on an horizontal shaft is another cast iron pinion; this shaft is arranged to run at 250 r.p.m. This arrangement of gearing forms a very silent running combination. The spindle for gate gearing is also extended and carried forward into the power house, having

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the hand-wheel fixed in a position to enable the attendant to have a full view of switchboard and the whole of the machinery. The turbine is also provided with a suction tube 3 ft. long to connect with tail water. Mounted on the horizontal shaft is a cast iron belt pulley which drives the generator by means of a 6 in. cotton woven belt. The horizontal shaft is supported by three large self oiling bearing, and the vertical shaft bearings are provided with side feed lubricators, thus enabling the whole plant to run long periods without attention.

The dynamo is of open protected multiple compound wound type direct current, capable of giving an output of 20 kw. at 1,100 r.p.m., and is fitted with commutating poles. The pressure of supply at consumers terminals is 230 volts.

The switchboard calls for little attention, suffice to say that it is built up on enamelled slate mounted on teak battens and provided with the following:—Everett Edgcumbe voltmeter and ammeter, voltmeter key, lamp bracket, D.P. main switch and fuses and shunt regulator.

The power house consists of a wooden building with corrugated iron roof, the whole being securely bolted down to the foundations. The floor is of concrete and finished off with cement. The principal dimensions are 20 ft. long by 9 ft. wide and 7 ft. 6 in. high to eaves with a lean-to built over the turbine pit to cover the gearing 8 ft. by 8 ft.

Immediately outside the power house at a point near the switchboard is the terminal pole carrying the main feeder cables, these being 19/15's single braided and compounded aerial pattern. These are carried across the river, and for a distance of approximately 600 yards across fields and open country. The poles are the ordinarycreosoted stock pattern, 30 ft. long, except in one or two special cases, and provided with oak arms and insulators.

At a point at the bottom of the village, these cables terminate at a distribution board consisting of slate panels mounted on teak battens and fitted with bus-bars, S.P. knife switches and D.P. porcelain handle replacement type fuses to control distribution mains. This board is fitted inside a weatherproof cupboard, on the pole, about 10 ft. from the ground.

The distribution mains from this point consist of 7/14's aerial cables, same class as others and are run, as far as possible, at the back of the houses so as to be out of sight. Advantage has been taken of the opportunity of using bracket supports on chimneys to do away with poles, where convenient.

From the foregoing it will be seen that the whole distribution system is arranged overhead, and the services will be taken off at the nearest and most convenient points.

The price for lighting is 5d. per unit, and Reason electrolytic meters are used. Power rates for heating, small motors, etc., will be specially arranged between the company and the consumers as they will be very few.

It will be noticed that the plant is of the simplest description throughout, this being necessary for many reasons. In the first place, capital cost has to be kept down to a minimum, and the plant had to be so arranged and made as simple as possible to reduce, not only wear and tear, but to enable it to be left for long periods without attention, and it had to be so designed and of such a nature that it was not necessary for an engineer to be in constant attendance, as it will be readily understood that the revenue accruing from a station of this size will not warrant a large wage bill.

Apart from a guarantee which the engineer has given, Mr. Pullan will act as electrical and general adviser to the Company.

It is to be hoped that the Company and undertaking generally has a prosperous future before it, and that this scheme will be the forerunner of many similar ones that will be installed for the utilisation of streams and rivers in this country that have low falls, and therefore provide a means of efficiently and economically lighting many towns and villages by electricity that would otherwise be left with the old and primitive candles and oil lamps.

Apart from this aspect of the question, it provides another opening for our electrical manufacturers and another field of labour for that deserving individual, the electrical contractor.

The water turbine and gearing was supplied by Jas. Gordon & Co., of London, the generator by Messrs. Phœnix Dynamo Manufacturing Co., Ltd., of Bradford, the cables by Messrs. The British Insulated & Helsby Cables, Ltd., of Prescot, and the switchboards by Messrs. The Midland Manufacturing Co., Ltd., of Birmingham.

DIARY:

FRIDAY, NOVEMBER 12.

INSTITUTION OF ELECTRICAL ENGINEERS (Birmingham Section).—At the *Grand Hotel*, annual dinner.

SOCIETY OF MOTOR MANUFACTURERS AND TRADERS.—At Olympia, London, motor exhibition opens.

PHYSICAL SOCIETY OF LONDON.—At 8 p.m., at the Imperial College of Science, Imperial Institute-road, South Kensington, "The Absorption Spectrum of Potassium Vapour," by P. V. Bevan, M.A.; "Some Further Notes on the Physiological Principles underlying the Flicker Photometer," by J. S. Dow, B.Sc.; "Exhibition of a Colour Perception Spectrometer," by F. W. Edridge-Green, M.D., F.R.C.S.; and "Table of Ber and Bei and Ker and Kei Functions, with Further Formulæ for their Computation," by H. G. Savidge.

NORTHAMPTON INSTITUTE (Engineering Society).—At 5.45 p.m., at the Institute, "Steam Turbines as Applied to Marine Propulsion," by C. B. Dicksee.

SATURDAY, NOVEMBER 13.

GLASGOW TECHNICAL COLLEGE SCIENTIFIC SOCIETY.—At 7.30 p.m., "Modern Condensing Installations," by W. A. Dexter of Messrs. The Merrlus Watson Co., Ltd.).

MONDAY, NOVEMBER 15.

ELECTRO HARMONIC SOCIETY.—At 8 p.m., at Holborn Restaurant, concert (ladies' night).

WIMBLEDON CORPORATION.—At Wimbledon, Electrical Exhibition opens, and will be continued till 20th inst.

TUESDAY, NOVEMBER 16.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Local Section).—At 7.30 p.m., at the University, "Telephones," by L. E. Wilson.

JUNIOR INSTITUTION OF ENGINEERS.—At 8 p.m., at the Royal United Service Institution, Whitehall, Presidential address on "Recent Warship Machinery," by Engineer Vice-Admiral Henry J. Oram, C.B.

INSTITUTION OF ELECTRICAL ENGINEERS (Glasgow Local Section).—At Bath-street, inaugural address by the Chairman (Mr. E. G. Tidd).

JUNIOR INSTITUTION OF ENGINEERS.—At 8 p.m., at the Royal United Service Institution, Whitehall, Presidential address on "The Propelling Machinery of Warships" by Engineer Vice-Admiral Henry J. Oram, C.B., Engineer-in-Chief of the Fleet.

WEDNESDAY, NOVEMBER 17.

SOUTH WALES INSTITUTE OF ENGINEERS.—At 7 p.m., at Institute-buildings, Cardiff, special meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Leeds Local Section).—At 7.15 p.m., at the University, Sheffield, "Some Experiments on Single and Stranded Fuses," by W. T. MacCall.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section).—At 7.45 p.m., at 92, Victoria-street, S.W., opening address by Mr. J. H. Rider (member), "The Importance of Attention to Details."

THURSDAY, NOVEMBER 18.

ILLUMINATING ENGINEERING SOCIETY.—At 8 p.m., at the Royal Society of Arts, 18, John-street, Adelphi, W., Inaugural address by Prof. Silvanus P. Thompson, D.Sc., F.R.S., first President.

FRIDAY, NOVEMBER 19.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—At Sunderland, general meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Glasgow Students' Section).—At 8 p.m., at Glasgow Technical College, "The Localization of Breaks in Submarine Cables," by W. H. Young, B.Sc.

INSTITUTION OF MECHANICAL ENGINEERS.—At 8 p.m., at the Institution House, London, paper by H. A. Humphrey.

SATURDAY, NOVEMBER 20.

JUNIOR INSTITUTION OF ENGINEERS.—At 3 p.m., visit to foundation work of the new County Hall of the London County Council, Belvedere-road, Lambeth, S.E.

MONDAY, NOVEMBER 22.

MUNICIPAL AND COUNTY CLUB.—At Whitehall-court, London, S.W., house dinner, Col. Hughes, C.M.G., ex-Lord Mayor of Sheffield, guest of the evening. Lord Alverstone, G.C.M.G., P.C., will preside.

TUESDAY, NOVEMBER 23.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Students' Section).—At 7.30 p.m., Municipal School of Technology, "The Testing of Electrical Machinery," by R. F. Blackmore and V. W. Newman.

WEDNESDAY, NOVEMBER 24.

ROYAL SOCIETY OF ARTS (London).—At 8 p.m., at John-street, London, W.C., "Photo-Telegraphy," by T. Thorne Baker, F.R.G.S.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

"If thou hast knowledge, let others light their candle at it."

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should be *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

QUESTIONS.

Question No. 1210.—What are the advantages of electric motors over steam engines for driving rolling mills? Please give some idea of the power required for rolling stated sections and of the extent to which electric motors have replaced steam engines in this service. Is the *replacement* justifiable, or are electric motors only commercially practicable in *new installations*?—C. T.

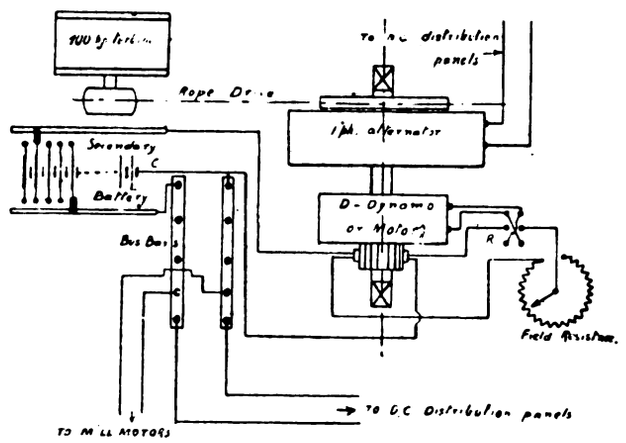
Question No. 1211.—How far is it possible to use a given cable for telephone *and* telegraphic purposes? To what extent does one use interfere with the other, and what precautions must be taken when arranging for such double working? How does distance affect each form of communication?—"ENQUIRER."

———

Question No. 1205.—An electric supply company having single-phase (periodicy 100) water power plant situate in old corn mill is going to instal a 100 h.p. turbine and rope-driven alternator. To provide against shortage of water power in the summer, it is also proposed to instal accumulators (capacity 40 kw. for three hours). It is also required to drive corn mill by electric motors. Would it be feasible to instal a continuous current machine and alternator on the same shaft, using the former as a dynamo in the daytime to drive motors in corn mill and charge accumulators, and as a motor (driven by accumulators) at night during peak loads to help to drive alternator when water-power would be insufficient? Give particulars of any alternative arrangement you would recommend.

Answer to Question No. 1,205 (*awarded* 10*s.*).—The suggested arrangement is quite feasible and is practically the only means whereby the desired object could be effected. The scheme is not without its difficulties, however. In the first place, the high frequency of the alternator necessitates a higher r.p.m. than is desirable for the direct current machine coupled to it. Assuming a 50 to 70 kw. dynamo D (Fig. 1) a speed of not over 400 to 500 r.p.m. would be the upper limits in ordinary practice, but, even assuming a 20 pole alternator, the speed must be 600 r.p.m. in the present case if direct coupling is employed. It is not advisable to gear the machine D to the alternator it being preferable to pay a little more for the higher speed of D.

The size of battery suggested will not enable a very large peak load to be dealt with. If the peak load is 95 h.p. and the minimum turbine horse power, in the driest summer, is 50 h.p., the battery will only cope with the surplus demand for about 2½ hours and will be overloaded during the whole of this period. Such overloading, if constantly repeated, will rapidly deteriorate the cells. Whether 2½ hours will carry the supply over the peak period obviously depends essentially on the nature of the load curve. In a country district and in summer it is possible that the heavy demand would not persist longer than from, say, 8 p.m. to 10 p.m., but in towns a peak load lasting from 4 to 5 hours even in summer must be allowed for. It would, therefore, appear wise to instal a rather larger battery, say, of 50 kw. capacity for 4 to 6 hours. The cost of such a set would probably total nearly double that of the proposed battery but additional d.c. load could be dealt with during the day, and, if necessary, the cells could help the alternator over any day peaks (due to power demand, etc.). The overall capacity and flexibility of the equipment would be much extended by the use of a larger set of cells and the availability of direct current for driving miscellaneous agricultural, farming and dairy implements is usually much appreciated in country districts. In a very similar case to the present, within my own knowledge, an electric plant driven by an old mill water wheel has been equipped with accumulators and operates on an excellent load factor, the day load being composed of motors driving oil-cake crushers, turnip cutters, chaff cutters, horse clippers, churns, separators, small pumps and so on.



The machine D in the present case will need to be fitted with a considerable range of field resistance to enable it to charge the cells C, and, moreover, to enable its speed adjustment during the evening run when aiding the turbine. When D is to be run as a motor its field connections must be reversed in order to preserve the same direction of rotation: the reversing switch shown in Fig. 1 is drawn thus for simplicity. Actually it must be of special form enabling the field current to be first brought to zero (gradually), and then built up in the opposite direction. Sudden reversal would produce serious arcing at the switch contacts and probably puncture the field insulation by the inductive pressure kick causes. Suitable field reversing switches can be obtained from any manufacturer of boosters or balancers.

The rope drive between the turbine and alternator will eliminate, by its slip, much of the trouble which might otherwise be experienced, owing to small differences in r.p.m. of the two drivers. The turbine has, no doubt, been designed for a certain speed-load characteristic and this should on no account be varied. The electric motor must always be regulated to run at the same speed as the turbine and never *vice versa*. The least tampering with the speed or other running conditions of a turbine is followed by disastrous loss of efficiency, whereas the electric motor is, of course, perfectly flexible in this respect. Speed indicators on both machines (turbine and motor) should be placed in easily accessible positions. Electric indicators with instruments on the switchboard are the best for this purpose. The general connections required in the above scheme are indicated in Fig. 1. Measuring instruments, fuses and switches are omitted, the location of these depending purely on the exact conditions of working and being at once obvious to the engineer in charge of the erecting work.

As regards alternative schemes, the most obvious and, as far as can be determined from the query, the most satisfactory one, would be to dispense with the a.c. plant entirely. In such a small power scheme the question of transmission can hardly be concerned. Even should the alternator be already installed the cost of the mooted d.c. plant will be nearly as great as that of a d.c. generator and battery capable of dealing with the whole load. Night shifts, with their attendant poor load factor, could then be dispensed with. The d.c. supply would be far preferable to the 100 single-phase supply for motors and is generally recognised as superior for lighting purposes; for electrolytic work it is, of course, essential. The only objection to such a course is that consumers may have a number of a.c. motors installed; in that case, unless

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the supply company considers it worth while to pay the expense of replacing the motors, the first mentioned auxiliary d.c. plant forms the best arrangement practicable.—S. M. P.

Answer to Question No. 1,205 (*awarded* 5*s.*).—So much depends, in a scheme of the present nature, on local conditions of energy demand that no definite conclusions can be formed as to the suitability of the exact size of battery installed and so on, but, by assuming a hypothetical load curve as below, the writer thinks the practicability of the scheme can be completely demonstrated though a higher capacity of battery would appear desirable. Since the accessory plant is stated to be only requisite in case of water shortage in the summer, it may be safely assumed that the maximum load even in winter can be dealt with by the normal full horse power of the turbine, *i.e.*, 100 h.p. On this assumption the lighting load curve of the station may well be as shown – – – – – – (Fig. 1). Let it be supposed that the maximum h.p. of the turbine falls in summer to 60 h.p.—it is shown below that this is the minimum value it must have if the battery is to be of the capacity stated. The mill motor load may be assumed to be practically constant at 25 h.p. from 6. am. to 5 p.m.—this will probably cover the somewhat varying demand. The gross demand, excluding the accumulator charging load is as shown — - — - (Fig. 1). The excess area of the peak load over 60 h.p. totals an amount of energy = 128 h.p. hrs.

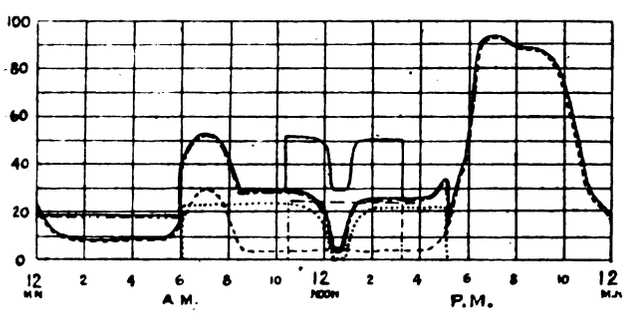

FIG. 1.

LOAD CURVES :— (- - - - - - - Lighting Alone.
..... Corn Mill Alone.
— — ··· — — Accumulators Alone.
———·— Total Load.

(from 6.30 p.m. to 10.30 p.m.) = 95 kw. hrs., hence the battery will be nearly discharged at the end of the evening run. An inspection of the gross load curve will show that there are only two periods available for charging the battery (*a*) from 11 p.m. to 6 a.m. (*b*) from about 10.30 a.m. to 3.30 p.m. Were it possible to shut down the a.c plant from midnight till 6 a.m. there would be no doubt that the day charge would be preferable, but since a small a.c. lighting supply has presumably to be supplied all night the plant can never be completely shut down, and, all-night attendance charges being unavoidable, a slow charge from 11 p.m. to 6 p.m. (at about 18½ h.p. = 13-14 kw.) is advisable. This is especially the case if an a.c. power load has also to be supplied during the day.

The above points may be further realised by a study of Fig. 2, which shows the horse power available at the turbine shaft after (*a*) supplying the lighting load, curve – – –, (*b*) supplying the lighting load + corn mill motors, curve ..... (*c*) supplying the lighting, motor, and accumulator loads. The accumulator charging curve, or the h.p. available after allowing for it as the case may be, is shown — — — · — · — · — throughout, and is shown at both of the available charging periods in Figs. 1 and 2.

The night charge is undoubtedly preferable under the present circumstances, the nett available power under the worst conditions assumed then being as shown by the shaded area, Fig. 2. It will be seen that if the day charge be adopted it would probably have to be at about 25 h.p., and, in summer, would leave a very small margin of turbine capacity to supply any a.c. power load.

For the above conditions and with only a small a.c. power load, if any, the 120 kw. battery suggested would probably suffice, though a rather longer discharge rate (and hence more costly battery) would be preferable. By increasing the battery capacity by about 50 per cent., however, the discharge period being lengthened to about 5 hours, very considerable advantages would accrue.

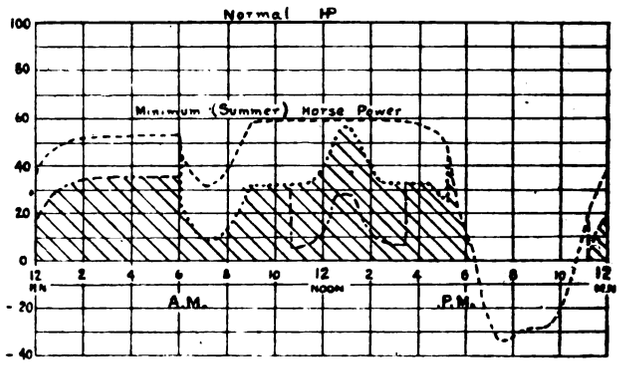

FIG. 2.

— — H.P. Available - - - - - - - - After supplying A.C. Light. Load.
..... Ditto + Mill Motors
— — ···· — Ditto + Accumulators.

In the first place, a greater shortage of water supply would be safeguarded against, and, in a dry summer, it is quite possible that the turbine h.p. would fall below 60 per cent. of its winter rating. As to some extent compensating the latter liability, however, it should be noted that the load curve is by assumption the most severe to be dealt with, *i.e.*, the winter curve. In summer the lighting peak would be appreciably lower: in winter the suggested plant could deal with a considerably higher load than that shown in Fig. 1, because, in addition to the accumulators, the full h.p. of the turbine would be available.

A further advantage of installing a larger battery would be that a small supply of direct current energy could be offered to the station's consumers at all hours of the day and night, and without sacrificing the balance of a.c. energy (Fig. 2) available during the day for power, etc. The 7-hour night shift would still be amply sufficient for charging purposes, and the improved utilisation of the turbine during these hours, together with the increased number of consumers that might be safely anticipated, owing to the advantages of direct current for small motors, and its suitability for plating, etc., would result in a substantial improvement in the station load factor, and a corresponding reduction in working costs. The cost of battery renewals and repairs would also be reduced, the battery not being so heavily loaded, in proportion as the one suggested in the query would be.—W. M.

HYDRO ELECTRIC PLANT FOR MEXICO.

A contract has been made between the Mexican Ministry of Fomento and Mr. José Luis Requena, empowering the latter to utilise water from the river Tepeji (State of Hidalgo), to an extent not exceeding 5,000 litres per second, for the purpose of generating motive power. The contract is for a term of 20 years. The concessionaire undertakes to commence operations within 24 months, and to complete the work within seven years. The electrical energy generated may be carried either overhead by means of aerial wires, or underground by means of insulated conductors. The concessionaire is granted the right to import, free of duty, once only, all the machinery and apparatus necessary for carrying out the work, and is also authorised to construct any bridges, telegraph and telephone lines, according to his discretion.

A similar contract has been made authorising Mr. Salvador Serrano Hermosillo to utilise water from the river Lagos (State of Jalisco) for irrigation purposes, to an extent not exceeding 1,000 litres per second. Work must be completed within seven years. The concessionaire may import, free of duty, once only, all the machinery and apparatus necessary for carrying out the work, and is also authorised to construct any bridges, telegraph and telephone lines that may be required.

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ELECTRICAL PROGRESS AT HOME & ABROAD

FROM OUR SPECIAL CORRESPONDENTS.

TYNESIDE NOTES.

NEWCASTLE.

In addition to the brief financial statement which was given under the head of "Companies' Meetings and Reports," in the last issue of THE ELECTRICAL ENGINEER, it is interesting to give one or two notes concerning engineering developments in connection with the Cleveland and Durham Electric Power Co. This company depends to a certain extent upon its waste heat stations operated from the gases from coke making plants and blast furnaces. These stations operated by the company have not been run at their best advantage during the year, as, owing to a reduction in the quantity of pig iron produced, furnaces have been shut down. This has resulted in blowing engines being laid off duty, with a consequent reduction in the amount of steam placed at the disposal of the company. With reference to the large number of collieries in the area, it is expected that the Eight Hours Bill will compel colliery owners to adopt more efficient labour-saving plant, and as mechanical power can be applied far more conveniently and cheaply by electricity than any other means, it is expected that the connection of collieries to the system will proceed apace. Already the current year shows considerable improvements in connections to the system. Down to a fortnight before the date of the Chairman's address a report showed a revenue of £26,423, as compared with £20,315 for the corresponding period of the previous year, the profit being £4,008, as compared with £1,507. The company is laying out further extensions in order to cope with the expected demand. During the past year an extension of the cable system has been taken from the North Bank of the River Tees, through the East Durham coalfield, to Murton, where it joins the cable system of the Newcastle and Durham Companies. This was put into commssion on June 29 last, and at the present time the plant at the Newport waste heat station is being doubled, and it is expected that the additional plant will be in operation at the beginning of next year, when the coal consumption at Grangetown will probably be considerably reduced.

Electrically Equipped Concerns Successful.

Messrs. Wise, Speke & Co., of Newcastle-on-Tyne, have recently issued a *brochure* entitled "North of England Coal, Steel and Iron Industries," in which a summary is given of the various companies operating in the North-Eastern counties and their financial position. It is interesting to find that so many of these companies, representing the strongest financial interests in these counties, are, either partially or wholly, electrically equipped, and the effect of electricity may be traced in the comments of Messrs. Wise, Speke & Co. For example, in the case of Messrs. Bolckow, Vaughan & Co., Ltd., of Middlesbrough, it is stated that the total expenditure upon new by-product ovens, exhaust steam turbines, electrical installations, new iron stone mine machinery, extensions, etc., during the year 1909 was £298,149, in 1908 £244,989, and in 1907 £284,526. In the case of Messrs. Dorman, Long & Co., Ltd., of Middlesbrough, the booklet states that a new cogging mill, furnished with the Ilgner system of electric driving, the first equipment of this character of entirely British manufacture and design, has been put into commercial service. The electrical portion of the equipment makes it possible to work at a rate considerably in excess of the average, whenever necessary. Other names, such as Swan Hunter & Wigham Richardson, Ltd., Smiths' Docks Co., Ltd., Pease & Partners, Ltd., Palmer's Shipbuilding & Iron Co., Ltd., etc., are all found in the list of consumers of the Electricity Supply Companies operating over these areas, and there is no doubt that all this affords a valuable testimony to the effectof electric power from a central station upon manufacturing enterprise.

Specimen Electrical House.

An interesting feature of local enterprise, which is probably one of the first of its kind, at any rate, in the provinces, is the equipment by Messrs. H. Chapman & Co., art house furnishers, of Newcastle, of a specimen house, which is on exhibition in one of the best residential suburbs in Newcastle, namely, Jesmond. This firm has taken for a period of three months an ordinary dwelling-house of good class, and furnished it completely throughout in modern style, the idea being that the whole of the furnishing can be accomplished for a moderate sum. Co-operating with them is the Newcastle-upon-Tyne Electric Supply Co., who have supplied electricity for lighting, heating, cooking, etc., and are exhibiting various styles and examples of lighting fittings, lamps, heating devices, radiators, etc. The wiring for the work was done by Messrs. Robson & Coleman, of Newcastle-on-Tyne. The exhibition during the first fortnight of its run attracted some 500 people per week, and at this rate it will during its three months prove a most valuable advertisement for electricity in the neighbourhood. Demonstrations are being arranged in the domestic uses of electricity, including heating for irons, kettles, etc., laundrying and vacuum cleaning, and a strong feature is being made of the use of 250 volt metallic filament 27 watt lamps. It is interesting to note in this connection that the Newcastle-upon-Tyne Electric Supply Co., Ltd., have now upon their mains some 200 electric irons, either purchased outright, or upon the hire or hire-purchase system, excluding many which have been bought from contractors and agents in the city, and of which the company have no knowledge. This, considering the shortness of time since the electric iron was commercially introduced, is a surprising figure. Another feature which the Supply Co. intends to push very vigorously during the coming spring is the hiring out of electrically-operated vacuum cleaners, an example of which is on exhibition at the model house. The rental of the apparatus will probably be in the nature of 10s. 6d. per day, and it will probably prove a valuable revenue raising medium for the company and of distinct advantage to the householder within reach of the mains.

Electrical Contractors' Association.

The Northern Section of the Electrical Contractors' Association, Incorporated, has recently been reviving its strength to a most remarkable degree. Recently a meeting was held at the *Corporation Hotel*, Middlesbrough, at which Mr. W. A. Shaw, of Stockport (Chairman of the Association), and Mr. J. MacDermont, J.P., attended, in order to put the aims and objects of the Association more strongly before the local contracting firms. Among the points which were more especially emphasised were the questions of municipal trading, and it was mentioned at the meeting that the Contractors' Association was taking steps to dispute the attitude taken by the Corporations of Leicester and Sheffield. Another subject which received considerable attention was the abuse of sales of metallic filament lamps. As it is very strongly felt by the electrical contractors, manufacturers should not go directly to the general public, but should allow sales to be effected through the customary channels. As the result of this campaign, all the leading firms of the district have joined the Association, and the Secretary of the Northern Section, Mr. R. Robson, 10, Stanley-terrace, Gosforth, Newcastle-on-Tyne, is very confident of increasingly strong local support, which will be considerably affected by the attitude which the Association has taken with regard to the recent Electrical Lighting Acts Amendments Bill.

MIDLAND NOTES.

BIRMINGHAM.

The Birmingham section of the P. and O. Batti-Wallahs Society held their second Bohemian concert of the present season in the Grosvenor Room, *Grand Hotel*. The company, ladies and gentlemen, numbered about 270. Mr. J. P. Kemp (Resident Engineer, Birmingham Corporation Electrical Station, Summerlane) presided. The Chairman announced that the annual ball of the Batti-Wallah Society in Birmingham will take place next month. The programme of the evening included several excellent contributions by members, among them banjo duets by Messrs. Pitt and Boulton, and humorous songs by Mr. R. G. Mercer. Mr. David Wilson (of London) gave a highly popular item, entitled "Deeds of Magic: the Illusive B.T.U." The toast of "The Ladies" was given by Mr. Maurice Solomon, whose speech, as usual, was a feature of the evening. The section of which Mr. E. Sheppard (who took a prominent part in the formation of the Society in London) is Hon. Secretary, now has a membership in Birmingham of 70, a larger number than that of the London section.

Institution Gathering at Birmingham.

Apart from the address by Mr. R. K. Morcom, the newly-elected Chairman, the inaugural meeting, at the University, of the Birmingham Local Section of the Institution of Electrical Engineers was an interesting gathering. The large attendance was a good augury for the success of the coming session. Professor Kapp, Professor of Electrical Engineering at the Birmingham University, occupied the chair at the commencement of the proceedings, and expressed his satisfaction that the Council in London had agreed to alter the area covered by the Local Section, making the new area to extend within a 50 miles radius of Birmingham. The effect of this would be to add 71 new members, bringing the total number up to 401. The Presidential address was preceded by a vote of thanks to the retiring Chairman. Mr. Chattock, the City Electrical Engineer, said they all congratulated themselves on having had such a Chairman for the past two years. The time and trouble he had expended had been greatly to the benefit of the Local Section,

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Dr. Kapp, in addition to the chairmanship, had had duties in connection with the London Council. The doctor had been most helpful also in contributing to the discussions, to which he had brought a great amount of theoretical knowledge. The vote was seconded by Mr. Railing, Managing Director of the General Electric Co., Witton. They had, said the speaker, all been extremely proud to act under the authority of Dr. Kapp, whom they congratulated on having been elected to the general presidency of the Institution of Electrical Engineers. Dr. Kapp assured the meeting that though the work had been arduous, it had been, indeed, a labour of love. At the same time, he congratulated them on having, as his successor, a chairman at least as enthusiastic as himself.

"The Fly-Wheel of Industry."

Mr. Morcom illuminated the reading of his address with touches of humour not always embodied in the printed text. For instance, there was a ripple of fun through the meeting when he remarked, after one of his best turned sentences: "I think that is very nice." This frank expression of humorous self-complaisancy highly amused the audience. The sentence he referred to was the following: "Capital is the fly-wheel of industry, which keeps things going steadily under the fluctuating impulses of demand, and enables the machinery to grind out at an even rate the current of wages." A number of other bright little "asides" were highly appreciated.

The vote of thanks to the Chairman for his address was carried enthusiastically, on the proposition of Mr. A. M. Taylor, seconded by Lieut.-Col. Lester, Engineer of the Southern Army. Mr. Taylor thought the address furnished much matter for profitable reflection. Colonel Lester, referring to the competition of the metallic filament lamp, said they must not accept defeat, and the engineers must create a demand for something else to employ their current. The severity of the competition had at all events brought their machinery to a pitch of perfection which made it second to none, and when demand came along that should secure them their share of the world's business. The speaker entirely endorsed the Chairman's remarks on the value of mathematical training, which Birmingham engineers had the best opportunities of obtaining.

LANCASHIRE NOTES.

MANCHESTER.

Business in the district has again slackened off very considerably during the week. One or two of the large firms here are practically depending on foreign orders and unless trade improves very soon expect to go on half time. Enquiries are numerous, but orders are scarce and quoting is keen. The depression is largely due to the poor state of the cotton trade. In the Bolton district, where Egyptian cotton is mostly spun, trade is much better, but in the Oldham and Rochdale districts many mills are working short time, or closing alternate weeks on account of the condition of the American cotton market.

Manchester Tramways.

In consequence of this bad trade the tramway receipts here are now several thousand pounds less than last year, although the track mileage has increased. As a result various working economies are being effected and fewer cars are being run; the speed being increased to keep up the service. The track on the Cheetham Hill and Hightown routes is now being relaid. These were the first two routes converted to electric traction, and it is more than seven years since they were opened. The traffic is heavy, particularly so in summer (as Heaton Park is reached by the route), and the wear on the thread of the rails has been about seven-eights of an inch in the seven years. The work proceeds in the daytime and very little delay is occasioned to the traffic; one track being relaid at a time, and the other worked as a single line. Another alteration in progress is the substituting of side poles and span wires for centre poles. This work was commenced about two years ago in consequence of a successful action against the Corporation for damages caused by a motor dashing into one of the centre standards. In Victoria-street, where the road is nearly all built on bridges, the work has been rather difficult and expensive, long pillars having to be put in under the bridge to carry each pole. *Apropos* of the loop line collision on a neighbouring system last week, it is interesting to note that automatic signalilng is used on the few loop lines in use on the Manchester system. The arrangement has been developed by the Tramway engineers and is made at Mr. Dewhurst's works at Preston. Instead of the customary four contacts, eight are used, giving two signals at each end of the loop, ensuring protection under all circumstances. Deliberate disobedience to the signals alone can cause collisions, and even this would be proved by the position of the signal at the time of the accident.

In common with many other large systems, Manchester now builds her own tramcars, and has splendidly equipped works at the Hyde-road Depôt. The trucks and electrical equipments are bought and assembled, while the bodies are built right through. The electric drive is used, the motors and shafting in the case of the wood work-shop being installed in the basement underneath. The repair shops contain the usual large machine tools.

Stuart Street Station.

Manchester's second 6,000 kw. turbine—a Howden Zoelly—has been tested and the results published. The full load steam consumption is 14·6 lbs. per kw. hour, while at 7,500 kw. (25% overload) it is 14·92 lbs., the pressure being 188 lbs., with 137° Fahr. of superheat. These figures show that large impulse turbines are by no means inferior to the large reaction type. Next to the turbines at Stuart-street are the enormous 6,500 h.p. marine engines by the Wallsend Slipway and Engineering Co., and the difference in dimensions between the two sets, particularly the alternator portion, is very striking.

Electric Driving at Hans Reynolds.

As is well-known H-T current is supplied to a few works in the district from Stuart-street, being transformed down in a sub-station at the works. Hans Reynolds' new works at Burnage (really in a residential district), is a very interesting example of this. The works are driven by three-phase Peebles motors. Each motor, with its starting gear, is mounted on a concrete pedestal at about 6 ft. from the floor, and drives a line of shafting through Renold chain, running at about 1,150 ft. per minute. The sub-station, which is just oustide the main building, contains a bank of Berry single phase natural air-cooled transformers reducing the 6,600 volt current to the working pressure. A Ferranti board controls the works. Flame lamps and numerous incandescent lamps are employed for lighting. The whole installation has proved very satisfactory and the works are laid out on model lines. The Renold chain is employed instead of belting throughout, except for some small lathes, and great economy in capital outlay and in running costs is claimed for its use.

Fire at Cable Works.

In the early hours of morning a serious outbreak of fire occurred in the top storey of Messrs. Connolly Bros.' cable works at Blackley, Manchester. Before it could be mastered considerable damage had been done and the loss is very heavy (though covered by insurance), the braiding and stranding shops, as well as much finished material in the stores, being burnt out. Work in stranding and braiding has, however, now been recommenced in their branch works near by and every effort to make up for delay is being made. I understand some 6 core cable for the Manchester Corporation was burned, and also that some of the firm's fireproof cable, which was actually in the fire, was found with the fireproofing in perect condition, thus proving in a very practical manner, its good qualities.

Canal Water for Condensing.

Arising out of a local case, in which the Rochdale Canal Co. sought to restrain the Crawford Spinning Co., Rochdale, from using canal water for boilers, an interesting appeal was decided this week. By the Canal Co.'s Act of 1794, riparian millowners on the bank may take water from the canal for condensing purposes only. The difficulty in this case was that steam (raised from Corporation water) was cooled by spraying with canal water so that the two mixed in the hot well, from which the boilers were kept filled. The Canal Co. complained that this was using their water for steam, and in this Vice-Chancellor Leigh Clare decided in their favour. On appeal, however, this has been reversed and the Court decided that so long as the canal got back a daily volume of water equal to the quantity abstracted, the company had no cause for complaint.

AMERICAN NOTES.

NEW YORK.

Striking details are published of the great electrical irrigation works which are converting into large tracts of fertile country the hitherto barren areas of Central Washington. Nature has made the transformation possible by running through the Columbia River Valley a broad and rushing stream, which is capable, duly harnessed, of producing more than 1,000,000 h.p. The first of the power sites to be developed is Priest Rapids, where the Hanford Irrigation and Power Company of Seattle have laid down works costing upwards of $1,000,000. Of these works a Government report gives the following details: The power canal is 10,275 ft. long, with a weir across a narrow channel in the river which connects it with an island, making in effect a wing dam about 3,000 ft. long. The canal below the weir, for a distance of 7,000 ft., follows a natural rock channel, having a width at low water averaging 500 ft. and at high water 1,000 to 1,200 ft. Below this point it is excavated to a bottom width of 67 ft. and a top width at high water line of 133 ft. The material taken from the excavation, consisting of earth, gravel and rock, is placed in the embankment between the canal line and the river.

Power House and Transmission Line.

The power house is built of re-inforced concrete, complete for two power units and one exciter unit. It is 67·5 by 70 ft. and about 90 ft. high above foundations. This power house may be

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extended down stream a distance of 2,000 ft. along the gravel bench which would carry the power canal. The turbo-generator unit already installed furnishes power in excess of the amount required to operate the pumps. The pumping station is of reinforced concrete, built to accommodate four motors and pumps, with lightning arrestors and transformers, bilge pumps, and full equipment of instruments. The two synchronous motors and pumps already installed and in operation are of the vertical centrifugal type, carrying the motor directly connected to the shaft. The speed of the motors is synchronous with the generator, and the column of water pumped is controlled accurately by regulating the speed of the turbines. Their nominal capacity is 64 cubic ft. per second each, at a speed of 175 r.p.m. Their combined capacity is 83,000,000 gallons per day, a sufficient quantity to irrigate 16,000 acres. The transmission line which conveys the power from the power house at Priest Rapids to the pumping station at Coyote Rapids is 16·3 miles long, consisting of three No. 4 copper wires, and carrying 46,000 volts. The transmission line is now being extended to the town of Hanford, to furnish power for lighting and heating the town, pumping the domestic water supply from the Columbia River, and running other machinery. The plant at Priest Rapids has only been in operation six months, but there is already an enormous demand for power to operate small pumping plant for local irrigation.

Units and Symbols.

Commenting on the report of the German Committee appointed to consider and recommend technical notation and symbols for use by engineers, the *Electrical World* makes some suggestions, which are likely to commend themselves to general acceptance among electrical engineers. The Committee recommend the adoption of the symbol *A* (the initial of the German word "Arbeit") to denote "work." This, it is urged, is a mistake, and *W* is recommended in its place. For "power," the Committee select *L*, the initial of "Leistung," which is unfortunate, observes the *World*, since it displaces this symbol from its ordinary use for designating self-inductance; while even if, as the Committee tentatively suggests, the script form of the letter *L* is adopted, it suffers from the objection that it would be the only script letter in a company of otherwise unbroken Latin type. It is urged, therefore, that *P* be used for "power," and *L* be left as before to indicate inductance. For "resistance," which in German technical literature is often represented by *W* as the initial of "Widerstand," the Committee recommend the adoption of *R*, which is generally acceptable. In a general comment on the whole matter, the *World* observes: "That national system of notation and symbols is the best which best lends itself to international adoption. If any one country possessed a monopoly of all science, both pure and applied, then that system of notation which best suited the language, literature and habits of thought of that country would be the best to employ. But the sciences belong to every country as much as the international atmosphere, the international ocean, or the international ether; so that the best interests of scientific development are found in a symbology that lends itself to international adoption, with the minimum sacrifice of orderly arrangement and systematic construction."

$4,500,000 Worth of Cars.

San Francisco journals announce that for the new Alameda electric local lines, including the Oakland, Fruitvale and Berkeley branches, tenders are to be invited for the supply of an aggregate of 250 steel passenger cars, estimated to cost something like $4,500,000. The coaches are to seat about 100 passengers each, and be constructed of steel throughout. Even the window sashes and door frames are to be of steel. The cars are to be fitted with double platform and double doors, which will permit the egress or ingress of two persons at once. While they are not to be equipped with the common accordion vestibules, the coaches are to have rounded ends, which will enable passengers to go from one car to another with perfect safety.

S.W.G. and Others.

The vexed question of wire gauges forms the subject of a vigorous editorial note in the current issue of the San Francisco *Journal of Electricity*. The writer says: "There is nothing in electrical work so prone to cause confusion as the senseless practice of designating wire sizes by arbitrary numbers, especially when the perplexity is aggravated by a multiplicity of gauge systems. England and America are the chief offenders in this respect, as most of the European countries usually specify the smaller wire sizes in terms of their metric diameter. In England neither the Birmingham Wire Gauge, which is the oldest, nor the British Legal Standard or Standard Wire Gauge, which succeeded it, are based upon any regular law. The American or Brown & Sharpe Gauge, which is also based upon the Birmingham, has been so calculated that the diameters corresponding to the various numbers are in geometrical progression. Other gauges, such as the American Steel & Wire, Washburn & Moen, Old English, and Stubb's are largely empirical. As conducive to reform in this matter, we are glad to note that the Association of American Steel Manufacturers now recommends that wire sizes be expressed in decimal parts of an inch, instead of being indicated by number. This entails no change in existing standards, being merely a matter of nomenclature. It would seem advisable that this trend toward standardization be extended to the adoption of the metric system of measurement, thus becoming more nearly universal."

Telephone and Train Despatching.

The use of the telephone for train despatching is likely soon to become general. Three important new adherents are notified this week. The Lake Shore is making provision to equip the Youngstown division with telephones for dispatching, and is making the Clearfield branch a part of its telephone system. This is the second telephone circuit to be installed on the Lake Shore, the first one, between Buffalo and Erie, having been in service for over a year. The Michigan Central has just completed a 76-mile telephone circuit for train dispatching, between Niles, Mich., and Kensington, Ill., the fourth circuit of its kind on the road. There are 18 regular trains on this section of the line, and all dispatched entirely by this system. When the circuit now being installed between Jackson, Mich., and Niles-Mich., is finished, all trains on the Michigan Central, between Chicago and Detroit, Detroit and Toledo and Detroit and Sagi, naw, will be operated by telephone. The telephone is also to supplant the telegraph in train dispatching over the entire Santa Fe system. Authority has been granted for the equipment of the Albuquerque and Arizona division with telephones, and the work will be begun at once. These two divisions total 887 miles.

New Electric Locomotive.

The speed tests in Pittsburg of the new electric locomotives which have just been constructed by the Westinghouse Electric and Manufacturing Company at their East Pittsburg shops, have been eminently satisfactory. The tests were carefully watched by Mr. James McCrea, President of the Pennsylvania Railroad Company, by whom the engines will shortly be taken over. All the cars were removed from the track on which the train carrying President McCrea and party was running, and the one on which the electric locomotives were being tested. When the train carrying the officials arrived at Pitcairn the electric locomotive was started, and the officials thoroughly inspected the engine, which eventually is to be used on that system provided the tests are satisfactory. Instructions were then given for the electric locomotive to proceed to East Pittsburg, a distance of four miles. Following instructions of the operating officials, the train and electric locomotive were run at high speed with the result that the latter reached East Pittsburg ahead of the President's train. The officials are said to be highly pleased with the tests so far.

Chicago Electrification.

A campaign is being organised in Chicago to ensure the adoption of the Electrification Ordinance recently issued over the name of Alderman Snow. At one mass meeting more than twenty aldermen volunteered to agitate in support of the movement initiated by the Anti-Smoke League, and it is to be urged that the Legislature pass laws giving the City full control over the railroads. Meanwhile, the railroad managers, while remaining steadfast, in their determination not to electrify their tracks, are trying many experiments in effort to lessen the smoke nuisance. It is thought the use of coke on the locomotives will help considerably. The North-Western has arranged a series of experiments, and has invited the City smoke inspectors to be present. The Illinois Central has placed a contract for coke to be used on its suburban trains.

Electric Pumps and Leakage.

A remarkable law suit is threatened in connection with alleged defects in the great pipe line which supplies Lockport, New York State, with water. Something like 700 leaks have been found in the pipe line, and the contractors, the T. A. Gillespie Company, have been occupied for several months in effecting the necessary repairs. The expense has been enormous, and the City authorities declare that the Gillespie Company should bear it, as they supplied the defective pipes. The Gillespie Company is to sue the City for the cost of the repairs, alleging that the leaks have been caused by the faulty operation of the electric pumps at the North Tonawanda pumping station. They declare that the motor used to work the pumps is one of the constant speed type, and as a result when the switch is turned it either throws the power entirely on or entirely off. When the power is thrown off, a vacuum is created behind the rushing column of water, and the pressure on the pipes thereby created naturally opens the joints, causing leaks. The Gillespie Company also alleges that the pipe line is so near to the Buffalo and Lockport trolley tracks that a flow of electricity is being constantly carried by the pipes, and will in time do great harm. The line, according to the contractor, was not built to withstand either of the conditions set forth.

Current Items.

The General Electric Company has secured the contract for the apparatus to be used in the extension of the Niagara, St. Catherine's, and Toronto Railway from Port Colborne to Fort Erie. Work on the extension from Welland to Port Colborne is

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already under way. The Fort Erie projection will touch Lorraine, Point Abino and Crystal Beach, and will be a boon to the farmers in that section of the province. The line from Welland to Port Colborne will be eight miles long. The rails to be laid will be 60 lb., and on the Fort Erie projection will be of the same weight.

Plans are being made for the construction of an electric railway from Vernon, Ill., to a point on the Mississippi River, near Chester. The road will pass by way of Winkle, Ill., and will be about 83 miles in length. It will be constructed especially for the transportation of heavy freight, although a passenger service will be provided.

Mr. James R. Brailey, of the United States Telephone Company authorises an official denial of the report that he has sold the controlling interest in the United States Telephone Company to the Bell interests. Mr. Brailey added that the United States Company would do everything in its power in behalf of the independent telephone interests, and that his object in gaining control was for the sole purpose of giving the independents additional protection.

Mr. S. Insull, President of the Commonwealth Edison Company, Chicago, declares there is no truth in the widespread rumour that a $300,000,000 combination of all the traction, electric service, and gas interests of Chicago is to be effected.

It is announced that the business of the General Electric Company has expanded at such a rate, that contracts have been placed for the construction of two new buildings at Schenectody and three large structures at Lynn. At the latter place the staff is to be increased from 9,200 to 15,000 men.

GERMAN NOTES.

BERLIN.

The Union of German Electro-Technicians recently issued a most interesting report, whereby it is shown that on April last there were 2,050 electricity works in Germany, providing altogether 4,650 towns and districts with current. The capacity of these works is put down at 1,200,000 kw. About two-thirds of the works are run as private concerns, the others being either State or municipal works.

Thermo Electric Detectors.

A detector for wireless telegraphy or telephony, depending on varying contacts between a metallic point and a surface of iron pyrites, has been known and used for a year or two. It would appear, however, that greater sensitiveness is secured by using copper pyrites, especially in the form of the definitely crystalline mineral chal-copyrite, and that without any more liability to chemical change than occurs with iron pyrites itself. This result is easily understood if we remember that copper and iron pyrites are far apart in the thermo-electric series, and that the presence of two metals is favourable to electrical action.

Ozone Production.

Dr. F. Fischer, of Berlin, has discovered that air, if heated to a very high temperature and then suddenly cooled, develops ozone. In consequence of this discovery an electric works at Vienna has erected a plant in which air is driven by an electric fan at a suitable speed over a Nernot lamp. The stream of air is heated to a temperature approaching 2,000° C., and cooled by passing into a cold chamber. In this way 4% of the oxygen in the air treated can be converted into ozone, but no more.

Transformer Cooling.

The Maschinenfabrik Oerlikon proposes to cool transformers placed in difficultly accessible situations by means of small electric air fans, started automatically as soon as the transformer is set to work. Such an arrangement has been tried with conspicuous success at the silk spinning mill at Krieas in Switzerland. Here three 450 kwa. transformers reducing the voltage from 24,000 to 500 have to be cooled. The cooling fans are driven by alternating current motors each of 0·1 h.p. and working at 500 volts. These keep the temperature, which rises in the transformer to 50° C. without them, down to 35° C. As above stated, the fans are driven by the low voltage current issuing from the transformer, and are therefore at work when the transformer is in action and at no other time.

Testing the Vacuum of Incandescent Lamps.

This is usually done by bringing the lamp into the field of a very powerful Ruhmkorff coil. This lights the lamp and an expert can tell by its appearance whether or not the vacuum is satisfactory. The method is, however, dangerous to the operator, and hence there is a strong temptation to execute it hastily and carelessly. Another disadvantage is that if a spark should get at the lamp the glass is perforated and the lamp is spoiled. These difficulties are avoided, according to A. Pfeiffer, by using a testfield. One pole of the transformer is attached to the lamp, or set of lamps, and the other pole is attached to a ring with an insulating handle, whereby the operator can pass the ring over the lamps at such a distance that no sparking over it is possible. The voltage can then be so high that even lamps with a bad vacuum are lit up in the field.

Rapid Running Motors.

During the last ten years there has been a great tendency to increase the speed of electro-motors. Some important advantages are gained. A smaller motor, *i.e.*, one lighter in weight and more economical in space, will give out as much power as a larger one running at a lower speed. On the other hand, certain precautions have to be taken. To lessen the circumferential velocity of the rotating part as far as possible its diameter must be made as small as possible. At the same time this velocity is unavoidably very great, so that the effect of the centrifugal force must be met by extra strong construction. Hence the maker has to combine small diameter with strong construction, and his skill is largely shown in reconciling these partly contradictory factors. Balancing is of enromous importance in these rapid running motors. Unless this is done to perfection, the motor cannot run true, and will wear quickly and exert its power unevenly. The bearings require great attention. They must have a large rubbing surface to diminish the risk of heating or irregular wear, and hence require perfect lubrication. As the object of increasing the speed of the motor is to diminish its size for the same power output, there is no chance of having much cooling surface, so that cooling by radiation must be replaced to a greater or less extent by a current of air from a fan. The lubricant used must be a thin very pure petroleum with a high flashpoint. Economy in this respect is to be deprecated. High speed motors are largely employed for driving pumps and air fans in mine works, for blowing engines in ironworks, for saw-mills, and for stone polishing and cutting machines.

LINCOLN ELECTRICAL ENGINEER'S FAILURE.

At the Lincoln Bankruptcy Court, Samuel Emerson Smith, living at Coulby House, Carholme-road, and formerly carrying on business as an electrical engineer at 27, High-street, attended for examination.

The liabilities were expected to rank at £125 2s. 11d., and the assets were estimated to produce £220, there thus being a surplus of £94 17s. 1d.

Debtor stated as the cause of his failure, "My goods and machinery being illegally seized and sold."

Questioned by the Official Receiver (Mr. F. C. Brogden), debtor said he commenced business in 1903 at 19, Mint-street, in the name of "A. Smith & Co." He got into difficulties, and made an assignment in November, 1904, a trustee being appointed. His liabilities were then £400. He never heard what dividend was paid, and never inquired. After the assignment he managed the business for his wife at 30, The Strait. That business was started a few weeks before the assignment was made, and was in the name of "A. C. Smith," his wife. After being there 18 months, his wife removed to 271, High-street, still trading as A. C. Smith. She paid him £2 per week, and she had the profits. He saved a portion of the £2 in the Post Office Savings Bank. That book was given up three or four years ago. He used the money for speculating. His wife's business was eventually formed into a company, "A. C. Smith, Lincoln Engineers, Limited." He held £500 of the shares, his wife £1,000, there were five others of £1 each, and one had £30. He still continued to manage it, but his pay was not increased.

The Official Receiver: Were you both managing directors?—Debtor: No; managing director and secretary.

Replying to further questions, debtor said in November last year they got into difficulties and a receiver was appointed, and he sold everything connected with the business by auction. Prior to then they were in business in Francis-court as "Ados, Limited." There were the usual seven concerned in What business. That company also got into difficulties. A liquidator was appointed and the estate realised. "A. C. Smith, Limited," would be wound up in a few days. There was a business still carried on in the High-street, "Smith's Electrical Co." He was manager and his wife the secretary. There was an arbitration in the matter of "Ados, Limited," and the arbitrators found that he owed them £95, but he would swear that he did not owe them anything.

Mr. Tweed: In the face of this award?—Yes.

The examination was adjourned.

SALE OF A TRACTION COMPANY.

According to the *Canadian Electrical News* the South Western Traction Co., operating between London and Port Stanley, have sold out their interests to Mr. J. E. McDougall, of London, who represents a syndicate of Toronto, Hamilton and London capitalists. The price paid is $535,000. The railway is 28 miles long, about one-half being on private right of way and half on public highways. Power is developed by steam, the total capacity of the generators being 800 h.p. The rolling stock includes 12 passenger coaches and a number of freight cars. It is said the road will be extended to Aylmer and Delaware.

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BUSINESS NOTES AND NEWS.

LIGHTING AND GENERAL—Home.

AMBLE.—To the Urban Council Mr. Cecil Esmarch, M.I.M.E., of Newcastle, submitted a report with reference to the proposed lighting of the town by electricity. The approximate cost of the generating station, which included buildings, foundations, producer gas engines, dynamos, pipes, and accessories, was £1,903 14s., house for engineer £265, switch gear and other appliances £200, making a total estimated cost for the station of £2,368 14s. He estimated the cost of a distributing system, which included 150 poles, with 100 street lamps attached, overhead mains with connections and wiring for small consumers, at £1,793 18s., making a total outlay for the whole scheme of £4,162 12s. The annual upkeep he estimated at £668. This would include, he said, the payment of interest and capital. The revenue, based on 600 private dwellings, 30 business premises, 8 public places, and 100 street lamps using the current, was £765 per annum, leaving, he thought, a satisfactory surplus. The Council decided to place the scheme before the town and take a vote on the question.

ARDSLEY.—The Ardsley Urban Council decided to write to the Yorkshire Electric Power Co., asking if they were contemplating introducing electric light into the township.

BATH.—At the Town Council meeting, Mr. Hatt, in moving the adoption of the report of the Electric Lighting Committee, referred to the subject of the application for the cessor of the powers of the Somerset and District Electric Power Co., with respect to the city of Bath. The Board of Trade, he said, had informed them that they did not consider it desirable to grant the cessor of powers until a conference had been held between the parties concerned, and it was arranged that such conference should be held at the Board of Trade Offices. The Town Clerk, the Engineer and himself were appointed by the Council to attend the conference, but they had received an intimation from the Board of Trade that the Somerset Power Co. did not desire to appear at the conference, which was, therefore, not held. They had also been informed that the Board of Trade intended to grant the cessor for which they had applied. There was a resolution that they should apply for an extension of the area of their present supply; that their Provisional Order should be so amended as to extend the area to a radius of three miles from the Guildhall. Statutory notice of the application had already been given in accordance with the Act. The Report was adopted.

BENTLEY.—The Corporation of Doncaster agreed to carry the electric light to Bentley village, and expressed themselves prepared to extend the supply of light to Arksey, if the demand justifies the outlay.

BERKHAMSTED.—The Rural Council passed an agreement with the Chesham and District Electric Light and Power Co. for powers in the district.

BRIDLINGTON.—At a meeting of the Parliamentary and Electricity Committee, a letter from the churchwardens of Holy Trinity Church asking if the Council would undertake the external illumination of the proposed clock in the church tower was considered, and the Borough Electrical Engineer was instructed to prepare an estimate of the cost. The question of electrically-driven 'buses has been under the committee's consideration.

BRIGHTON.—The western part of Brighton was plunged in darkness on the night of the 7th inst. owing to the failure of the electric light. At the Electric Theatre, Western-road, which was crowded at the time, a rush was made for the exit doors, but the manager averted trouble by announcing that the whole of the street lamps were out. The light appeared again after a few minutes.

BURNLEY.—At the Town Council meeting, Councillor Bleasdale urged that the sooner there was a severance between the Electricity Committee and the Cleansing Committees with regard to the destructor the better for both.

CLEVEDON.—The Urban Council discussed the electric lighting question. Mr. Christie, a member of the firm acting with the Council, gave particulars of the steps to be taken if an order was to be applied for to authorise the Council to generate and supply electricity for public and private purposes within the area to be agreed upon. The Chairman asked for note to be made that if the order was transferred the Council must protect themselves in Section 9 (that of control). Mr. Christie said it would be an overhead system, with iron poles and ornamental brackets within the compulsory area, and wooden poles outside that area. The order would be based on the assumption of 250 lamps, each of 50 c.p., at 37s. 3d. per lamp per annum, on the assumption there were 1,750 lighting hours. The agreement between the Council and the company was to be for five years, the Council to have power to renew if they choose.

DARLINGTON.—The Corporation decided to support the Maidstone Electricity Department in the promotion of a Bill in Parliament to empower local authorities to fix fittings for electric lighting in houses.

ECCLES.—The Council adopted new conditions and regulations under which they will supply electrical energy to consumers. The following is the scale of rent for a meter or meters supplied:—2½ ampere 1s. 6d. per quarter; 5 ampere, 1s. 6d.; 10 ampere, 1s. 6d.; 20 ampere, 2s.; 40 ampere, 2s. 6d.; 80 ampere, 4s.; 120 ampere, 4s. 6d.; 200 ampere, 5s. The Electricity Committee adjourned consideration of letters received by the Borough Electrical Engineer from Mr. J. S. Highfield (London) with regard to a proposed scheme for the purchase of electric heating apparatus. Alderman Pearson stated that a clause was included in the regulations and conditions for the supply of current providing for disputes to be settled by the consumer and the Borough Electrical Engineer. The Town Clerk said that if the parties failed to settle the dispute the Electric Lighting Order provided for arbitration.

FRIMLEY (Surrey).—The Frimley Urban Council decided to apply to the Board of Trade for the grant of a provisional order authorising them to supply electricity, under the Electric Lighting Acts, for public and private purposes, within the parish of Frimley.

HORNSEY.—The report of the Borough Electrical Engineer showed that the number of consumers on September 30 was 1,640—a net increase of 23 on the number at the end of the previous month. An extension in Perth-road, Stroud-green, was authorised, and it was stated that this extension would enable the Committee to reach the Council Schools in Woodstock-road. The Maidstone Electricity Committee wrote expressing disappointment that the powers that be had allowed the wiring clause in the Electric Lighting Amendments Act to be deleted without a struggle of any sort. They suggested that a one-clause Bill should be promoted by the municipalities to replace the deleted clause. The Hornsey Committee expressed the opinion that representatives of the Council should attend a proposed conference on the subject, but without power to commit the Council to any expense, and on the previous understanding that the Council would not support any Bill granting power to municipalities to carry out private installation work without the intervention of a contractor. They further decided in favour of the matter being referred to the Parliamentary Committee for their consideration, with power to act.

LITTLEBOROUGH.—The District Council approved a revised agreement with the Rochdale Corporation for a supply of electricity in bulk from their transforming station in Butterworth-street, Featherstall. The Clerk was directed to write to the Corporation Tramways Committee suggesting the arrangement of a 1½d. stage from Stubley to Albert Royds-street.

LONDON.—The County of London Electric Supply Co. propose to lay mains in Selkirk-road, Ravenslea-road, Dendy-road and Boundaries-road. They also intend to lay mains in Jamaica-road, New Church-street, and Tulip-place, and to construct inspection boxes. A further proposal by the Company is to lay mains in Dockhead, Hull-street, Bermondsey-wall, George-row, and Jacob-street, and to construct inspection boxes.

MERTHYR.—The Electric Traction Co. protested against the way in which tenders for street lighting were dealt with by the Corporation. The company declined to alter their quotation. At a meeting of the Public Works Committee, Mr. F. S. Simons supported the protest. He considered it very unfair that after the Traction Co.'s tender had been accepted, Nixon's Navigation Co. should have been asked to quote against them. The Chairman said undoubtedly they had treated the Traction Co. rather shabbily, and the Mayor agreed with this opinion. The Gas Co.'s reduced tender was accepted.

MIDDLETON.—The Council agreed to apply for borrowing powers for £3,000 for the provision of an electrical cable.

NEWCASTLE EMLYN.—Electric light will be installed throughout the Urban District by arrangement with the Electric Light Co.

NOTTINGHAM.—Local opposition has been raised to the action of the Postal Department in rearranging the electrical engineering section of the North Midland District in such a way that Nottingham ceases to be the headquarters, necessitating the removal of thirty or forty members of the staff.

NOTTINGHAM.—The city auditors report that in the last financial year the gross profits on the Corporation electricity undertaking amounted to £465,113, and on the tramways, £50,767.

OLDHAM.—On the evening of the 5th inst., when the town was plunged into partial darkness owing to a short circuit on the electric mains, the places of amusement and business houses were especially inconvenienced. The electricity department were immediately informed, and Mr. Chamberlain, the Electrical Engineer, with a number of assistants, toured the town in a motor car, seeking at the various mains to discover the defect

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PADDINGTON.—The Metropolitan Electric Supply Co. propose to lay high tension mains in Harrow-road.

RHYL.—Mr. H. R. Hooper, Local Government Board Inspector held an inquiry into the Council's application to borrow £5,000 for the purposes of the electric lighting works. Mr. Wright (the Electrical Engineer) stated that it was felt that the plant was not up-to-date, and was too big for the town's needs. What was required was a smaller plant of an up-to-date pattern. The cost of the works originally was £27,000, but that included provision for a tramway, which was never made. The Inspector said it was a novel application, as the Council wanted to substitute a smaller for a larger plant. Mr. Wright replied they would save at least £350 per annum on the works cost by putting up the smaller plant. The Inspector said he realised that Rhyl had been hard hit by the undertaking, but he urged that the proper course to adopt was not so much to reduce the works cost, but to develop and secure fresh consumers. He suggested that the Council should borrow money for mains extension, and by careful developing bring the works to making a profit. The period of reckless expenditure was reduced, and there was a future for the concern.

SHIPLEY.—To the District Council's Electricity Committee the engineer reported that seven new consumers had been added during the month of September, making a total of 485. Councillor Raisbeck mentioned that the Committee had had before them a financial statement concerning the electricity department for the half-year ended September 30. Compared with the corresponding half of the previous year the lighting and power receipts had gone up slightly, but on the other hand the revenue for traction had gone down considerably. The receipts form that source were less by £270, which was probably partly due to the wet summer, and partly to the fact that meters had been fixed on the cars and instructions issued to drivers as to where the current might be shut off, with a view to minimising as much as possible the cost of running. The net loss on the income side for the half-year was £65. On the expenditure side they showed a saving of £317 compared with the corresponding half of the previous year. Altogether the finances of the department were in a very satisfactory condition.

STEPNEY.—The Council intend to lay electricity mains in Ocean-street and Plumbers'-row.

ST. PANCRAS.—The Metropolitan Borough Council propose to lay electricity mains in Merton-lane, Millfield-lane and Fitzroy-park.

WHITCHURCH.—The Local Government Board has sanctioned a loan of £2,960 for the Whitchurch electric lighting scheme for a term of 20 years. The scheme is for the taking of electricity from the South Wales Power Co. and lighting the district.

YOULGREAVE.—The new public hall presented to the village is lit by electricity.

LIGHTING AND GENERAL—Overseas.

BOMBAY.—A small Marconi wireless telegraphy station has been installed near the Back Bay Baths, to work in conjunction with the apparatus fitted to two new P. and O. liners, the range being from 200 to 300 miles. The installation will put mail steamers fitted with wireless apparatus into touch with Bombay 24 hours before arrival.

BRITISH COLUMBIA.—The Cranbrooks Electric Light Co. will instal a seven thousand dollar power house and thirty thousand dollars of new machinery. Five wireless plants are being installed by the Government, viz., at Gonzales Hill, Paschena, Deluge Point, Triangle Island and Prince Rupert.

CANADA.—Coaticook, Quebec, proposes to develop a new site on the Coaticook river a short distance below its present power house. Plans have been adopted for a stone and concrete dam 32 ft. high, stone and concrete power house, 2 horizontal turbine wheels, direct-connected generator, direct-connected exciter unit, with provision for a duplicate unit. The total head will be 41¾ ft. and when completed will more than double the present capacity. The transmission lines will all be reconstructed, and the present 550 volt, d.c. power circuit disconnected, as will also be the present single-phase lighting circuits, and d.c. arc system. All will be converted into a 250 kw., three-phase, 60 cycle, 2,200 volt, light and power system, the streets lighted by a tungsten series incandescent system, with possibly a few a.c. arcs in circuit.

BULAWAYO.—The Municipality are considering a proposed scheme for public electric lighting, at a cost of between £25,000 and £30,000. The town is at present lighted electrically by the local waterworks company.

CANADA.—A correspondent states that a syndicate of Oshawa manufacturers will build an electric road from Coburg through Bowmanville, Oshawa, Whitby, and Pickering, to Toronto. Application will be made to the Dominion Parliament at the approaching session for a charter for the "Toronto and Eastern," as it will be known. Construction will be financed entirely by local capitalists, and it is expected that the work will be well advanced within a year. The South-Western Traction Co.'s electric tramway, running between London, Ontario, and Lake Erie at Port Stanley, has been sold by auction to Mr. J. E. McDougall, of London, representing a syndicate of London, Toronto, and Hamilton capitalists. At Fort Frances, on the Rainy River Ontario, a hydro-electric power plant is being installed. It is stated to be one of the most complete installations of the kind in Canada.

COREA.—The Japanese Government will construct a telephone system at an estimated cost of 70,000 yen.

ITALY.—The Italian Minister of Posts and Telegraphs will shortly submit to Parliament a Bill designed to hasten forward the construction of a number of telephone lines. The cost of this work is estimated at 25,000,000 lire (£1,000,000), and provision for this amount will be included in the Bill.

NEW SOUTH WALES.—Electricity works have been installed at Balmain by the Electric Light and Power Supply Corporation, Ltd. The present plant, which is contained in a very substantial steel-framed building, comprises two 5,000 volt 3-phase Thomson-Houston generators, direct-coupled to two Belliss & Morcom's triple-expansion high-speed engines of a total capacity of 1,200 h.p. These are supplied with steam from two Babcock & Wilcox water tube boilers, fitted with super-heaters, and automatic chain grate stokers; in addition, there is a Babcock & Wilcox boiler connected with the garbage destructor, and the latter is more than sufficient to supply the steam necessary for lighting the whole of Balmain. Connected with the boilers is an economiser for heating the feed water, and all the condenser steam from the engines is returned through a series of chemical tanks which cleanse it free of all oil ready for use again; this process is quite automatic. The electricity from the generators is controlled by a switchboard, supplied by the Australian General Electric Co., and one of the unique features of it is an automatic controller, which dispenses with the services of an attendant. This is the first of its kind erected for a supply authority in Australia. The whole of the auxiliary plant, with the exception of the feed pumps, is driven by electrical motors, which reduces attendance to a minimum.

WINNIPEG (Canada)—The United Wireless Telegraph Co., which owns wireless telegraph stations along the Atlantic and Pacific coasts, propose erecting a string of such stations across Canada. The first plant is now being installed in Port Arthur, and it is expected work will be commenced in Winnipeg before the end of the year.

TRACTION.—Home.

LONDON.—The County Council Improvements Committee decided to draw attention, as a matter of urgency, to the proposals for widening the main thoroughfare from Dockhead to Greenwich. The scheme has been proposed in connection with the reconstruction for electric traction of the existing tramways from Tooley-street to Deptford, and their extension over Deptford-creek-bridge to join the electric tramways in Greenwich. The gross cost of the improvement was estimated at £151,000, and the net cost at £148,500. The Committee recommend the construction of a new street between Dockhead and Jamaica-road. In connection with the reconstruction of the Highgate-hill tramways, it is proposed, owing to the steep gradient of the route, to fit with a special kind of brake the electric cars to be used on these lines, and to lay the slot rail with a projection of one-eighth inch above the adjacent paving in order to provide for the efficient working of the brakes. With the view of testing the working of the special brake in question, it has been decided to arrange for a short length of track at the central car repair depot in Woolwich-road to be laid with the slot rail raised above the surface of the track. The cost of this work is estimated at £50.

WOOLWICH.—The London County Council Highways Committee passed a resolution in favour of the construction of an electric tramway from Woolwich to Eltham. This line, over two miles in length, will be constructed on the overhead system at a cost of £76,480. In order to overcome the objection raised by the Greenwich Observatory authorities, it is proposed to use two overhead wires instead of one only for each track, thus completely insulating all conductors. To construct the line on the conduit system would, it is estimated, cost £104,120, and the delay in proceeding with the work has been due to the difficulty in adopting a cheaper system of traction in view of the probability of there being a loss on working for some years to come. It is proposed to run through cars between Eltham and Abbey Wood. The Borough Council has carried out street improvements in anticipation of tramways being laid.

TRACTION—Overseas.

AUSTRIA-HUNGARY.—The construction of an electric tramway will shortly be undertaken in Kassa. Concessions have been granted for the construction of the following sections of electric tramways in Klagenfurt: (1) from Klagenfurt Station to Annabichl-Zentralfriedhof; (2) a branch from this line to the Military Swimming School; and (3) a line along the south

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bank of Lake Wörther to Velden. The Burgomaster of Klagenfurt is one of the concessionaires.

INDIA.—The Bombay Port Trust Board are arranging with the Electric Tramways Co. for the running of an electric railway between Carnac Bunder and Sewree. The Bengal-Nagpur Railway Co. have ordered an installation from home for the electric lighting of the large new shunting yard at the Kharagpur Junction Station. The Bengal and North-Western Railway Co. have equipped a large number of their passenger coaches with electric light, Stone's system.

ITALY.—A decree has been issued approving the agreement between the Ministry of Public Works on the one hand, and the Communal authorities of Clusone and the Ponte di Nossa-Clusone Railway Co. on the other, for the construction and working of an electric railway from Ponte di Nossa to Clusone. The line, which will be about 4 miles long, must be completed within one year from the approval of the plans. The cost of the work is estimated at 783,380 lire (£31,335). The concession is for 70 years, and during this period the State is to pay an annual subsidy of 7,000 lire (£280) per kilometre.

SWEDEN.—A Swedish engineer has drawn up a project for the construction of an electric railway from Malmo to Copenhagen, passing under the Sound. The line would be 236 kilometres (about 147 miles) long, with 16 kilometres (about 10 miles) of tunnel. The project has been submitted to a special commission appointed by the Swedish government.

SWITZERLAND.—Messrs. Ch. Masson, of Lausanne, and O. Kluser, of Brigue, on behalf of a company to be formed with head office at Lausanne, have been granted, an 80 years' concession for the construction and working of a narrow-gauge electric railway from Stalden to Saas-Grund. The railway will be a secondary one. The line, which is to be a single track of metre gauge, must be completed within three years from the commencement of work.

Mr. Alfred Hurter, of Oerlikon, on behalf of a company to be formed with head office at Saas-Fée, has been granted, an 80 years' concession for the construction and working of a funicular electric railway from Saas-Grund to Saas-Fée. This railway will also be a secondary one. The line, which is to be a single track of metre gauge, must be completed within three years from the commencement of work.

PERSONAL.

Mr. H. B. Saxby, the recently appointed Electrical Engineer of the B. B. & C. I. Railway, inspected and studied the Lucas-Leitner system of the electric lighting of trains, previous to his leaving England for Bombay to join his new appointment.

A committee consisting of Mr. Gunnell Wood, Officiating Chief Engineer, Mr. Stanley, Officiating Sanitary Engineer, two Superintending Engineers, Irrigation Department, Captain Anderson and Mr. Rennie, will sit at the close of the monsoon to decide what steps will have to be taken for the permanent safety of the Mussoorie hydro-electric works at Galogi, India.

Mr. W. R. Wilson, Electrical Inspector, Punjab, has been placed in charge of the lately constituted Simla Hydro-Electric Division, with headquarters at Basantpur.

Mr. A. Smith, electrician to Messrs. S. Pearson, Joint Dock (late electrician in the City Engineer's Department, Hull), has been appointed electrical engineer to Messrs. Watson & Co., for their new oil mill at Selby.

The British Columbia Electric Railway Co. have appointed Mr. Allan Purvis as manager of their new Fraser Valley branch, running from New Westminster to Chilliwack.

THE METAL FILAMENT LAMP CASE.

At the Clerkenwell Police Court, on Saturday, the hearing was resumed of the prosecution against the Welsbach Incandescent Gas Light Co., Ltd., at the instance of the General Electric Co., Ltd., and the Wolfram (Tungsten) Metal Filament Lamps, Ltd., for alleged infringement of the Merchandise Marks Act. The case against the defendants was that they had in their possession for sale electric metallic filament lamps with a false inscription attached, and also for causing a false trade description to the lamps.

Evidence was given by Mr. J. Young Fletcher, of the electric light department, General Electric Co., Ltd., to the effect that his firm were the agents in England for the Auer Co., of Berlin, which owed its title to its connection with Baron Auer Von Welsbach. Osram lamps were made by that company and the General Electric Co. were the only firm selling them in this country. A factory had been erected for the manufacture of the lamps in England since the Patents Act was passed. The stamping of the lamps with the words "Aur" and "Welsbach" would lead people to believe that they were made by the Auer Co., or as they were sometimes known in England, the German Welsbach Co. The case was further adjourned.

COMPANIES' MEETINGS AND REPORTS.

ROSARIO ELECTRIC.

The seventh annual general meeting of the Rosario Electric Co., Ltd., was held at River Plate House, Finsbury-circus, E.C., Mr. W. T. Western (Chairman of the Company) presiding. The Chairman said that the accounts again showed continued progress. The units of current sold were 32% in excess of those sold in the preceding year. Of the current sold, about one-fourth was for power, instead of one-fifth, as previously. The gross receipts had increased from £73,100 to £91,300. They were taking slightly less per unit, consequent upon the larger proportion used for power and public lighting. The works cost of running were very nearly the same as last year, which, at first sight, seemed an anomaly. The explanation was that in the previous year they bore the cost of trimming street lamps in respect of the street lighting. This year the municipality bore these arc charges, paying them for the current used only. Making this correction, their cost of working had gone up £1,900, the smallness of which figures was accounted for by the lower price of fuel, and still more so by the benefit obtained by the use of their new condensing plant. After providing for depreciation, there remained £35,000, against £23,000 last year. This enabled them to pay a dividend on the Ordinary shares of 8%, and to place £15,000 to reserve, making the reserve £30,000. Their relations with the municipal authorities had been harmonious. The expenditure on capital account has been £33,700, including completion of our condensing plant, and about £13,000 for additional mains. They had agreed to purchase some land at Sorrento, where they contemplated erecting a turbine plant of the latest pattern, with its proper equipment of condensing plant. This would cost £100,000 to £120,000 for the first portion of the power station, to which would need to be added the cost of cables and transformers, making in all, perhaps, £200,000, to give them a station about equal to our present one, or (say) to double their present effective capacity. Towards this expenditure they proposed to ask the shareholders, at a meeting which would shortly be called for the purpose, to sanction the issue of £100,000 in new Ordinary shares. The form of providing the balance could be decided later on.

CORDOBA LIGHT AND POWER.

The ordinary general meeting of the Cordoba Light, Power and Traction Co., Ltd., was held at 62, London-wall, E.C. Sir J. Irving Courtenay (the chairman of the company) presided.

The Chairman remarked that they had been successful in placing the company's prospects upon a very much firmer basis than they were able to reckon upon when it came into existence, as there had since been secured for the American company a new concession, which extended its life to forty years, as compared with the thirteen years remaining of its old concession when they acquired control. Naturally, they would not expect that this first year should show great results in the form of dividend. Steam plant, and especially hydraulic installations, took time to instal and develop, and tramways also required a period in which to extend and reach their full yielding capacity. Active progress had been made in every direction during the year. Their holding in the American company had been increased by further exchanges of its shares for those of their company, so that they now hold 90% of its share capital. They had acquired the entire share capital of the Cordoba (Argentine) Electric Tramways Construction Co., Ltd., which owned a seventy-five-year concession. They had also entered into an agreement to purchase the more important of the two other tramways—viz., that known as the Ciudad de Cordoba Tramway, a purchase which should not only materially improve the efficiency and economy of their tramway service, but would also strengthen very much their position in relation to the supply of electric energy.

EDISON AND SWAN ELECTRIC.

At the twenty-sixth ordinary general meeting of the Edison & Swan United Electric Light Co., Ltd., yesterday, at Winchester House, Old Broad-street, E.C., Mr. Henry Wolfenden (Chairman of the company) presided.

The Chairman said they were again faced with a large decrease in the profits, caused by the decline in the price of carbon lamps, which were the principal lamps they had been dealing in so far. This decline was not the result of any falling off in their quality which had been fully maintained at its high standard of excellence; nor was the shrinkage the result of any falling off in turnover, as they would see when he told them that the total business done in the year under review, in all classes of goods taken together, showed a reduction of only 1·5% in value when compared with the previous year. Having regard to the depression in trade generally, and in the electrical branch in particular, this, in itself, was not unsatisfactory. On analysis, however, the carbon lamp sales showed a decline of 6% in volume, but the value was reduced by 17½%; and here they got the clue to the shrinkage of profits, namely, lower selling prices of carbon lamps without corresponding reductions in the cost of manufacture and distribution. The smaller sales and lower selling prices were the

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result of the diminished demand for this class of lamp, owing to the change-over to metal filament lamps, and they had been actively engaged during the year in pushing forward this new type of manufacture. As stated in the report: "There has been expended on capital during the year ended June 30, 1909, £19,813 0s. 9d., almost entirely on account of additions to buildings and plant in connection with the manufacture of metal filament lamps." This £19,813 divided itself thus: buildings £7,782 and plant £12,031. They had reduced the production of carbon lamps, but they still thought that there would always be a field for their use; and they had materially increased the production of metal lamps, though the year ended June 30 last did not have the full benefit of this increase.

BORDEAUX ELECTRIC TRAMS.

The Comptoir National d'Escompte de Paris, 52, Threadneedle-street, E.C., have received instructions to pay on 15th inst. dividend No. 16 of the Compagnie Française des Tramways Electriques et Omnibus de Bordeaux, as follows: Fcs. 4·80 on Registered shares by endorsement on certificate, fcs. 4·48 on Bearer shares against coupon 16.

CONTRACTS OPEN.

HOME.

BIRMINGHAM.—Parochial Offices.—Tenders for maintenance of private telephone installation at Birmingham Workhouse, Dudley-road, for period of 12 months. November 20.

DUBLIN.—United Tramways Co., Ltd.—Tenders for supply of general stores for the year ending, December 31, 1910. By November 29.

EDINBURGH.—Corporation.—Electrical Installation at McLeod police station. November 23.

EDMONTON.—Board of Guardians.—Cables and switchboard in connection with new infirmary. November 23.

INVERNESS.—Corporation.—Tramway permanent way. November 24.

LONDON.—London County Council.—Tenders for covering with asbestos tape about 2¾ miles of lead covered high and low tension cables in manholes. November 30.

SUNDERLAND.—Tramway foundations, track, etc. November 25.

YORK.—North Eastern Railway.—Tenders for arc lamp carbons, electric lamps, wires and cables, electric lighting, etc. November 25.

OVERSEAS.

HOBART (Tasmania).—Postmaster-General.—Telegraph and telephone material, etc. Part. as above. December 20.

LIEGE.—Electric lighting at Jupille. December 31.

LUCKNOW.—Municipal Board.—Tenders invited for a concession for the supply of electric energy, coal or oil gas, for house and street lighting, and other domestic or manufacturing purposes. December 31.

MADRID (Spain).—Direccion-General de Obras, Publicas Madrid.—For a 60 years' concession for construction and working of an electric tramway from Sans to Coll-Blanch (Barcelona). November 20.

MELBOURNE.—Deputy Postmaster-General.—Two sets of accumulators. By 3 p.m., November 23.—Postmaster-General.—To supply coin attachments (for coins of different values) for telephones. Spec. No. 184. 370 50 c.p. metallic filament lamps, with bayonet cap fittings, for 110-volts A.C.; 630 25 c.p. ditto; 160 16 c.p. Linolite carbon filament lamps, 110 vofts A.C.; 1,000 16 c.p. T.H. screw socket carbon filament lamps, 110 volts A.C.; and 100 32 c.p. metallic filament lamps, with bayonet cap fittings, 200 volts A.C. December 7.

MELBOURNE.—Railway Commissioners.—One single-phase turbo-alternator, etc. December 17.

SYDNEY.—Postmaster-General.—Switchboard apparatus for subscribers' premises. Particulars of all Australian contracts, 72, Victoria-street, Westminster, S.W. January 10, 1910.

TURKEY.—Broussa Municipality.—For a concession for the installation of electric light and power, and for the construction of an electric tramway. December 13.

TENDERS OPEN—Home.

BRADFORD.—Corporation Tramways Department.—Supply of electric lamps for cars, etc. November 13.

LEYTON.—Messrs. Johnson & Phillips obtained the contract for the electrical installation at Canterbury-road school, the amount of the tender being £143 9s. 6d.

LONDON.—Metropolitan Asylums Board.—The following contracts were made: Messrs. J. W. Gray & Sons, re-establishing telephonic connection between Gore House and hospital, £56 10s.; Messrs. W. J. Fryer & Co., two electric motors, with cables, switches, etc., £129 18s.

SHEFFIELD.—The Corporation accepted the tender of the British and Insulated Helsby Cables for two miles figure 8 copper wire at 7⅞d. per lb., less 2½%.

CABLE AND WIRE NOVELTIES.

ELECTRICAL STUDENTS AT WOOLWICH.

A party of students attending Mr. Kilburn Scott's lectures at the Northampton Institute visited Messrs. Siemens' Works at Woolwich on Saturday last. They were shown several novelties, including the manufacture of the new Stannos wire, and the enamelling of fine wire for the instrument work. In the Stannos wire a flat strip of tinned copper is drawn through a special die along with the insulated wire which it is intended to cover. The copper strip is bent round twice and it then passes over a series of gas jets, which just melt the solder so as to make the two layers homogeneous. In some cases there are two wires, and in others a layer of tin is spirally lapped round the insulation so that, should the outer tube be made discontinuous, there will be the spiral metal lapping to carry the current. This seems to be an unnecessary precaution, but, having been specified for a particular job, the makers are turning it out without difficulty.

The enamelling of the wire struck the visitors as being a great advance on the old system of depending only on a double silk or cotton covering. The wires now being covered with enamel range from ·004 to ·02 in. diameter. The wire is first passed through a bath of black Japan and then through a stove about 10 ft. long heated to 650° Fah. It then passes through another bath of Japan and again through the stove. It usually passes through three baths and as many times through the stove, but more can be arranged. It then travels for some distance through the air to thoroughly cool, after which it is automatically wound on to bobbins. The thickness of the Japan is $\frac{1}{1000}$ th of an inch, which is one great advantage in self-induction instruments where it is necessary to get the wires close together. When the copper is permanently stretched the enamel stretches too, and preserves its homogenity. Messrs. Siemens see no reason why it should not be used for the larger wires than ·02, and certainly for shunt wires of dynamo machines it should be just the thing. The cotton covering still used on wires for dynamos and motors is a reminder of the old sealing wax and string days, and the sooner it goes the better. The ideal machines of the future will be constructed solely of steel, copper, mica and Japan. The insulation of the Japan is sufficiently high for the wire to be used satisfactorily for mine exploders; but, even if it were low, its being absolutely homogeneous is a great advantage.

In the cable testing department the arrangements for testing cables were explained. A cable for 11,000 volts is tested to 20,000, but tests to destruction show that it will stand 40,000 to 60,000 volts, which is a factor of safety of 4 to 6 to 1. The steel strip for armouring is electrically welded by a modification of the Barnardos process. The operator is protected by sheets of red and green glass, as these colours are much more effective than any other colours.

A good deal of welding in the works is done by the oxygen acetylene flame. This gives a very intense heat, and the apparatus is easily handled.

The submarine cable department was visited, and it was interesting to hear that the longest cable made in one length was 930 miles for the Black Sea. Two of the cable-making machines will pass 26 knots of cable in one day of 24 hours. The speed is 100 r.p.m., and the hydraulic brakes are so powerful that the machine can be stopped from full speed in one revolution.

One most interesting and quite new feature of submarine cables was pointed out. It is the use of what are known as Pupin self-induction coils and arranged in the cable itself to counteract capacity.

It was good to hear that there are 360 Fuller slide rules in constant use in the works, for it indicates that our manufacturers are making up leeway.

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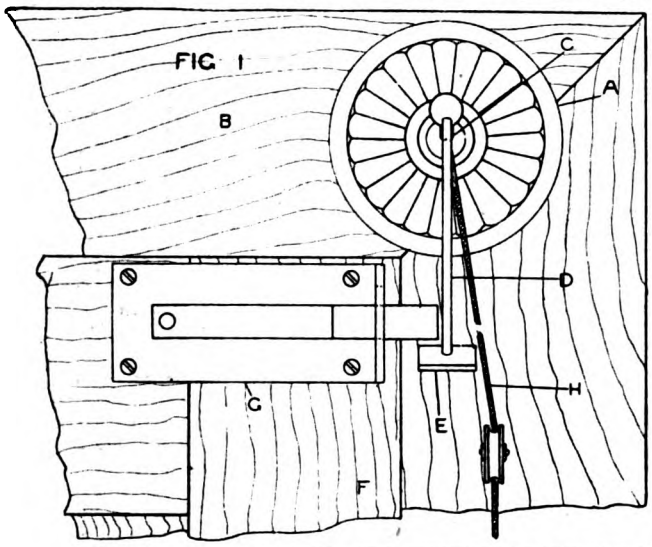
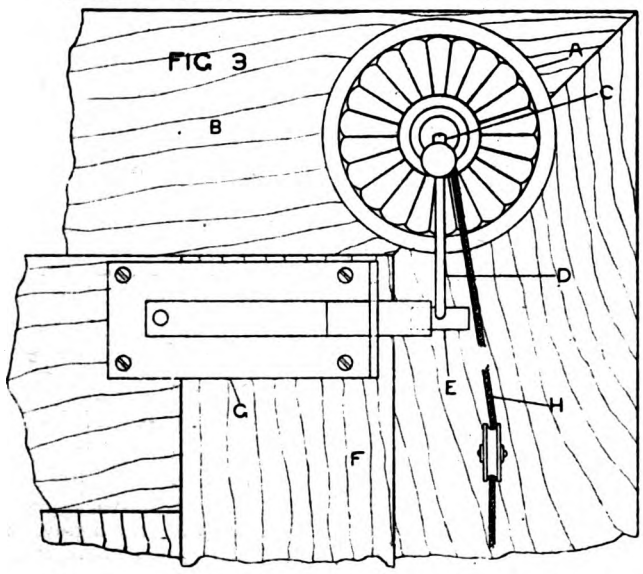
PATENTS.

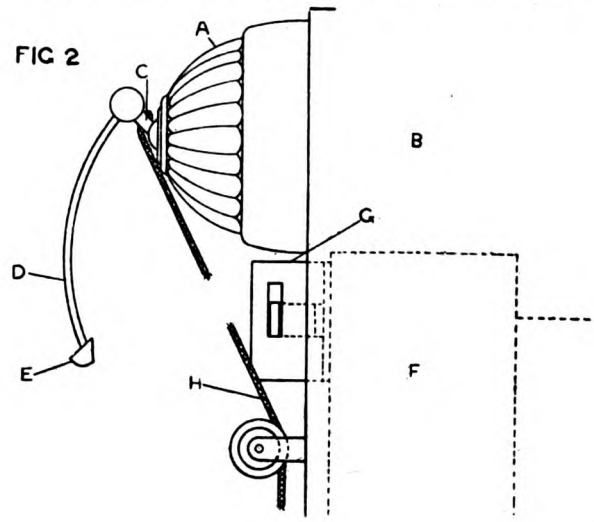
Electric Door Switches.

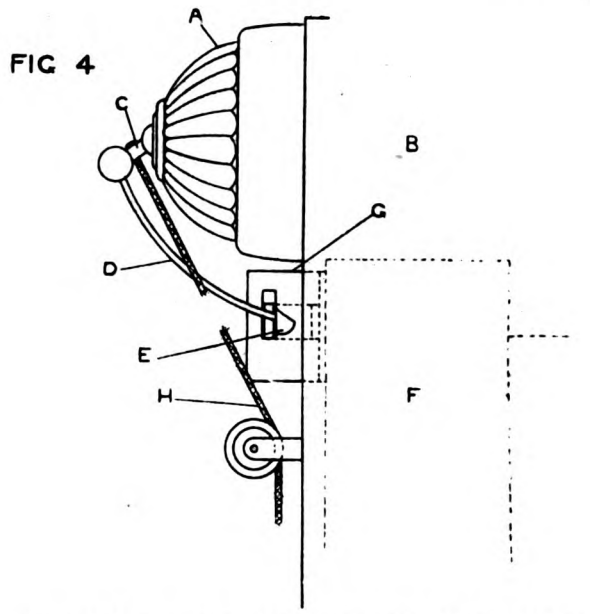
27953.—1908. R. JACKSON & C. GAFFNEY, Manchester. The improvements in electric switches applicable to the doors of rooms where it is desirable or necessary to control the switching of electric circuits by the movement of the doors such as those in telephone boxes, lavatories and water-closets. In door switches, as they are usually arranged, it very easily happens that the circuits are left closed when they ought to be open, also current is switched on during daylight every time a door is fastened, thus abnormally increasing the current consumption. In this improvement these defects are obviated and a reliable and effective switching method obtained. Figs. 1 and 2 are a front and side elevation respectively, showing a switch and latch mounted in position with the switch "off," and Figs. 3 and 4 are similar views showing the switch "on." The switch A is mounted on the framework of the door at B. This switch of the well-known tumbler type is not altered internally, but adapted by attaching to the tumbler handle C, the arm D terminating in the catch-piece E. The contact lever of the ordinary tumbler switch is locked in the on position by the actuating lever having the requisite length





of movement, but the contact lever is prevented from being so locked by reason of the movement of the extension arm D being limited by the end E striking the framework B, and the contact lever can only be held in the on position by the catch-piece E engaging with the latch-piece G. On the door F is mounted the latch-piece G; attached to the switch C is a chain or cord H, or a rod pivotted on C may be employed, which, being pulled, operates the switch into the on position. The same action swings the arm D into the position shown at Figs. 3 and 4 where, as will be seen, the top edge of the side of the catch-piece E, sliding under the lower edge of the latch G, lifts the latter until they pass each other, and the latch G is permitted to fall over the catch-piece E and be retained against the pull of the switch spring. This action of locking the switch in the "on" position is only possible after the door is closed and the lights required to be on, and it will be seen that when the door is opened after such action, the latch G moving away from the front of the catch-piece E instantly releases it and, consequently, allows the arm D to swing up so that the switch spring may operate the switch automatically into the off position. The closing of the door cannot switch on the lightning circuit, as this is always





dependent upon the switch being operated inside the room by pulling on the arm D, and thus current can only be consumed when the room is occupied. If the room be already lighted by daylight, the switch need not be operated; thus great economy in current consumption is obtained.

Electric Switches for Surface Contact Electric Traction Systems.

21089.—1908. W. M. MORDEY, Westminster. This invention consists of improvements in switches through which current flows between a buried electric conductor and a moving tramcar or other vehicle in surface contact electric traction systems. It is found in practice that when there is an appreciable amount of leakage of current over the surface of the road, there is a tendency to the formation of persistent arcs between the buried conductor and the movable contact pieces of the underground switches. Fig. 1 shows a known arrangement of switches for surface contact electric traction to which the present invention is applied, *a* being the buried main conductor, *b* the road studs made of magnetic material, and *c* the movable switch contacts connected to the studs *b*, and adapted when the studs are magnetised automatically and successfully to make contact with the iron cable as the vehicle *e* carrying a magnetic skate *f* or other magnet travels over the studs. The improvement consists of condensers *g g*, each permanently connected in shunt across the switch contacts. Figs. 2 and 3 show arrangements in which instead of providing each switch with a stationary condenser, as in Fig. 1, each vehicle is provided with a single condenser, the condenser in each example being connected between the stake *f* and a trailing brush *h* which, in Fig. 2, is arranged to make contact with each stud *b* before the collector *f* leaves such stud, and in Fig. 3, after the collector has left the stud. The contact brush *h* may conveniently be in the form of a light wire brush suspended loosely from the vehicle, contact thereof with the studs *b* being ensured by its weight. To prevent any possibility of the brush not making contacts with the studs at any time, owing to vertical oscillation, due to irregularities of the road, or to

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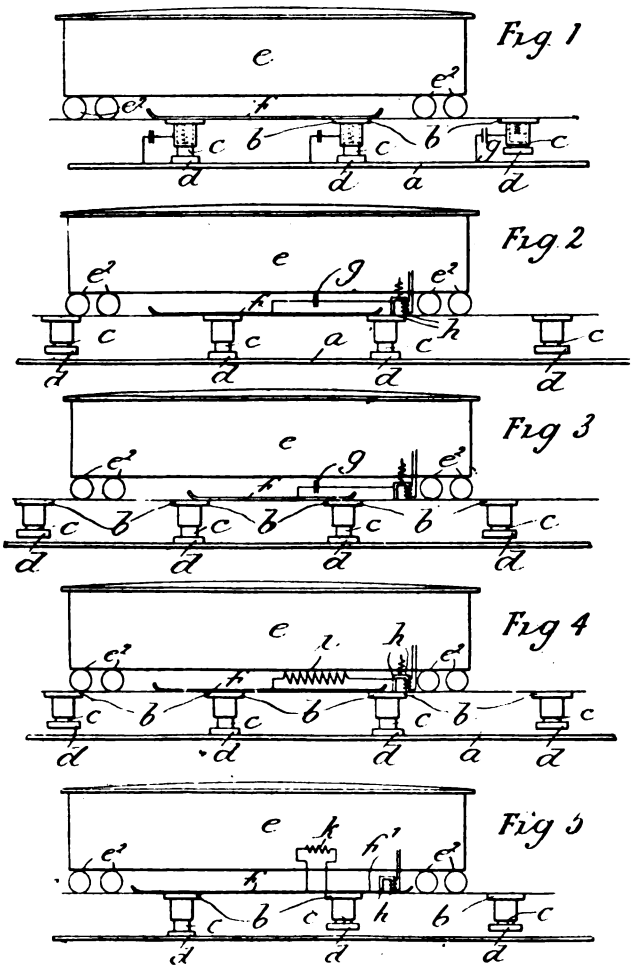
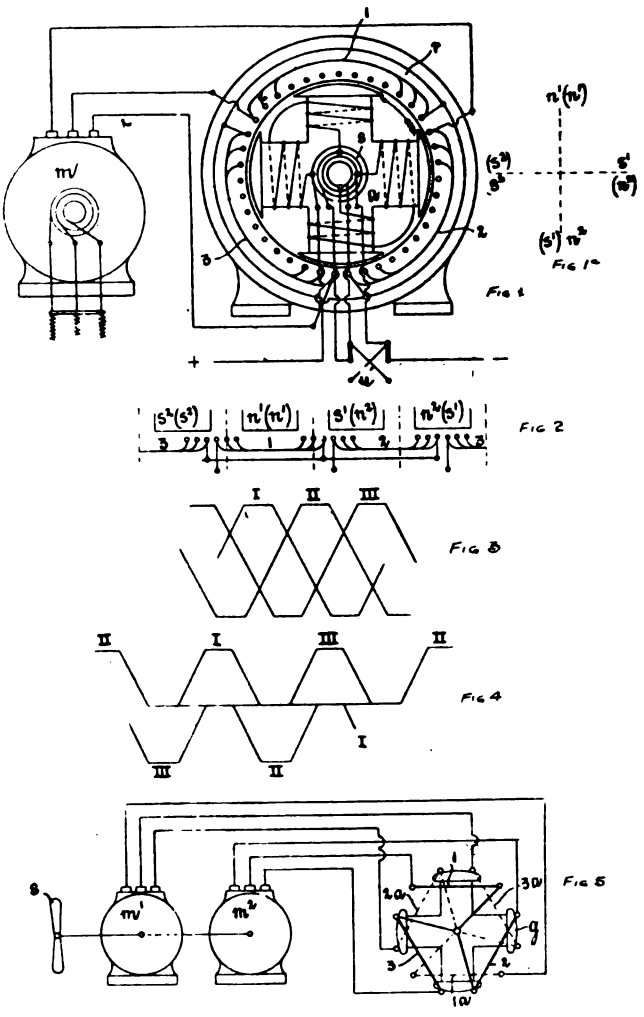
pitching of the vehicle, the brush may be made of ⊓ shaped iron wires and be magnetised by a coil that is preferably fixed to the vehicle and connected to an electrical circuit which may conveniently be the circuit of the collector magnets, the brush being free to move independently of the magnetising coil. It will be seen that in each case the condenser *g* is arranged as a shunt to a part of any leakage circuit that may exist between the main conductor *a* and earth through the switch and over the road surface, the condenser in Fig. 1 being arranged as a shunt to each switch; that is to say, to the part of the leakage circuit that is in the switch box, and between which an arc is liable to be formed with the ordinary arrangement. In Fig. 2 the condenser is also arranged as a shunt to each switch in succession at the moment the skate leaves it, connection of the condenser with the conductor *a* being by way of the skate and one or more forward studs. In Fig. 3 the connection of the condenser with each stud *b* occurs at a later period than in Fig. 2. The capacity of the



condenser or each condenser is important, and depends on the amount of leakage current that has to be dealt with. In Fig. 4 the condenser is replaced on the vehicle by a resistance *i* of such a value that while it stops the arc it does not permit an inconvenient amount of short circuit current to pass in the event of the trailing brush touching a rail, as at a crossing, while the collector is on a live stud. This condition is suitably met in practice on a 500-volt circuit, by a resistance which may be as much as 100 to 200 ohms. Or, when the system is such that the magnetism of the collector or skate *f* is used to move the contact piece *c* of the switch, instead of using a brush, as above described, as shown in Fig. 5, a non-magnetic prolongation f^1 of the magnetic collector *f* may be connected to such collector or skate through a resistance *k*. To ensure contact between the stud head, and the collector the non-magnetic prolongation f^1 may be weighted or be acted upon by a spring. Or, as shown, it may be provided with a small horseshoe magnet f^2 so arranged that while acting attractively on the head of each stud *b*, it will not magnetise the lower part of the stud. With this arrangement no arc can be formed between the stud or switch contacts by surface leakage, as those contacts, at the time of opening, are shunted by the closed circuit of the other stud or studs *b* under the car.

Alternating Current Dynamo Electric Machines.

9048.—1909. Siemens Shuckert Werke, G.m.b.H., Berlin. It is at times desirable to be able to vary the speed of asynchronous alternating current motors by changing the periodicity of the source of electric power, and this invention is an improved polyphase electric generator, by means of which the periodicity can be altered in the ratio of two to one by merely re-arranging the polarities of the poles of the generator field magnet system, and without any interference whatever with the generator armature windings, supply mains, or motor windings. Moreover, the speed of the generator may remain constant whilst the change of periodicity is being effected. Fig. 1 shows a three-phase generator arranged according to this invention and electrically coupled to an asynchronous three-phase motor. Fig. 1a shows how the polarity of the field magnet poles must be altered in order to effect the desired change of frequency. Fig. 2 is a developed view of the poles and armature or stator winding of the generator shown in Figs. 1 and 1_a. Fig. 3 shows the shape and sequence of the voltage curves generated or induced in the generator armature windings when the poles are arranged for high frequency, and Fig. 4 shows in a similar manner the shape and sequence when the poles are arranged for the low frequency. Fig. 5 shows a modification of the generator winding consisting in arranging a second stator winding on that part of the latter which would otherwise have no winding, and in connecting this winding to a second motor. In Fig. 1 the stator *r* of the generator is provided with the three coils 1, 2, 3, which are arranged in the well-known star system of connecting up, and are also con-



nected to the three terminals of the three-phase asynchronous motor *m*. The rotating field magnet *a* has four poles, each provided with a winding. These windings are connected through four slip rings *s* with a source of direct current, and a reversing switch *u* is interposed in such a manner that by merely throwing it into one position or another the windings on the poles will magnetise the latter either as indicated by $n_1\ s_1\ n_2\ s_2$ (not in brackets) in Fig. 1_a, or by $n_1\ n_2\ s_1\ s_2$ (in brackets). The dotted lines in Fig. 1_a represent the four poles in positions similar to those shown in Fig. 1, *n* denoting north magnetic polarity and *s* south magnetic polarity. The first position of the switch *u* makes the poles around the field magnetic alternately north and south, in which case the generator acts as a four-pole machine, and the second position makes one set of two adjacent poles north, and the other set of two adjacent poles south, when the generator acts as a two-pole machine. In an ordinary four-pole generator of this kind there would be six stator coils in all, practically the whole of the stator circumferential winding space being occupied by the coils. It is not possible to arrange six coils in the usual manner with the variable frequency

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generator shown in Fig. 1, since when working as a two-pole machine the voltages induced in the coils would neutralise one another. Accordingly, the essential feature of this invention consists in using only half the number of stator coils necessary for an ordinary generator so that only about half the stator circumference is occupied by the windings, and in this particular case, therefore, three coils are used instead of six. When *u* is placed in the position corresponding to four poles and *a* is rotated in the direction indicated by the arrow. The stator coils are acted upon electrically by the rotor poles in the order 1, 2, 3; that is to say, the voltage induced in coil 2 is 120 electrical degrees in phase behind the voltage induced in coil 1, and the voltage induced in coil 3 is the same number of electrical degrees behind the voltage induced in coil 2. The voltage curves numbered I., II., III., in Fig. 3, are produced at the terminals of the respective stator coils 1, 2, 3, each curve representing one of the three electrical phases. In Fig. 3 vertical distances represent voltage and horizontal distances time, and the chronological sequence of the phases is, therefore, I., II., III. Also, as two poles of like sign move across each stator coil once per revolution of the field magnet *a*, there will be two complete cycles or periods induced in each stator coil per revolution. When *u* is placed in the position corresponding to two poles and *a* is rotated in the direction indicated by the arrow, the stator coils are acted upon electrically in the order 3, 2, 1, and the voltage curves numbered I., II., III. in Fig. 4 are produced at the terminals of the stator windings, each curve representing one of the electrical phases. Vertical and horizontal distances represent voltage and time in a similar manner as with Fig. 3. In Fig. 4, however, the chronological sequence of the phases is III., II., I., instead of I., II., III., as for Fig. 3, and the motor *m* will, consequently reverse its direction of rotation as soon as *u* is changed to the position corresponding to Fig. 4 from that corresponding to Fig. 3. The number of cycles or periods per revolution is also in Fig. 4 half its value in Fig. 3, since only one pole of like sign moves across each stator coil once per revolution. The shape of the curves in Fig. 4 is peculiar in that positive and negative portions are separated in the horizontal direction by a considerable distance. Owing to the latter peculiarity, the mean effective voltage with the two-pole half frequency arrangement (Fig. 4) is only about half as great as with the four-pole full frequency arrangement (Fig. 3). This property of the new winding is sometimes of considerable advantage, since when the motor is running at half frequency it is desirable that it should also only have about half normal voltage applied to its terminals. If it is desired to make the half frequency voltage more equal to that at full frequency; this may be done by broadening the stator coils. Moreover, the shapes of the curves in Figs. 3 and 4 may be altered considerably by alterations in the pitch of the stator coils or in the pitch of the main poles. It is very desirable, on economical grounds, to make effective use of the space on the stator circumference which is free from winding, and Fig. 5 shows how this may be done in the case of a generator similar in other respects to Fig. 1. The arrangement consists in winding a second and entirely independent (except that the neutral points of both windings may be connected together if desired) three-phase stator winding, 1*a*, 2*a*, 3*a*, in the unappropriated space, which winding is arranged and connected up in a manner similar to the coils 1, 2, 3 in Fig. 1. Two electrically-separated supply systems such as the two motors $m_1 m_2$ in Fig. 5 may then be fed one from each set of generator windings, and the full capacity of the generator is thus made use of. In Fig. 5 *g* represents the generator with the two sets of stator windings, 1, 2, 3, and 1*a*, 2*a*, 3*a* connected respectively to motors $m_1 m_2$ mechanically coupled together and to a screw propeller *s*. In the case of ship propulsion with such an arrangement, it would be possible by merely operating the reversing field switch *u* to reverse the motors from full speed ahead to half speed astern with a constant speed of the driving engine or turbine. By also operating a second reversing switch connected in the main leads between generator and motors, the motors may be caused to rotate at half speed ahead instead of half speed astern. The new generator may be employed in a variety of cases other than ship propulsion, such as in connection with the driving of rolling mills, lifts and traction installations.

Fastening Filaments to Electrodes.

20015.—1908. T. McKenna, London, E.C. The metal filament is coated at its ends with the metal of which the conducting wire consists. After this the end of the filament is applied to the leading in wire and fixed by fusion of the metal coating to the wire and fixed by fusion of the metal coating to the wire, by which an intimate and thoroughly conducting connection is obtained.

Wireless Electric Signalling.

13165.—1908. R. A. Fessenden, Brant Rock, Mass., U.S.A. The invention provides a means for annulling the effects of atmospheric disturbances which interfere with the reception of wireless messages. The receiving circuits are so arranged that the disturbing impulses are divided and oppose each other's effect on the receiver.

Electric Switches.

20590.—1908. H. J. Fisher, F. Coates & H. W. Clothier, Newcastle-on-Tyne. The main switch can be closed by the pulling action of an electro-magnet of one value, and maintained closed by the pulling action of an electro-magnet of lesser value in accordance with the operation of a controlling switch. These operations are actuated by mechanism adapted to lessen the power required to maintain the switch closed. The circuit controlled by the main switch is completed through a plug interlocked with the controlling switch.

Controlling Electrical Circuits.

21674.—1908. T. J. & E. Rorke, Barnes. In an electric switch adapted to be rocked into its closed and open positions by electro-magnetic action, and provided with a tube containing mercury and electrical contacts carried by the arm of the switch, the arm is provided with a bridge piece, which carries the main current.

Dynamo Electric Machines.

19394.—1909. F. R. Kunkel, Pittsburg, U.S.A. The field magnet winding of the machine has its polar projections integral with the yoke and is provided with enlarged shoes adjacent to the armature. The winding is such that it may be wound separate from the machine in coil form and afterwards readily applied to the polar projections.

Insulators for Telephone and Telegraph Wires.

18690.—1909. A. M. Bourke, Maitland, Australia. The insulators are provided with a slot having oppositely situated outsets projecting therefrom and a groove at the base for part reception of the wire. The slot receives a correspondingly shaped wedge provided with a groove in register with that of the slot. The wedge holds the wire in position. The wedge is itself held in position by means of projections and screw caps.

Jointing Electrical Conductors.

15413.—1909. C. Vernier, Gosforth. The connections for jointing the conductors are formed of a large number of fine wires, at first disposed to bridge the joint, and afterwards secured to the ends of the conductor by soldering or other means.

Electric Terminals.

10539.—1909. C. J. Beaver & Co., Hale. The upper plate of the terminal is free from all openings in order to prevent the access and accumulation of water near the conductor. The plate is connected to the main body by a liquid seal.

Magneto Ignition Device.

7299.—1909. W. A. Trier, Camberwell. The timing of the ignition is determined by the breaking of the primary circuit. A subsidiary circuit containing an auto-trembler and a battery is connected in shunt across the contact device. The effect of closing the switch of this additional circuit is to produce a spark sufficient to start the engine without rotation.

Electrical Conductor Joints.

2611.—1909. British Aluminium Co., Ltd., & F. Horn, London. The ends of the conductor to be joined are butted together and welded. By the side of the weld is placed a splint, and these are enclosed in a sleeve. The whole is then twisted up into a torsion joint.

Electrically Heated Air Baths.

1922.—1909. W. Otto, Berlin. The heater consists of a heat proof electrically insulating core traversed by a central duct and star shaped in cross section. The heater is placed in the delivery pipe of a blower so that air flows through the channels at its circumference under the wire and also through the central duct over the hot internal surface of the heater.

Electric Vehicles.

1019.—1909. C. W. Mallins, Liverpool. The footboard is arranged on pivots or supported by springs, so that it yields when a passenger steps on it. The depression of the board operates an audible or visible signal in the guard's van, whereby he is aware of a passenger boarding or alighting from a train.

Control of Dynamo Electric Power Systems.

21580.—1908. Aktiengesellschaft Brown, Boverie & Co., Baden. The invention comprises the use of a buffer machine characterised by a single or polyphase induction machine governed by a polyphase commutator motor connected in cascade and acting in connection with a fly-wheel.

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COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last prices. £
British Insulated and Helsby Cables, Ord. 1-100,000	5	7-7¼
—— 6 p.c. Cum. Pref., 1-100,000	5	6¼-6½
—— 4½ p.c. Mortgage Debentures	100	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100	89-94
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 1-200,000 and 275,001-475,000	3	¾ ⅞
—— 4 p.c. Mortgage Debenture Stock	100	48-52
Callender's Cable, Debentures	100	105-107
—— Ordinary	5	10¼-10⅜ xd
—— 5 p.c. Pref.	5	5⅛-5¼
Consolidated Electrical Co., Ordinary, 1-110,000	1	⅛-¼
Dick, Kerr, and Co., Ordinary, 1,260,000	1	1 1⅛
—— 6 p.c. Cum. Pref., 1-305,000	1	1-1¼
—— 4½ p.c. Debenture Stock.	100	100-103
Edison and Swan United, "A" Shares, 1-99,261	3	⅞-1
—— "A" Shares, 01-017,139	5	1-1¼
—— 4 p.c. Deb. Stock, Red.	100	68-73
—— 5 p.c. 2nd Debentures	100	82-85
Electric Construction, Nos. 1 to 112,100	2	7/16-11/16
—— 7 p.c. Cumulative Pref.	2	1 3/16-1 7/16
—— 4 p.c. Perp. 1st Mort. Deb.	100	63-68
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100	68½-74½
General Electric Company (1900) 5 p.c. Cum. Pref.	10	8-8½
—— 4 p.c. 1st Mort. Deb. Stock	100	83-87
W. T. Henley's Telegraph Works, Ordinary	5	12½-13¼
—— 4½ p.c. Preference	5	5¼-5⅝
—— 4½ p.c. Debentures	100	106-108
National Electric Construction Co., 1-170,000	1	⅝-¾
Telegraph Construction and Maintenance	12	34½-36
—— 4 p.c. Bonds	100	101-103

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Bournemouth and Poole, Ordinary	10	9½-10
Brompton and Kensington, Ordinary	5	6½-7⅛
—— 7 p.c. Preference	5	6¾-7⅛
Canadian General Electric Co., Common Shares	$100	114-119
—— 7 p.c. Cum. Pref. Stock	$100	117-120
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5	3¾-4⅛
—— 4½ p.c. Cum.. Pref., 1-80,000	5	4⅜-4⅝
—— 4 p.c. Debenture Stock, Red.	100	98-101
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5	3¾-4⅛
City of London, Ordinary	10	10½ 10¾
—— 6 p.c. Cumulative Pref.	10	11⅜-12⅛
—— 5 p.c. Debenture Stock	100	121-124
—— 4½ p.c. 2nd Deb. Stk. Red.	100	100-103
County of Durham Electrical Power Distribution Co., Ordinary, 1-50,000	5	1⅛-2
—— 5 p.c. Preference, 1-50,000	5	2⅞-3⅛
County of London Elec. Supply, Ordinary	10	7⅛-8⅛
—— 6 p.c. Cum. Pref.	10	10⅛-11⅛
—— 4½ p.c. Debentures Prov. Certs. Al pd., Rd.	100	105-108
—— 4½ p.c. 2nd Debentures, Red	100	98-101 xd
Edmundson's Electricity Corporation, Ord., 1-80,000	5	⅜-5/16
—— 6 p.c. Cum. Pref.	5	⅜-½
—— 4½ p.c. First Mort. Deb.	100	57-60
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100	91-94
Kalgoorlie Electric Power and Lighting, 6 p.c. Non. Cum. Pref., 1-150,000	1	⅝-¾
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000.	5	7-7½
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100	95-98
London Electric Ordinary	3	1¾-2⅛
—— 6 p.c. Pref.	5	4⅞ 5⅛
—— 4 p.c. 1st Mortgage Debenture Stock, Red.	100	93-97
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	73½-77⅛
Metropolitan Ordinary, 100,001-300,000	5	4-4⅛
—— 4½ p.c. First Mortgage Debenture Stock	100	106-109
—— 4½ p.c. Cum. Pref.	5	4⅝-5
—— 3½ p.c. Mortgage Debenture, Red.	100	83½-86½
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,050 ($500) M 1-4,400 ($1,000)	—	80½-82½%
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb. Red	—	98-100
Newcastle-upon-Tyne Electric Supply, Ord., 1-50,000 and 57,010 to 137,500	5	4 4⅛
—— do. 50,001 to 57,009	5	4-4⅛
—— do., 5 p.c. Pref., 1-137,500 Non. Cum.	5	4⅞-5⅛
Notting Hill Electric Lighting	10	12½-13⅛
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	6-6¼
—— 4 p.c. Debenture Stock	100	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1	1⅛-1⅛
—— 6 p.c. Non-Cum. Pref., 1-100,000	1	1⅛-1⅛
—— 5 p.c. Debenture Stock, Red.	100	103-106
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5	5⅛-5⅜
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5	6¼-6⅞
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	—	105½-107½%
Smithfield Markets Electric Supply, Ord., 1-12,000	5	⅝-¾
South London, Ordinary	4	2½-3
South Metropolitan Electric Light and Power Ord.	1	5/16-9/16
—— 7 p.c. Cum. Pref.	1	1 1/16-1 3/16
—— 4½ p.c. 1st Mort. Deb.	100	100-103
St. James's and Pall Mall, Ordinary, 101-20,080 and 40,081 to 60,100	5	8½-9
—— 7 p.c. Pref. Non. Cum.	5	7-7⅛
—— 3½ p.c. Deb.	100	84-88
Urban Electric Supply Co., Ordinary	5	⅜-½
—— 5 p.c. Cumulative Preference, 50,001-100,000	5	1⅛-1⅜
—— 4½ p.c. First Mort. Debenture Stock, Red.	100	77-78½
Westminster, Ordinary	5	8½-8⅝
—— 4½ p.c. Cum. Pref., 110,101-191,379	5	4⅞-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 5 p.c. Cum. 1st Pref., 1-640,000	5	4½-4⅞
—— Debenture Stock, Red	100	90½-92
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,000	1	⅛-¼
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1	⅛-¼
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	87-90
British Columbia Electric Railway Co., Ord. Def.	100	147-152
—— Ord. Pref.	100	122-126
—— 5 p.c. Cum. Perpetual Pref. Stock	100	108-111
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	102-104
—— 4½ p.c. Vancouver Power Deb.	100	102-105
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10	⅛-1
—— 6 p.c. Cm. Pf., 30,001-60,000	10	2⅛-2⅜
—— 5 p.c. Perpetual Debenture Stock	100	83-86
—— 4½ p.c. 2nd Deb. Stock	100	58-62 xd
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100	97-99
Calcutta Tramways, Ord., No. 1 137,610	5	4½-5
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5	4⅝-5
—— 4½ p.c. 1st Deb. Stock, Red.	100	101-104
Cape Electric Tramways, Nos. 1-491,222	1	3 16-7 16
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5	4⅝-5⅛
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100	96-100
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5⅛-5⅜
—— 4 p.c. Deb. Stock, Red. (1985)	100	98-101
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12⅛-13⅛
London United Trys (1901) 5 p.c. Cum. Pref.	10	2⅛-2⅜
—— 4 p.c. 1st Mt. Db. Stock, Red.	100	67-70
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	1/32 5/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1	1⅛-1¼
—— 4½ p.c. Deb. Stock, Red.	100	93-96
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100	100½-103½
Provincial Tramways Co., Ordinary, 1-24,912	10	4-4⅛
—— 6 p.c. Cum. Pref., 1-10,000	10	9½-10½
San Paulo Tramway, Light, and Power Co.	$100	147-150
—— 5 p.c. 1st Mort Deb., Red. (1929) 1-12,000	$500	101½ 103½
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅜-½
—— 4 p.c. Deb. Stock, Red. (1940)	100	69-73
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5	⅛-¼
—— 6 p.c. Cum. Pref., 1-46,261	5	1⅛-2⅛
—— 4½ p.c. 1st Deb. Stock, Red.	100	81-85

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100	60-62
—— 4 p.c. Pref.	100	85-87
—— " " deferred	100	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	101-103
City and South London, Consolidated Ordinary	100	30-31
—— 4 p.c. Debenture Stock	100	100-102
—— 5 p.c. Pref. Stock '91	100	108-110
—— " " " '96	100	104-107
—— " " " '01	100	100-103
—— " " " '03	100	96-100
Underground Electric Railways of London, 5 p.c. Prior Ln. Rds.	—	100 101 xd

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10	3-3¼
—— 5 p.c. Debs., Red., within 1-1,609 Red	100	96-99
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000	96-98
Anglo-American Telegraph Co., Ordinary	100	61-63
—— 6 p.c. Preferred Ordinary	100	101½-102½
—— Deferred Ordinary	100	22½-22¾
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100	87½-89½
Direct Spanish Telegraph Co., Ordinary	5	3-3¼
—— 10 p.c. Cum. Preference	5	8-8½
—— 4½ p.c. Debs., 1-600	50	100½-102½
Direct United States Cable Co.	20	13-13½
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 p.c. Mort. Debs., within 1-8,000 (1913,	25	99-101 xd
—— 4 p.c. Reg, Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	—	—
Eastern Extension, Australasia and China, 1-300,000	10	11½-12⅛
—— 4 p.c. Mort. Deb. Stock, Perp.	100	102-104
Eastern Telegraph Co., Ordinary Stock	100	126-129
—— 3½ p.c. Preference Stock	100	83½-85½
—— 4 p.c. Mortgage Debenture Stock	100	102-104 xd
Great Northern Telegraph Co. (of Copenhagen)	10	28½-29½
Marconi's Wireless Telegraph Co., Nos. 1-394,190	1	⅜-½
National Telephone, Preferred	100	107-108½
—— Deferred Stock	100	119½-121½
—— 6 p.c. Cum. First Pref.	10	10¾-11
—— 6 p.c. Cum. Second Pref.	10	10¼-10⅞
—— 5 p.c. Non. Cum. Third Pref.	5	5¼-5⅜
—— 3½ p.c. Deb. Stock, Red.	100	98-100
—— 4 p.c. Deb. Stock, Red.	100	100-102
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100	100-102
West Coast of America, 1-30,000 and 53,001-53,008	2½	1⅛-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	100-102
West India and Panama Telegraph Co., Ordinary	10	⅜-½
—— 6 p.c. Cum. 1st Preference	10	8⅛ 9⅛
—— 6 p.c. Cum. 2nd Preference	10	8⅛-9⅛
—— 5 p.c. Debs., Red., 1-800	100	102-104
Western Telegraph Co., 1-207,930	10	13¾-14
—— 4 p.c. Debenture Stock, Red.	100	103-105

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THE
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NOTES.

THE INSTITUTION.

Dr. Gisbert Kapp's inaugural address as President of the Institution of Electrical Engineers was a fine performance. It was characterised by a depth of knowledge, a breadth of view, and an optimism that was quite refreshing and greatly impressed his auditors. The Institution may well be proud of its President, as he is of his Institution. Referring to the fact that at midsummer the Institution had 7 honorary, 1,142 full members, 2,387 associate members, 1,042 associates, 1,432 students and 107 foreign members, he pointed out that it was most satisfactory to find such a large number of students, as this shows that the rising generation appreciates the importance of electrical engineering, and justifies the hope that with so large an influx of fresh and vigorous intellect the Institution will continue to prosper. There is, indeed, every indication of this, and not the least of the signs is this thoroughly competent and manly address.

THE INDUSTRY'S FUTURE.

There is no half-heartedness about our new President. He believes in the electrical industry and its future, and speaks of present difficulties and troubles without whining. Which is good. Referring to the progress made, he said: "We may take our membership as a rough indication of the number of persons engaged in the electrical industries. In 1899 our membership was 3,254, now it is 6,117—nearly double; but the capital employed in these industries is nearly quadrupled, so that the efficiency of labour, both mental and manual, has increased by about 70%. Or, to put it in another way, each man or group of men can now produce, control, or utilise, 70% more wealth than the same man or group of men could produce, control, or utilise, 10 years ago. This shows that we have made considerable technical progress."

PROGRESS ABROAD.

If Dr. Kapp in his review of important developments and general tendencies, dealt largely with Continental experiments and practice, that was quite as it should be. He recognised wisely and generously British initiative and inventiveness. But if we are to remain in the forefront, it is only by sticking to our work and keeping a sharp eye on what our foreign friends are doing. Not that we need copy slavishly, but on the Continent big problems have to be faced, and there is formidable enterprise and almost a genius for some forms of electrical designing abroad. It behoves every engineer to be posted in what is going on outside our own borders.

COAL MINE COMMITTEE.

The Home Office Departmental Committee on electricity in coal mines has held its first meeting. It was then decided that the taking of evidence is to be postponed to the new year, when witnesses from the various coal mining districts will be called. Expert electricians will also be heard, but nothing was said about carrying out experiments; yet this is a vital point if the Committee's labours are to be of any permanent value.

POWER IS OUR HOPE.

In a brief review of the Glasgow Corporation's Electrical Department report, a northern contemporary points out that although the total output last year was 1,670,000 units more than during the previous twelvemonths, the maximum load fell by 601 kw., an appreciable step towards evenning up night and day load. This phenomena is, of course, due partly to an increase of the use of electricity for power, and a reduction of consumption for illuminating purposes (though coinciding with an increase of customers) as the result of the metallic filament lamp coming into general service. Our contemporary regards this as a blessing, because it will cause central station engineers to pay more regard to the question of supplying electricity for power. While hardly going so far as to say with our friend that the lighting load of the average electricity station is one of the greatest hindrances to the development of electric supply undertakings, we agree that the fall of maximum loads in so many accounts is an encouraging feature for the future of the industry.

ELECTRICITY AND TEXTILES.

Mr. W. B. Woodhouse, whose original paper on "Electric Driving of Textile Factories" gave rise to the Bradford Engineering Society's enquiry into the subject and their recent report, writes to point out that he is in many ways opposed to that report. He denies that exhaustive tests were made apart from those on speed variations, which were really in favour of electricity. He adds that no figures were presented to the committee on the relative output of mechanically and electrically driven machines, but to say that "no evidence of increased output from electrically driven machines can be supplied" is incorrect, and that "the committee have been unable to obtain any proof based on actual experience" is more—it is misleading. Evidence of increased output due to electrical driving is available from all parts of the world. Several of the other conclusions, he contends, are worded in the same curious manner. As example, he cites the words "where power is generated on the site the mechnical losses are less than the electrical," and "mechanical losses are excessive if the friction load exceeds 30%." But there was not even a single test to support them. For the reasons given, Mr. Woodhouse dissociated himself with the report.

DESTROYING INSECT PESTS.

It will be remembered that some time ago the Germans made use of electricity in order to destroy a pest of moths and other winged insects. A modification of this has been devised in connection with winged parasites attacking vineyards. The method adopted is to place a number of posts in the vineyards, supporting 5 c.p. electric lamps, and just beneath the globes small saucers of water with a top dressing of petroleum. It was found that when the lamps were lighted at night insects swarmed round the lamps and were destroyed in the petroleum. Experiments were made as regards the distance apart from lamp to lamp, and the position of the saucers. Success was attained when the lamps were about 75 ft. apart, and when the saucers were suspended only a few inches above the ground.

LIGHTING OF PATENT OFFICE LIBRARY.

Readers who frequent the Patent Office Library will have noticed that a much-needed reform has been made in the method of illuminating the tables. Previously the light was obtained from pendant fittings 6ft. or more away from the tables and 10 ft. above floor level. Not only was the amount of illumination on the tables insufficient, but lamps came in the line of sight. In the new method metal

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standards are fixed in the centre of each table, so that the lamps are only about 2 ft. above the table. Experiments are being made with various reflectors and shades, and the one which appears to give the best results is a deep shade which hides the lamp entirely, and of very dark glass, so that very little light comes through the shade. In connection with this matter, it may be of interest to mention that the metal filament lamp is particularly rich in ultra-violet rays and, consequently, trying to the eyes. Darkened glasses do not protect against these rays, yellowish or greyish green is more effective. The men who work the arc process of welding have their eyes protected by two superposed sheets of red and green glass.

ECONOMISING OIL IN POWER STATIONS.

In large power stations, the cost of the oil used for the various journals is a serious matter, and, further, the attention required to watch various lubricators forms a large proportion of the total labour charge. Some of the oil could be saved and part of the labour done away with, by having a centralised supply. Mr. Dickenson, of the Leeds electric light station, was one of the first to appreciate this point, and the first four 500 h.p. Belliss engines which he installed were oiled from a central source. The oil ran from the crank chamber direct into some galvanized iron tanks in the basement. Two Worthington steam pumps lifted the oil from these tanks into a tank overhead, where it was strained, and from thence gravitated back to the engines and was strained again at each engine. The overhead tank was about 30 ft. above the engines, and so gave good pressure on the bearings. A fault with some quick speed engines is that it is difficult to keep a tight joint between the lower end of the cylinder and the crank chamber. In one well-known type a gland was placed immediately on the top of the casing and the piston rod lengthened, so that that part of the rod which entered the cylinder did not enter the lower gland at the top of the casing. This got over the difficulty altogether.

TRANSFORMER OIL.

It is a long step since Messrs. Johnson & Phillips first tried immersing transformers in oil, and those who watched the experiments of 20 years ago, had little idea of the importance that transformer oil would attain to in the electrical industry. Although so much oil is used, we are a good deal in the dark, even now, as to what are the exact qualities which make a first-rate transformer oil. One of the principal difficulties is the presence of water, for a very small quantity will materially lower the insulation; for example, ·06% of water in one case lowered the insulation of the oil about 50%. One method of testing for water is to measure the voltage necessary to force a spark across two brass knobs immersed in the oil. The knobs are ½-in. diameter and 0·15 in. apart, and in oil free from water 25,000 volts is required. The presence of water can also be detected by the following chemical test: A test tube is filled with oil, and a small quantity of anhydrous copper sulphate is added. If water is present, it will combine with the sulphate to form a blue solution. The sample should, of course, be drawn from the bottom of the tank, as it is there that the water particles collect. The sample can be obtained by means of a long glass tube. One end is closed effectively with the thumb and the tube plunged into the oil. When the thumb is removed the oil rises up in the tube, and it can then be taken out by closing the tube with the thumb and withdrawing the tube with the oil in it. When oil has been in use for some time it tends to become dirty, and the insulation is considerably lowered. This is due to small sparks which decompose the oil depositing carbon and releasing the hydrogen as a gas. The decomposition is due to the local heating of the spark, and not to electrolysis. Of course, when the spark has passed, the oil seals up automatically, and this may go on for years until sufficient carbon has been deposited to permanently bring down insulation to a dangerous point. The Standard Oil Co. make an oil which is said to be absolutely free from acid of any description, and is so manufactured that it is incapable of developing any traces of acid under any action to which it may be subjected. It is also incapable of absorbing moisture in any indirect way, and if it should come in direct contact with water or moisture contained in a transformer not properly dried it separates readily from the moisture, and by heating becomes as free from any tendency to absorb moisture as it was in its original condition. The flash point and viscosity have been subordinated to such conditions as will secure the greatest resistance to current. The flash point is above 300°F., which secures immunity from flashing or firing under normal conditions. The viscosity has only a relative bearing upon electrical resistance. In order to test for dielectric strength, a 30 3-kw. single-phase 60-cycle transformer is used. This steps the current up from 110 to 50,000 volts, and with a needle point gap of ·2 in. at 100°F the oil breaks down at 49,000 volts.

STEAM TURBINES AS APPLIED TO MARINE PROPULSION.*

By C. B. DICKSEE.

The turbine was first applied to marine propulsion in 1543, by Blasco de Garay, a Spaniard, who propelled a vessel by means of an engine of the *Hero* type. The honour of being the first to do anything practical belongs, however, to the Hon. C. H. Parsons. In 1894 he built a vessel 100 ft. long by 9 ft. beam by 3 ft. draught, into which he placed one of his compound land turbines, developing some 2,000 h.p. The results at first were unsatisfactory, only 14½ knots being obtained. After some experimenting, however, he obtained the then record speed of 35 knots. This was only attained by splitting the turbine up into three parts, as the power was too great to be absorbed efficiently by a propeller of the small dimensions, necessary on account of the high speed at which it had to run.

Turbine boats are either triple or quadruple screw, single and twin screws never being employed. Quadruple screws are only employed in the largest battleships, and liners such as the *Mauretania*. Lately a "mongrel" system has been introduced, which consists of a combination of h.p. triple expansion engines and l.p. turbines.

After the *Turbinia*, as Mr. Parsons' first ship was named, various vessels were built, two being destroyers for the British Navy, one of which, the *Viper*, attained 37·1 knots on trial. Both these destroyers were, unfortunately, lost at sea before any reliable comparison could be formed between them and the standard 30 knot boats.

Several river steamers then appeared, which showed a very marked economy over the paddle boats in the same service, one, the *King Edward*, steaming a further distance in a given time on 480 tons *less* coal.

From this period the advance has been rapid, till we have giant liners of 70,000 h.p. doing 25 knots, and a battleship projected which is to indicate 80,000 h.p., and have a speed of 28 knots, propelled entirely by turbines of the Parsons' type.

The published results of similar ships, engined, one with turbine and the other with reciprocating engines of the most modern type, are few, so that it is difficult to come to any definite conclusion, but those which have been published show a marked economy for the turbines where the speed is greater than about 75% of the maximum. Also when the maximum is not less than a certain figure, which, however, is somewhat disputed, M. Rateau makes this limit 20 knots, but several ships, including the two 'Allan' liners, have been built to steam economically at a maximum speed below this figure.

AUDIBLE TRAMWAY SIGNALS.

The Board of Trade are issuing a circular pointing out that, owing to the drawbacks attaching to the red lamp warning on trams, they have expressed their preference for an audible signal. As a result of a fatal accident to a passenger on the Wolverhampton District Electric Tramways, the Birmingham and Midland Tramways Joint Committee, who work the line, have decided to make a daily test to see that the trolley standards are properly insulated, and to equip all cars with a magnetic blow-out fuse giving a distinctly audible signal. The Board are advised that pending the adoption of an audible signal, the lamps should be bridged with a suitable fuse, and that the signal device should be tested at least once a week.

* Abstract of paper read before the Northampton Institute Engineering Society, Mr. H. M. Hobart, M.Inst. C.E., M.I.E.E., in the chair.—Nov. 12.

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INSTITUTION OF ELECTRICAL ENGINEERS.

PRESIDENTIAL ADDRESS OF DR. GISBERT KAPP.*

We may take our membership as a rough indication of the number of persons engaged in the electrical industries. In 1899 our membership was 3,254, now it is 6,117—nearly double; but the capital employed in these industries is nearly quadrupled, so that the efficiency of labour, both mental and manual, has increased by about 70%. Or, to put it in another way, each man or group of men can now produce, control, or utilise, 70% more wealth than the same man or group of men could produce, control, or utilise ten years ago. This shows that we have made considerable technical progress.

The distinction between design and application of electrical apparatus is not always easy to maintain, because new uses of electricity demand new designs, and the two are so interdependent that a hard and fast demarcation line can hardly be drawn, but for my present purpose a rough division may usefully be made into two great groups: first, the design and manufacture of electrical machinery and apparatus; and, secondly, the application of electricity to various industrial purposes. I can only indicate some of the more important developments and general tendencies without attempting an exhaustive treatment of the subject.

The modern tendency is to instal very large units. This is partly due to the large demand made on the power house and the desire to restrict the number of units, and partly to the fact that the advantages of the steam turbine over the reciprocating engine become more pronounced with the increased size of the unit. The General Electric Co. of New York have built several turbo-alternators of

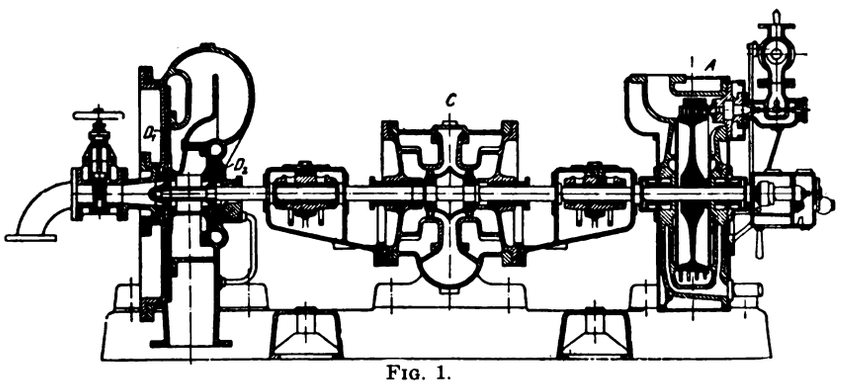

FIG. 1.

14,000 kw. at 9,000 volt pressure, and the British Westinghouse Co. inform me that it would be quite feasible to build sets of 15,000 kw. up to 13,000 volts, or, if necessary, 15,000 volts pressure. In water-driven alternators, also, the tendency is towards large units. Thus the power house of the Norwegian Nitrogen Co. at Svälgfos, near Notodden, has been fitted up with four turbine-driven 3-phasers, each for 10,500 kilovolt-ampere, and developing 7,000 kw. at a power factor of 0·67, the speed being 250 r.p.m., and the terminal pressure 10,000 volts at 50 frequency. The stator is 3,500 mm. in internal diameter, and 1,150 mm. long. The total losses at full load amount to 320 kw., corresponding to a generation of heat of 270,000 calories per hour for each machine. It is obvious that in these circumstances special ventilating arrangements become necessary. Air ducts are carried under the floor to each machine, but no provision is made to carry the heated air away; it simply discharges into the engine-room. Dr. Kloss, in a paper read before our Institution about a year ago, has pointed out that the scientific way of ventilating turbo-dynamos is to take the air from the outside and discharge it to the outside of the engine-room. The first part of his recommendation is already being followed in modern stations, though the hot air is generally discharged into the room. There is, however, no difficulty in arranging for a discharge through ducts under the floor, and this would certainly conduce to the comfort of the engine-room staff. No separate ventilator need be provided; it is quite easy to mount a fan on each end of the rotor, and so to case in the whole machine that the air is forced along prescribed paths. In the machines made by some large Continental firms this path is as follows: From the ducts underground into annular chambers surrounding the rotor shaft, then through fan-wheels of the "Sirocco" type into annular chambers on either side of the stator ends, through longitudinal holes in the stator iron, and radially outwards through the air discs of the stator. The hot air is thus discharged into a cylindrical space surrounding the stator and may be finally let out either at the top into the room' or at the bottom into a discharge duct. It is important that only clean air be used, and for this reason air filters are built into the inlet ducts. These are formed of pockets of porous cloth extended over wooden frames, and so placed that the dust which settles on the cloth may be removed by beating or with a vacuum cleaner. Washing or chemical cleaning is only required after some years of use.

In most modern electricity works the circulating and air pumps are driven by electric motors, but this method has been replaced at the works of the Allgemeine Elektricitäts Gesellschaft by a set of turbo-driven centrifugal pumps. Figs. 1 to 3 show the arrangement for a 6,000 kw. turbo-alternator. A is a small steam turbine running at 2,000 r.p.m., which drives the circulating pump C, the air pump D_1, and a pump D_2, which forces the water into the inlet chamber of the feed pump, the latter being also of the centrifugal type. No piston pumps at all are used, and the feed may be regulated without paying attention to the feed pump. The space saved by this modern way of dealing with the exhaust of turbos is shown in Figs. 2 and 3, both drawn to the same scale for two 6,000 kw. turbo-condensers. Water is admitted through the inlet valve on the left of D_1 (Fig. 1), and is discharged by the centrifugal pump wheel into a diffuser surrounding it. The annular space between fan and diffuser is in communication with the condenser, and the water flying across this space takes the air with it and discharges it at atmospheric pressure at the outer circumference of the diffuser. The individual particles of water act as so many tiny pistons, compressing and forcing the air forward; this is indicated in the figure by the black shadings in some of the diffuser channels. The water, which has been used for expelling the air, joins the water coming directly from the condenser, and is dealt with by the pump D_2, as already mentioned. Mr. Lasche, the writer of the article from which I take this information, says that the feed water obtained by this method is absolutely free from air, and that only 5% of make-up for the feed is required. Since no piston engines of any kind are used, there is no need for oil filters.

An important development in turbo sets was initiated about ten years ago by Professor Rateau with his exhaust steam turbine, and as far back as 1902 the Hon. Ch. Parsons made such a machine, but it is only recently that the commercial importance of these turbines has been fully recognised. I take from a German mining paper the following particulars of an exhaust steam turbo plant that has recently been erected in the Osterfeld Mine in Westphalia. From the existing winding engines, compressors, fans, and other steam engines a maximum of about 50 tons of steam per hour was available. The exhaust is taken into four Rateau thermal storage vessels at about atmospheric pressure, and from there to two 1,600 kw. Rateau-Brown-Boveri turbo sets. The capital outlay was £58,000, or £18 per kilowatt. This high cost is due to the circumstance that the intermittent character of the supply of exhaust steam necessitated the installation of a rather large thermal storage plant. With a yearly output of 17 million units, and allowing 10% on the capital cost for fixed charges, and also making allowance for a certain amount of live steam required to tide over gaps in the delivery of the winding engines, the cost per unit works out at 0·13d., whereas with an independent installation the cost of the unit, as shown by other installations in the district would have been 0·42d. The use of exhaust steam turbines thus results in an annual saving of about £20,000. That is 34·5% on the capital outlay.

A point which requires careful attention in the design

* Delivered at a meeting of the Institution, London, Nov. 11, 1909.

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of generators is the permissible drop. For safety, a large drop is desirable, whilst for regulation both the inductance and the demagnetising force of the armature should be kept as small as commercially possible. Thus the best design is as usual a compromise, but by an ingenious method devised by Mr. Miles Walker, and adopted by the British Westinghouse Co., this compromise has been made less difficult, especially in the design of turbo-driven alternators. The exciting coils are housed as usual in longitudinal slots in the rotor, but instead of arranging these coils symmetrically to the polar axis, Mr. Walker places the centre of the coils nearer to the leading edge of the pole, so that the teeth in that part of the rotor are more strongly magnetised than the teeth in the polar axis, whilst the magnetisation is weaker still in the teeth in the

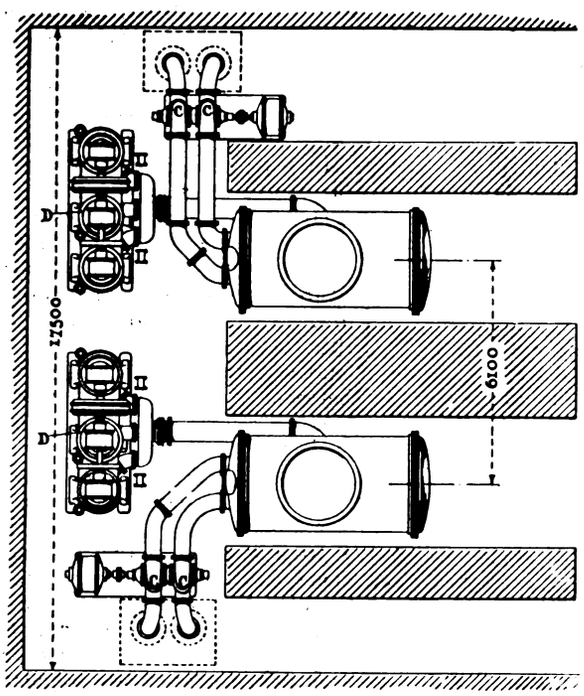

Fig. 2.

lagging polar edge. If the machine works at a power factor not much less than unity, the armature currents weaken the induction over the leading and strengthen it over the lagging polar edges. Since the latter are not highly magnetised to begin with, this strengthening action can take place fully, whilst the weakening action on the leading edge has much less effect on account of the initial saturation. Thus on the whole there may be no change or even a slight rise of total flux with an increasing load, so that the armature back magnetisation is compensated. This compensation fails, however, if owing to a short there is a great increase in armature current, for then this current lags so much that the pole as a whole is demagnetised, and the machine is in no worse condition than a machine of the usual type designed for a small short-circuit current.

The desire to reduce the cost and complication of a switchgear and to make paralleling easy has led to the use of non-synchronous machines as generators. It is well known that if the rotor of an induction motor be driven by power at a little over synchronous speed, the machine will act as generator. Such a machine, especially if turbo driven, has important advantages over the ordinary generator having the usual field system with continuous-current excitation. The machine can, of course, only work if excited with alternating current from the busbars, so that such machines are generally installed when an enlargement of existing plant becomes necessary. The rotor may be a squirrel-cage of very simple construction, and requiring hardly any insulation, no matter how high the pressure produced by the stator may be. The mechanical construction is easier than that of the revolving field of an ordinary turbo-alternator, and since the air space can be made small, the power factor is high.

There is some difficulty in the design of turbo-alternators for very low periodicity, since the speed becomes insufficient for the satisfactory working of the turbine. To meet such cases, Mr. E. Ziehl has devised a type of alternator which he calls a "double-field generator" (Doppelfeld generator). The principle may be explained as follows: Imagine a non-synchronous motor having precisely the same 3-phase winding in stator and rotor, and let the circuits be connected either in series or parallel in such way that a 3-phase current sent through the machine will produce fields which in stator and rotor revolve in opposite sense. If now the rotor be driven by power in a sense opposite to that of its own field, and with a speed corresponding to twice the frequency, the field produced by the rotor currents will in magnitude and direction of motion be identical with that produced by the stator currents. Thus, each of the two windings contributes one-half of the field common to both. At the same time the demagnetising action of each winding is eliminated by that of the other. The machine cannot work alone, but must be excited in the same way as a non-synchronous generator from some synchronous generator; it cannot give a wattless current, and in an installation where the power factor is less than unity, the synchronous machine must supply the wattless currents. As advantages, Mr. E. Ziehl claims the following: Since the e.m.f. is generated in both windings, only half the flux as compared to a synchronous generator is required; hence less hysteresis loss, smaller radial depth of stampings, and less copper weight, which is due partly to the small air-space and partly to the shorter pole-pitch. All these tend to reduce the cost of manufacture. Since the machine can only give a watt current, a short circuit on the mains cannot damage it. The paralleling is easy; the speed need only be approximately right, and if coupled up in a wrong phase position no damage is done, since the inductance is then very great. It is only when running at exactly synchronous speed, and in correct phase position, that the mutual compensation between the two windings takes place, and if the machine be switched on when out of phase it pulls itself quickly into phase without demanding from the busbars a large synchronising current. When used in connection with converter sub-stations, no separate alternating excitation is required, the converter itself acting as exciter.

Thanks to the researches of Sir Robert Hadfield, which have resulted in the production of the excellent material known as alloyed iron, the science of transformer making has developed in a remarkable degree. In transformers, also, there is to be noticed a general tendency towards large units, which is not surprising if one considers that for the calcium carbide industry alone about half a million h.p. in generating plant has been installed throughout Europe, and that most of the power has to flow through transformers to the carbide furnaces.

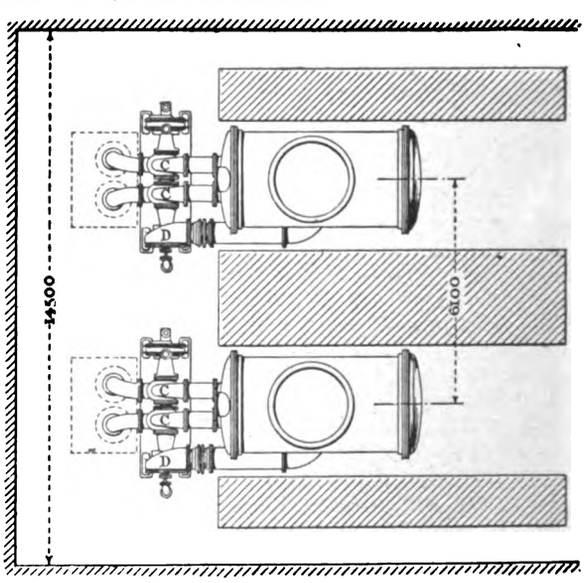

Fig. 3.

The largest European transformers of which I could find a record are some made by the Siemens-Schuckert Werke. They are of 3-phase 6,750 kilovolt ampere capacity oil cooled, for 66,000 volts on the high pressure side. The cooling arrangement is unusual, but probably very efficient. It is shown in Fig. 4. Usually the case is made much higher than the transformer, and the upper part is used for housing the water pipes. The oil on being heated by contact with the transformer, rises and gives up heat to the pipes, and

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then descends again to take up more heat from the active material. In the arrangement here shown the case is just high enough for the transformer, and no attempt is made to cool the oil in the case, but by means of an oil pump a definite and forcible circulation within the case is induced, whilst at the same time the oil, being passed through a worm outside, can be effectively cooled. This arrangement is especially useful in cases where the cooling water is dirty, and there would in consequence be the danger of a water worm of the usual type becoming choked up. The use of oil as a filling medium has made it possible to build transformers for very high pressure. In one American power-transmission plant now under construction the step-up transformers are intended to raise the pressure to 110,000 volts, but even higher pressures can be obtained. Transformers giving extremely high pressure on the secondary are used for testing insulators and insulating material.

The reduction in weight of transformers due to the use of alloyed iron, large units, and vigorous cooling is very remarkable. As an example of good modern practice, I take a Brown-Boveri transformer for 4,600 kw. at 27,000 volts, 50-frequency, 3-phase, oil-cooled, with water coils in the case. The active material, by which term I mean the iron carcase and copper coils, but exclusive of case or fittings, weighs only 3,124 kg. per kw., and the efficiency is 98·6% at full non-inductive load. In an Oerlikon 3,500 kw. transformer the active iron only weighs 7 tons, being at the rate of 2 kg. per kw. output. Its efficiency is also nearly 99%. This transformer is the more remarkable, as no oil is used. It is a so-called dry transformer with forced draught, yet the voltage on the high pressure terminals is 72,000 volts. Such an arrangement is safe enough in the pure air of the high Alps, but it would evidently be risky to adopt it in a town like London or Birmingham for any but a moderate pressure. Generally the modern tendency is to rely on oil for insulation, and, for units above a certain size, on water as the cooling medium. The largest self-cooling oil transformers of which I know are some 1,200 kw. 3-phase 40-frequency 5,000-volt transformers made by the British Westinghouse Co., but for larger unit artificial cooling becomes necessary. In some 1,850 kw. transformers made by the same firm, the cooling is effected by an air-blast directed against the outside of the case. The Siemens Schuckert Werke have also employed the principle of cooling the outside surface of the case, only in this case the cooling medium is water, which is sprayed against the case.

The aim of the designer of transformers for power or light supply is to reduce the inductive and ohmic drop as much as possible. If, however, the transformer is intended for furnace work, it is better to allow a rather large inductive drop so as to reduce the rush of current in the event of a short circuit in the furnace. Mr. Yazidjian has pointed out that the power factor of the primary current is not much lessened thereby, whilst the element of safety thus introduced is worth having. A large inductive drop means wide spaces between primary and secondary coils, thus facilitating insulation and cooling, but it also involves the necessity for good mechanical support. The mechanical forces acting on the individual coils are due to leakage fields, and where these are considerable, the mechanical stresses on the coils are also considerable. This is probably the reason why some makers prefer the core type with concentric cylindrical coils, the cylinder being the best shape for resisting radial forces.

The establishment of power-distributing systems on a large scale has strongly stimulated the manufacture of alternating current motors, and nowadays this type of machine is built by nearly all makers of dynamos. The manufacture has become perfectly standardised, and no startling improvement can be expected in the ordinary induction motor. Inventors are, however, busy in devising means for reducing the speed of such motors, and in this connection I must draw your attention to the principle of cascade working which has recently been developed by Mr. Hunt, of the Sandycroft Foundry. The ordinary cascade as used on electric locomotives requires two motors, the rotor of one sending current into the stator of the other. Mr. Hunt has, by an ingenious method of grouping the coils, succeeding in adapting the cascade principle to one motor only. He is thus able to run an 8-pole motor at the speed of a 12-pole motor, whilst getting a better power factor than is possible with the orthodox way of using two motors in tandem.

A remarkable improvement in single-phase motors has been devised by Mr. Deri, and practically developed by Messrs. Brown-Boveri. Mr. Deri's motor may best be explained by reference to the original so-called "repulsion-motor," invented very early in the history of alternating current engineering by Elihu Thomson. In this motor the rotor is of the same type as the armature of a continuous current motor, but the brushes are short-circuited on each other, and are mechanically so arranged that the brush axis may be set at various angles to the axis of the stator field. If set at 90° (electrical), no current passes through the rotor, and if set co-axially, the rotor takes a maximum current, being, in fact, the short-circuited secondary of a transformer. In both these extreme positions no torque is exerted, but in an intermediate position a torque is exerted, and if the rotor is allowed to run, the current is reduced and the power factor increased. Mr. Deri employs two sets of brushes: one being fixed in the polar axis of the stator, and the other so adjustable as to include different angles with the fixed brushes. In a 2-pole motor there are thus four brushes required. The movable brushes are not shorted on each other, but each is shorted on its corresponding fixed brush. If the fixed and movable brush are in line and bearing on the same part of the commutator, no current passes through the armature. If their angular distance is 180°, the armature winding acts as the shorted secondary of a transformer. In neither case is a torque exerted. If, however, the angular distance between fixed and movable brush is intermediate between 0° and 180° a torque is exerted, and if the armature is allowed to run the current decreases and the power factor increases. The effect of shifting the brushes is analogous to changing the impressed voltage on an ordinary continuous current series motor, and thus by adjusting the brushes the torque and speed may be regulated. This property renders the Deri motor valuable in all cases where delicate speed regulation is essential. It is largely used for working passenger lifts and other hoisting machinery, and also for driving ring-spinning frames, the speed regulation in the latter case being automatic. The result of automatic speed regulation is an increased output from the ring-spinning frames. Another application is for electric railway working, to which I shall refer later. An important point in these motors is their perfect commutation. I have a 7 h.p. 50-frequency Deri motor in my laboratory at the Birmingham University, and this works absolutely without sparking at any load and speed within its range.

There has been a considerable development in this branch of applied electricity in late years, but the development has been on different lines in different countries corresponding to their various topographical, industrial, and commercial conditions. With us it is not so much a question of carrying power a long way, as of distributing large amounts of power at numerous points within a restricted and densely populated area. For so-called water-power countries the problem is different. Although the district where the power is wanted may also be densely populated, the amount of power required per square mile is less than with us, whilst the distance between the source of the power and the points of its delivery is very much greater. Hence the necessity of using very high pressures in the transmission lines. In England a pressure of 20,000 volts may be considered as an upper limit for most cases, but on the Continent and in America higher voltages are very often necessary. As instances may be taken, the transmission of 3,900 kw. at Gaucin-Sevilla, over a distance of 125 km., at a pressure of 52,000 volts, and that of the Hydroelectric Power Commission of Canada over 500 km., at 110,000 volts. The voltage is limited not so much by the dielectric strength of the insulators as by dispersions of electricity through the air and the consequent loss of power. In this connection some admirable experimental work has recently been done by Mr. Ralph D. Mershon to determine the maximum voltage which may be used under given conditions on an overhead 3-phase line. He gives the following formula as a near approximation to the experimental results. The limit of pressure beyond which dispersion causes sensible loss of power is in virtual kilo-volts—

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$$K_V = \left(\frac{1}{1+K_4 p^1}\right) K_1 \left(1+\frac{K_2}{K_3+r}\right) r \log\left(\frac{s}{r}\right).$$

where K_1, K_2, K_3, K_4 are constants, p^1 is a quantity which Mr. Mershon calls the "vapour product," r is the radius of the wire, and s the distance between the two wires between which the pressure K V exists. It will be noticed that the temperature does not directly enter into Mershon's formula, though it is implicitly contained in the value p^1, whereas Ryan's old formula contained the temperature itself. By taking Mr. Mershon's curves and assuming proportionality between the barometric pressure and critical voltage as in Ryan's formula, I find that the following somewhat simpler expression represents fairly well the critical potential difference in virtual kilovolts—

$$KV = \frac{0{\cdot}115\,b}{0{\cdot}5+r}\left(\frac{1}{1+0{\cdot}013\,v}\right) r \log\frac{s}{r}.$$

Here b is the barometric pressure in mm. of mercury, r is the radius of the wire in cm., s the distance between the two wires in cm., and v is Mershon's "vapour product"—namely, the pressure of saturated steam in mm. of mercury at the given temperature multiplied by the relative humidity, or the ratio $\frac{\text{actual moisture}}{\text{possible moisture}}$

I have communicated this formula to Mr. Mershon, asking his opinion, and he writes as follows: "I find that your formula does not give quite as close results as mine, but I think perhaps the results it does give are as close as the measurements would justify, and as it is somewhat simpler than my formula, it is perhaps preferable for practical use."

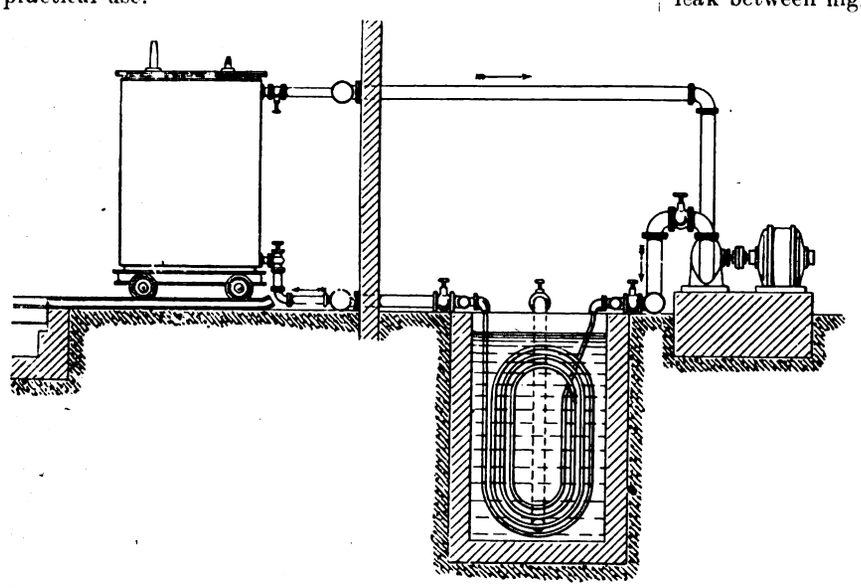

Fig. 4.

The protection of power lines against pressure surges due to atmospheric or other causes is a very important matter.

It is well known that the connection of an underground cable with an overhead line constitutes a special danger to the cable from atmospheric discharges. To protect the cable efficiently in such a case is not an easy problem, but a solution of the difficulty has been found and put into practice by our member, Mr. Semenza, of Milan. Originally, a large amount of the power required in the town had been brought from Paderno by overhead line right up to the sub-station in Porta Volta, but owing to the growth of the town it had been found necessary to stop short with the overhead line some distance outside Milan and use cables for the approach to the sub-station. Since the power for lighting, tramways, and industrial purposes has mainly to be transmitted through these cables, their protection is a matter of vital importance, and has been provided for by a kind of gigantic Faraday cage surrounding the point where the overhead lines are connected to the cables by transformers, The transformers, switches, lightning protectors, and accessory electrical appliances are placed in a large building which acts in the manner of a Faraday cage. The iron parts of the structure are earthed, the roof and the window-frames are of iron, and under the plastering of the walls there is iron netting. A direct metallic connection between the overhead line and the cage would, of course, give absolute protection to the contents and the cable, but this would be inadmissible, as thereby the whole of the lines would be earthed. The problem then was to find an arrangement which would give the protection of a direct connection without actually making it. This problem Mr. Semenza has solved in an ingenious manner by making use of resonant circuits. The frequency of a lightning discharge may be anything between 20,000 and 10 millions. If, then, a capacity and inductance tuned to any of these frequencies are placed in series and connected to line and cage, a current of that particular frequency will flow to earth as if the connection were direct. Even if the frequency were only approximately that to which the set was tuned, the reactance would not be excessive and the protection would be sufficient. Thus a set tuned to 1 million frequency would at 10 million frequency have a reactance of 158 ohms and at 100,000 frequency a reactance of 165 ohms. A set tuned to 100,000 frequency would at 20,000 frequency have a reactance of 192 ohms. A set for 1 million frequency may conveniently be formed of two Moscicki condensers in parallel, having together a capacity of 0·01 mf. and an inductance of 2·54 microhenry. The latter is obtained by two turns of 2 mm. copper wire 50 cm. in diameter. A set for 100,000 frequency would require 8 condensers in parallel and a coil of ten turns. For the ordinary working frequencies up to 50 either set has, of course, a practically infinite reactance, that is to say, it has no effect on the power current.

I must refer to another recent invention, the object of which is the prevention of the infiltration of high-pressure current into low-pressure lines. The danger of a short or a leak between high and low-pressure circuits does not lie in the transformer. This can be made absolutely safe; but the switches and leads to the transformer, and especially the outside lines where there are miles of them, are a source of danger. A broken wire or a branch of a tree blown across two lines by the wind are possibilities from which no excellence of workmanship can guard us. Some means should, therefore, always be provided to cut off the current automatically in the low-pressure circuit as soon as its potential to earth exceeds a predetermined limit. Such an instrument was perfected last year by Mr. Arcioni, of Milan, and is now being gradually taken up on the Continent. The essential parts are three electromagnets with shaded poles connected star fashion, with the centre point earthed, to the three wires of the low-pressure system. In front of the poles are the three legs of a star disc mounted on a counter weighted spindle. As long as the three wires have normal potential difference to earth the torque exerted by the shaded poles is insufficient to raise the weight, but if through in filtration of high pressure the electrical centre is displaced the torque increases, the weight is raised and makes contact in a relay circuit, which then trips the main switch. If the weight is adjusted to rise at double normal torque the apparatus also acts if one of the low-pressure wires should go to earth.

The commercial development of electric power distribution on a large scale in this country by companies established for this purpose may be said to have begun with the present century. The supply of power current from central stations is, of course, much older, but these undertakings, whether private or municipal, are working under "provisional order," and are supplying electricity over restricted areas for lighting and other purposes, power included. If customers are found ready to take large parcels of power they are a welcome addition to the general business, but it is not the main object with which the central station has been started. I exclude, therefore, such works and confine my attention to companies who work under so-called "Power" Acts, and whose main object is to supply power in large parcels to important industrial undertakings within a wide area. Of such companies there are now over a dozen at work in this country.

The public generally, and even some engineers, are still

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under the impression that a country of abundant water power offers better opportunities for electric power distribution than a country of cheap coal, but that this is in reality not so is demonstrated by the great development which power supply has reached in this country. In the country of waterfalls industries have to be introduced in order to utilise the power made available through electric transmission, whilst in the coal country highly developed industries of different kinds are already there. As regards capital outlay the advantage lies generally with the thermal station, quite apart from the extra cost of a steam reserve, which, for at least part of the power, in many cases is unavoidable. This drawback may be compensated by a very high load factor, such as is obtainable when the current is used in electrochemical processes, but with the load factor ruling in other industries the energy costs less in the country of cheap coal than in the country of abundant water power. If, then, we speak of the cheap water power of Swiss and Italian hydro-electric works, we do not mean that those works can produce power more cheaply than English thermal stations, but that they can produce it more cheaply than if they had to use imported coal.

The use of electricity for the propulsion of strain is so wide a subject that I am compelled to restrict my remarks to its latest phase, the use of alternating currents. I am quite aware that there are some enthusiastic adherents to the direct-current system who recommend working main lines by overhead wire at some 3,000 volts, but the majority of practical men hold that alternating current in some form or other must be the means to supply power to the traction motor. The only question on which there may be still difference of opinion is whether the current shall be 3-phase or single-phase. Electricians prefer the former, railway men the latter mainly on account of the greater simplicity of the overhead work. As the railway men are in reality the customers who give the order to the electrical engineer, it seems likely that the single-phase system will be the one more generally adopted; and indeed a very respectable beginning has within the last four years already been made on the Continent. From detailed tables kindly supplied to me by two of the largest electrical engineering firms in Germany, namely, Messrs. Siemens-Schuckert Werke and the Allgemeine Elektricitäts Gesellschaft, I find that each has up to the present either supplied or on order single-phase electric motor coaches and locomotives aggregating, on the 1-hour rating, over 50,000 h.p. Compared to these figures our own achievements in single-phase traction look rather small. Beyond the Morecambe-Heysham line, which has been in successful operation for some time, and the Victoria-London Bridge line which is about to be completed, we have nothing to show in this direction.

In Italy considerable progress is also being made. The Government have decided to electrify 11 sections on the State Railways, aggregating 337 miles of track, but on the 3-phase system. Thus the battle of the phases is still undecided. The decision of the Italian State Railways to use 3-phases, whilst in Germany, Austria, England, Sweden, and America the single-phase system is preferred, is highly interesting.

In Switzerland the Federal Government appointed some years ago a committee of electrical and railway engineers to report generally on the question of electrifying the Swiss railways. The first report dealt with the amount of power required, and urged the Government to secure water-power rights in time. The average power was estimated at 100,000, and that at peak time at 500,000 h.p. In a second report some standards as to weight and speed of trains, acceleration, horse-power required in starting and running, time interval between trains, and other matters connected with the future electrical service were suggested, whilst a third report dealt with the question of a standard frequency; but on the question whether the single or the 3-phase system is to be chosen the committee has not yet pronounced an opinion. From private conversations I have had with Swiss railway men, I incline to the belief that the decision will be in favour of the single-phase system, especially since by the use of the Deri type of motor it has been found possible greatly to simplify and also lighten the accessory equipment. The first test of this motor for traction was made on the 3-phase Engelberg railway, one phase

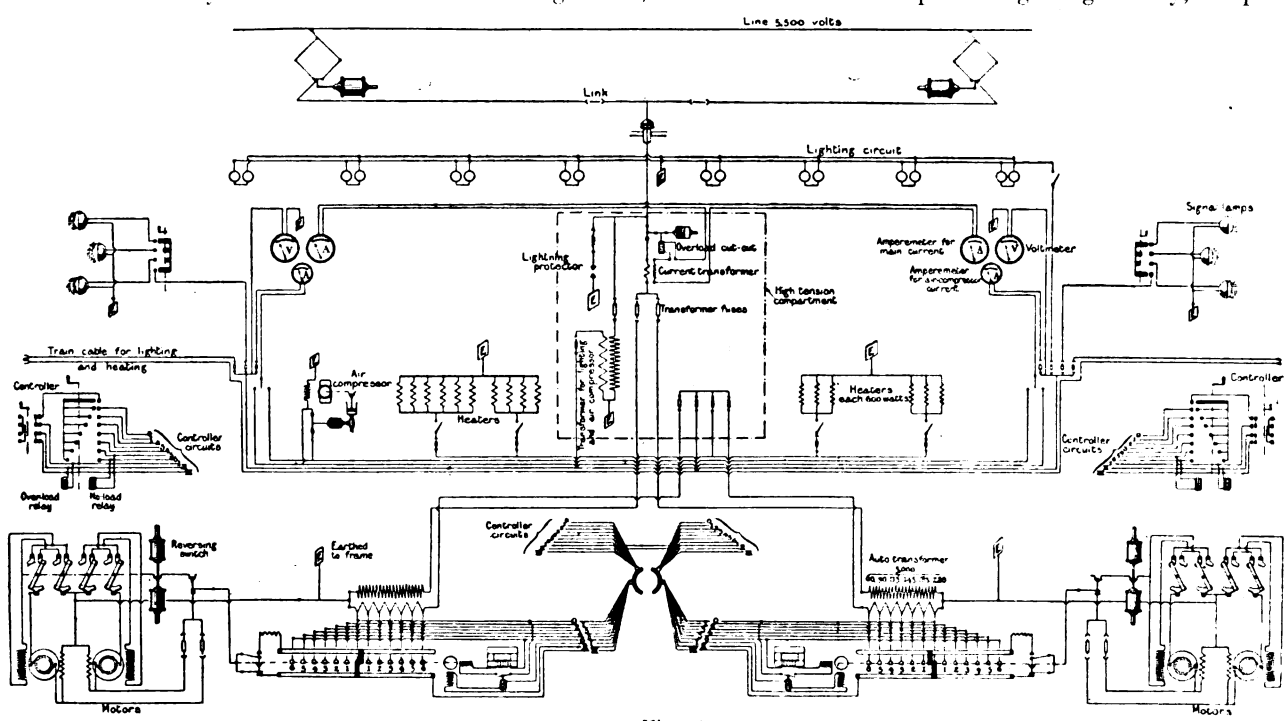

Fig. 5.

only being used. No resistances, auto-transformers, contactors, regulating switches, or controllers of the usual construction are required. The starting and the regulation of the tractive force and speed is effected simply by shifting the brushes. Thus all the driver has to do is to attend to a hand-wheel, whose motion is transmitted to the brush rockers by positive mechanical gearing. A glance at the diagrams, Figs. 6 and 7, will show how great is the simplification of equipment resulting from the use of the Deri motor instead of the ordinary compensated series motor. Fig. 6 shows the equipment of the motor coaches on the Seethalbahn running from Lucerne to Wildegg, a distance of 59 km. This line has been electrified by Messrs. Brown-Boveri, to whom I am indebted for the diagrams. Fig. 7 shows the equivalent equipment worked out by the same firm for Deri motors.

I have mentioned a moment ago that the Swiss committee has come to a conclusion as regards a standard frequency. Comparative estimates made for 15 and 25 periods and for single-phase working have shown a saving for the lower periodicity for the rolling stock and line as regards weight and cost, but an increase as regards generating and transforming plant. On the whole the balance is slightly in favour of the lower periodicity, and as this has also been already adopted in the South of Germany and in Italy the committee recommends 15 periods as a standard, with a

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latitude of 10% up and down. This latitude is recommended in order to give existing power works, whose frequency lies generally between 40 and 50, an opportunity to supply traction current by means of frequency changers having a ratio of 3 to 1. Thus a works supplying its other customers with current at 50 periods would supply the railway with current at 50/3 = 16⅔, and a 40-period station could supply current at 13⅓ frequency.

I take these two subjects together because the conditions under which electric driving is applied in both cases are more or less similar. Not only is the average demand for power large, but the maxima are large as compared to the average; the demand is intermittent; the pauses are short; the motion has to be reversed very quickly, and the torque the motor has to exert is at times very large. To meet these requirements many special systems have been devised, but all of them make use of two broad principles, namely, the use of a flywheel as a store of energy, and some means whereby the direct-current voltage supplied to the armature of the motor may be varied without sensibly diminishing the total power supplied to the armature. In some early applications of electricity to winding engines secondary batteries have been used as store of energy instead of a flywheel, but the cost of these, and the difficulties of keeping the contacts of the tapping-off switches in order, have prevented a general introduction of this system. Dynamic storage in some such way as first applied by Ilgner to winding engines, and voltage regulation on what may broadly be called the Ward-Leonard system, have made it possible to satisfy the very severe conditions under which winding engines and rolling mills have to work. In some special cases winding engines are driven direct by 3-phase motor, but the motor to which a reversing rolling mill is mechanically coupled is necessarily a direct-current machine. The motor which supplies power to the variable-voltage generator may be either a direct-current or an alternating-current motor. To make the flywheel effective there must be speed variation. Where the original source of power is continuous current, this is, of course, easily obtained without loss of energy. Where 3-phase current is the source of power the usual method is to employ a slip-ring motor and some automatic device for inserting and withdrawing resistance in the rotor circuit, but this means some loss of energy, and for this reason the speed range of the flywheel is generally made smaller than with a direct-current plant. It is, however, possible also in the case of 3-phase plant to avoid the loss of energy in regulating resistances by adopting some kind of cascade working. Such an arrangement has been worked out about a year ago by Messrs. Brown-Boveri. The variable rotor resistances are replaced by a direct-current armature working in a 3-phase stator, and the power developed mechanically by this armature may either be added mechanically to that of the 3-phase motor, or electrically to the supply circuit. In the latter case an additional generator is, of course, required. A good example of modern English practice in direct-current rolling-mill electrification is the plant supplied by the Electric Construction Co., Ltd., of Wolverhampton, to the steel works of Sir Alfred Hickman, Ltd., of Bilston. The makers have given me the following particulars: The flywheel set consists of a 2,000 h.p. direct-current motor, two 28-ton flywheels and two generators capable of giving any voltage between −1,000 and +1,000 volts. The excitation of the motor is adjusted automatically so as to produce a speed variation of the flywheels between 290 and 350 r.p.m. The energy given out when dropping from the higher to the lower speed is 46,000 h.p. seconds. This set supplies power to a cogging and a barring mill. The cogging mill motor works a 30-in. mill, and when cogging down ingots of 3 tons weight has to develop 4,800 h.p., and for 2-second periods once an hour 9,600 h.p. The barring mill motor works a 24-in. mill, and has to develop 6,000 h.p., and for 2-second periods once an hour, 12,000 h.p. The maximum speed is 120 r.p.m., and the time occupied in reversing from maximum speed in one direction to that in the other direction is 6 seconds. As an example of a reversible mill driven by 3-phase current I take that supplied by the British Thomson-Houston Co., Ltd., to Messrs. Dorman, Long & Co., Ltd. It is a cogging mill with rolls 28-in. centres, and the normal speed is 70, the maximum speed 90 r.p.m. The flywheel set consists of a 3-phase 950 h.p. non-synchronous motor, coupled to a 1,000 kw. 400 volt direct current generator and a 30-ton flywheel. The speed limits are 400 and 480 r.p.m., and the maximum peripheral speed of the flywheel is 295 ft. per sec. The mill motor is rated at 1,200 h.p., and has an overload capacity for short periods of 3,600 h.p. The time required for reversing from full speed in one direction to full speed in the other direction is 4 sec. The mill deals with 1,800-lb. billets 12 in. sq., reducing them to 3-in. sq. bars in 14 passes. The output is 15 tons per hour.

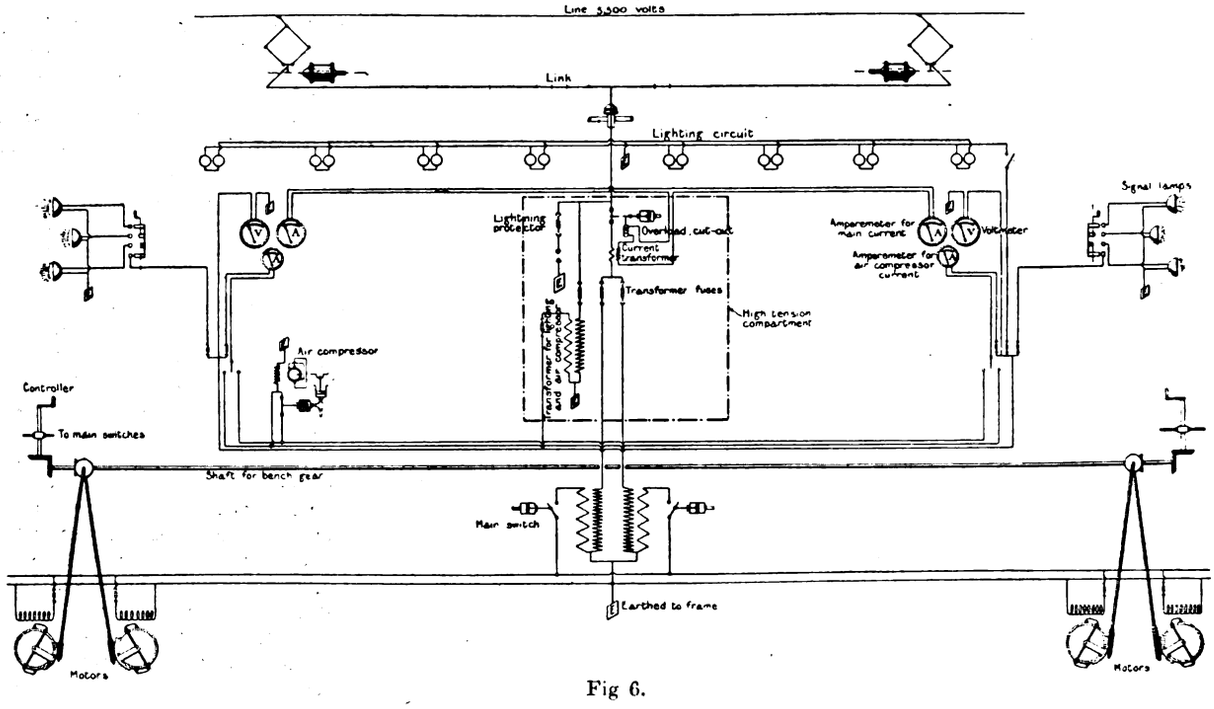

Fig 6.

The reduction of iron ore by heat applied electrically has not yet advanced much beyond the experimental state. A plant for the electric production of iron direct from the ore has been erected in Domnarfvet, Sweden—[This was described in the ELECTRICAL ENGINEER, October 1 and 29, 1909]—but the production is only about 6 tons a day. The saving of two-thirds of a ton of coke represents the commercial advantage of electric reduction of ore, and against this must be set the cost of energy. This process could only be successful in a country where electrical energy is exceedingly cheap and fuel very dear.

When we come to the manufacture of steel from pig or the refining of steel the outlook is far more hopeful; in fact, the experimental stage has long been passed and the practical results obtained are eminently satisfactory, not

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only in a technical, but also in a commercial sense. Even where, owing to the price of power, the electric process is no cheaper than the thermic process, the former enables the steel refiner to achieve results with certainty and regularity which under the old methods are hardly attainable at all, or only, so to say, by good luck.

The electric furnace for steel making and steel refining is now an important accessory in steel works, and thousands of tons of steel are produced annually, both in furnaces of the arc and in those of the induction type. Mr. Kershaw states that in England and the Continent there are between thirty and forty such plants in regular commercial operation, and gives a list of the more important steel works using electric furnaces.

Of the many methods devised for fixing atmospheric nitrogen with the object of producing a fertiliser to replace Chili saltpetre, I can only refer to two which have attained considerable importance. The two methods to which I refer here are: (1) The Birkeland-Eyde system, first introduced in Norway; (2) Frank-Caro system, first introduced in Italy.

I must mention a new process for the production of nitrous compounds, which is the invention of Messrs. Schoenherr and Heszberger, and is being introduced on a large scale in Norway by the Badische Anilin und Sodafabrik. In this process air is passed through an iron tube in which an alternating current arc of 5 metre length is maintained under a pressure of 4,200 volts. The air enters one end of the tube by a series of tangential holes, and the rotary motion thus produced keeps the arc confined to the axis of the tube. Each arc absorbs 600 h.p. The inventors claim a greater yield of fixed nitrogen than is obtainable under the Birkeland-Eyde method, and a compound richer in nitrogen—namely, 18% against 13%. The owners of the patents who have pooled their interests with the Norwegian Nitrogen Co. propose to erect large works in the western parts of Norway, utilising about 400,000 h.p.

It is not necessary to refer in detail to the use of electric motors for driving agricultural machinery on the field and in the farm, but it might be of interest to briefly glance at a new development in the application of electricity for the promotion of the growth of plants. The discovery that electrification of the atmosphere immediately above the plant stimulates in certain cases its growth, is already thirty years old, but only recently has this idea been practically developed—first by Professor Lemström in Sweden, and more recently still by Sir Oliver Lodge, in collaboration with Mr. J. E. Newman and Mr. R. Bomford, on an experimental farm at Bitton, Glos., and on a farm of about 40 acres at Evesham, near Birmingham, and at other places. A network of galvanised iron wires is stretched over the field to be treated and suspended 18 ft. from the ground from wooden posts and oil insulators. The posts are placed 70 yds. apart, so that about one post per acre is required. The network consists of No. 11 S.W.G. wire placed over the posts in parallel rows 100 yds. apart, and No. 20 S.W.G. wire cross-connecting the stouter wires every 10 yds. The attachment of the latter to the insulators is not direct, but by means of short links and tension insulators to reduce the electrical stress on the insulator itself. The network is positively electrified to from 60,000 to 100,000 volts by means of an induction-coil mercury gas break and Lodge rectifying vacuum valves. The induction coil is worked on the primary side by continuous current obtained from an ordinary dynamo. Mr. Lionel Lodge, who is the electrical expert for the various installations, informs me that there is no difficulty in keeping the potential in the network up to the figures given except in misty weather or during rain, when it may fall as low as 20,000 volts; also that the amount of primary power required per acre is very small, namely, from 10 to 20 watts. The installation is run for five or six months during eight to ten hours each day, and the total expenditure of energy is only about 20 B.O.T. units per annum per acre. Under this treatment the increase in the yield per acre is about 30%, but under certain conditions it may be even more. The system is in use on several farms in this country, on six farms in Germany, and on one farm in Holland.

In the time at my disposal I have only been able to refer to a few of the industries which have benefitted by the application of electricity; but when one reflects that nearly every industry in the country has been, or might be, furthered by the use of electricity in one form or another one comes to see that an enormous field of useful work is open to the electrical engineer—not only useful to himself, but even more so to the interests that employ him. How, then, comes it that electrical engineering is not as prosperous as it might be? Some of our members say, because we are backward as compared with our foreign competitors. If by that term they mean that our electrical engineering works cannot produce equally good plant as our rivals, I cannot agree. I have frequently visited continental shops, and, although I am quite willing to admit that excellent work is done there, I am also convinced that British shops can turn out work equally well and generally at a slightly lower prime cost. There is certainly no justification in reproaching the makers of electrical plant with backwardness; and, moreover, it is bad business policy. If, however, the reproach is levelled against the potential users of such plant there is some justification, and also a reason. Our great staple industries are old-established and have been fairly prosperous for generations; those on the Continent are of recent growth, and had to struggle into existence against English competition. To become successful they had to adopt every improvement which science put at their disposal. With them the application of electricity is almost a vital matter; with us only a desirable improvement. Is it, then, to be wondered at if a works manager or owner, who has grown up in the pre-electric days, and has been doing a prosperous business ever since, should be rather slow in embarking in new methods of working which, to his thinking, might entail the possibility of risk and the certainty of greater mental exertion? There are, of course, exceptions; and a good many of them, as witnessed by the great strides which electrical methods applied to our staple industries have already made; but, compared to what the development might be, we must admit that we have as yet only touched the fringe of this vast field. There is progress, but it is not fast enough, and to accelerate it we must educate the potential users of electrical plant. A beginning in this direction has already been made by the managers of electric light stations. They are educating the householder by local exhibitions and literature that he can understand. On the Continent every large electrical engineering firm has a literary department whose business it is to educate possible customers. No sooner is a new winding plant started, or a cotton mill electrically equipped, than well-written, well-printed, and beautifully illustrated leaflets are sent out into the world to tell possible clients of the work done by the firm. Here, such literary departments are the exception; and thus it comes about that we hear so much about the great advances made on the Continent and so little about equally good work done here.

Our Institution can also do something to accelerate the introduction of electricity into our great industries. It is, no doubt, very useful if we in our meetings read highly technical papers, and thus educate each other; but this is only part of our work. The other part is to educate the customer, and for this purpose we possess in our organisation of local sections the requisite machinery. By arranging for papers which shall be of interest to the particular industries carried on in the district of each local section, our Institution can further the adoption of electricity in these industries, and this will not only be to our own advantage, but even more so to the advantage of those whom we serve.

MOTOR EXHIBITION AT OLYMPIA.

Electric cars and accessories have attracted a large share of attention at the Motor Exhibition at Olympia, which closes on the 20th inst. Touring cars and electric run-abouts are shown by the Electric Vehicle Co., Ltd., and many other firms display cars fitted with the latest electrical equipment. In the large gallery there is a remarkably good collection of exhibits of electrical appliances for motor cars, speed indicators, improvements in coils, contact breakers, etc. The new Hall E.I.C. dual ignition system, the Lodge patent system of ignition, the Mira Electric horn, lithanode accumulators, the La Magicienne dynamo for lighting motor cars, Warner's speedometer, the Wimperis Accelerator and gradient measurer, and a great variety of other accessories are shown.

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ADVANCE IN A QUARTER OF A CENTURY.*

By E. GEORGE TIDD, M.I.E.E.

It is 25 years since I joined the Institution, and I propose to consider the progress made during this period. Electric lighting in Glasgow dates back to 1877, when an arc lamp was shown alight in a restaurant, the energy being supplied by a primary battery. In the same year a railway station was lit with arc lamps, but the first permanent plant was put down in 1880 to light Queen-street railway station, when both arc and incandescent lamps were used.

In 1899 Local Sections of the Institution were started. Starting with a membership of 158 in 1900, the Glasgow Local Section has now 305 members on the roll. In 1886 the parent Institution had 1,330 members, to-day it has 6,117 members of all classes.

With regard to telegraph work, the first installation was laid down in 1837, the first company was formed in 1846, and in 1880 the State took over the business of 30 odd companies. The number of telegraphic messages has increased from 33,278,459 in 1884 to 85,969,000 in 1908. The competition of the telephone is seen in the fact that the number of telegrams in 1902 was 92,471,000, as against the lower figure for 1908. In connection with submarine cables, the business has increased from 23 undertakings with a capital of £31,103,254 in 1896, to 34 undertakings with a capital of £36,283,938 in 1909.

Signor Marconi brought out the first practicable system of wireless telegraphy in 1895, and a company to exploit this was formed in 1900. Of the other nine systems of wireless telegraphy the best known is the "De Forest." In 1906–7 the Post Office transmitted 16,993 Marconi-grams, and in the following year the number was 21,792. Of the 186 commercial stations for wireless telegraphy, 63 are "Marconi." Last year there were 152 wireless stations in the United Kingdom, and these transmitted 2,000,000 words.

With reference to the development of telephony, in Glasgow a system of unification between the exchanges of the National Co. and Post Office is being carried out, and this will be nearly completed by 1911, when the Post Office comes to take over the National Telephone Co.

Dealing with the history of electricity supply, the Act of 1882 proved such a hindrance to the growth of the industry that from 1884 to 1888 there was only one provisional order granted. The 1888 Act, with much less onerous conditions, gave a new impetus to electrical undertakings, and between 1888 and 1906, 103 provisional orders were granted to 159 local authorities, and electricity supply in Glasgow has grown by leaps and bounds, until to-day, with an aggregate of some 40,000 h.p., the two large power houses of the Electricity Department are practically full.

Referring to electric traction, there were in 1896 only 473 miles of electric tramways in Britain, as compared with 12,000 miles in the United States. The overhead trolley system continues to be the standard. The capital invested in electric tramways in the United Kingdom at present is £68,199,918. The tendency is for cities to have their trams under the municipality, while suburban districts are mostly served by companies. There are 180½ miles of track at present in Glasgow, representing 13,000 h.p. of plant.

It was not till 1904 that a forward movement was made with electric railways, the Southport line of the Lancashire and Yorkshire Railway opening 82 miles of track, and the North-Eastern Railway a similar length on the Tyneside line. In 1905 the Metropolitan and District Railway opened over 200 miles of track for traffic. The self-propulsion of vehicles by electricity is still in a very backward state. A move is being made to utilise a petrol engine to drive a dynamo, the latter driving a motor, and some such system might come to be used in connection with railway work.

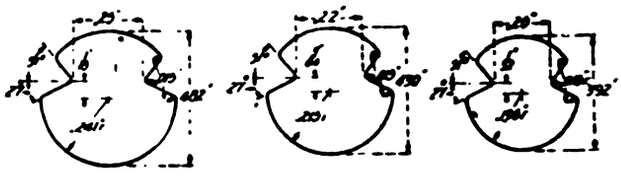
With regard to manufacture, this is put on the right basis by the recognition of the fact that sound mechanical engineering is the foundation of all good electrical machinery. Specialization has also been the means of greatly improving electrical apparatus. Coincident with the improvement in fittings, there has taken place a great cheapening of electric installations. Some of the earliest lighting installations were found on board ship, owing to the obvious advantages of electricity under seagoing conditions. In the Navy even greater use is made of electrical energy. Among the purposes to which it is applied may be mentioned ship and engine ventilation, coaling winches, boat hoists, capstans, pumping and refrigerating machinery, air compressors, ammunition hoists, passenger lifts, tool driving transforming energy for searchlights and telephone work, voice pipe and cabin bells, gun and torpedo firing and instruments for the transmission of order to the guns; it is also used for heating, cooking, X-Ray apparatus, wireless telegraphy, stoking indicators, helm indicators, etc., etc.

In 1896 electrical manufacturers engaged a total capital of 6½ millions sterling; in 1909 this figure had risen to 87 millions. The total capital invested in all kinds of electrical work was 61 millions in 1896, and 386 millions in 1909.

* Chairman's Inaugural Address, Glasgow Local Section, Nov. 16, 1909.

COPPER WIRE STANDARDISATION.

In our issue of October 8 we gave particulars of the proposed Standard Specifications for hard-drawn copper wire issued by the Wire Committee of the American Society for Testing Materials. These referred to (1) hard-drawn copper wire, (2) hard-drawn round wire, and (3) hard-drawn wire for cables or strands. We now give below the specification for



Proposed Standard Sections for Grooved Trolley Wire.

GROOVED TROLLEY WIRE.

10. Standard sections shall be those known as the "American Standard" grooved trolley wire sections, the shape and dimensions of which are as follows:

11. (a) Size shall be expressed as the area of cross-section in circular mils, the standard sizes being as follows:

211,600 c. m., weighing 3,386 lbs. per mile.
168,100 c. m., weighing 2,690 lbs. per mile.
133,200 c. m., weighing 2,132 lbs. per mile.

(b) Grooved trolley wire may vary 4% over or under in weight per unit length from standard, as determined from the nominal cross-section.

12. The physical tests shall be made in the same manner as those upon round wire. The tensile strength of grooved wire shall be at least 95% of that required for round wire of the same sectional area; the elongation shall be the same as that required for round wire of the same sectional area.

13. The requirements for electric conductivity shall be the same as those for round wire of the same sectional area.

ENGINEERING PROSPECTS IN IRELAND.

In his address to the Institution of Civil Engineers of Ireland, at a meeting at Dublin, Mr. George Murray Ross, President, said that the syllabus was prepared and the papers marked with due attention to the fact that the by-laws recognised mechanical and electrical engineers. As regards the prospect of work for young engineers, although the openings in Ireland were not very great, still there was a wide field even at home for what might be called municipal engineering. Abroad the prospect for the engineer was encouraging. He went on to observe that in electrical engineering, the improvement of the filament lamp has revolutionised the electric lighting industry in a similar manner to what the incandescent gas mantle had changed the aspect of the gas industry. For power purposes electricity was in increasing demand, replacing in their factories the belts and shafting of a few years ago, and their tramways and railways were now driven by electric power.

THE ELECTROLYSIS DIFFICULTY.

As a solution of the electrolysis difficulty, the British Columbia Electric Railway propose to instal a negative feeder to which the water mains will be bonded. Under the present system, bonds connect the mains with the street railway tracks.

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THE

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CONTENTS.

	PAGE
Notes	711
Steam Turbines as Applied to Marine Propulsion	712
Audible Tramway Signals	712
Institution of Electrical Engineers	713
Motor Exhibition at Olympia	719
Advance in a Quarter of a Century	720
Copper Wire Standardisation	720
Engineering Prospects in Ireland	720
Electric Smelting of Zinc	721
Correspondence	722
Electrical Propulsion of Warships	723
Congress of Radiology and Electricity	724
Wimbledon Electric Exhibition	724
Three Indication Block Instruments	725
Electric Show Rooms	726
Submarine Safety Signals	726
All-Motor Fire Station at Charlton	726
A Canadian Branch	726
Extension of Premises	726
Use of Electricity in Mines	726
Central Station Economies	727
Shop Testing: Direct and Alternating Machinery	728
Tyneside Notes	732
Midland Notes	732
Lancashire Notes	733
American Notes	733
German Notes	735
Lighting & General Notes	736
Traction Notes	737
Personal	737
Companies' Meetings and Reports	737
Companies Registered	737
Contracts Open	738
Some Contracts	738
Tenders Accepted	738
Postal Telegraphs and Telephones	739
Electrical Opportunities in Turkey	739
Diary	739
Patents	740
Companies' Stock & Share List	742

ELECTRIC SMELTING OF ZINC.

There are so many hygienic disadvantages connected with the manufacture and uses of oxide of lead that there is a wide tendency to replace it, at all events as a white pigment, or as a basis for paint manufacture, by oxide of zinc, which is practically non-toxic. Indeed, in France a law has been passed which totally forbids the use of white lead and litharge, both for outdoor and indoor painting within a certain date. Moreover, the oxide of zinc retains its bright white colour far better than lead, which is so easily blackened by even slight sulphurous fumes. Under these circumstances, zinc oxide is rapidly finding a wide demand. By far the largest proportion of the oxide is produced by an American patent process, which is worked not only in the States but in England and in many countries on the Continent. There have, however, been attempts to find some other equally cheap and efficient and rather more rapid process. The problem seems to have been solved in France by Messrs. E. F. Côte and P. Pierron, who produce the oxide direct from all forms of ore in a special electric furnace. The process appears so simple and efficient that it deserves the attention of British electricians and mining engineers. One immense advantage of the Côte-Pierron system is that even complex zinc ores containing a high percentage of lead in the form of PbS can be treated with success, the lead being completely separated with ease. After considerable experimentation both at Lyons and in the Pyrenees with different shaped furnaces and various kinds of electrodes, definite patterns were adopted, and the Société des Fonderies Electriques was formed to take over and work the process. A hydro-electric station in the Pyrenees is the present headquarters. The furnace is cylindrical in form, the base being a graphite crucible enclosed in sheet metal, the arched dome being of magnesia

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bricks, encased in refractory fire-bricks and the metal sheeting. One electrode, which moves up and down, descends from the dome to meet a projection connected with the opposite pole imbedded in the bottom of the crucible. On the top part of the furnace in front is a depression, leading to a funnel giving access to the interior. This depression is used for drying a charge of ore before it is admitted into the furnace by opening the funnel. If the metal form of zinc is required, the ore is mixed with iron, the reaction obtained being $ZnS + Fe = Zn + FeS$. But where a pure oxide for pigmentary purposes is required, free from iron, lime and carbon (the lime both as a flux and for reaction) are used, and then the reaction is $ZnS + CaO + C = CO + CaS + Zn$. When the charge is in and the funnel closed, the upper electrode is lowered and an intense heat is produced, though the mass of blende is only melted by contact with the electrodes, and not by the passing of electricity through the mass itself. In this process the lead falls to the bottom, and is allowed to escape through a pipe at the bottom of the crucible. The zinc itself is vapourised, and passes through an outlet towards the top of the dome, then downwards through a channel, and so into a cylindrical condensing chamber, filled with carbon and lime nodules, heated to red heat by an auxiliary electrode. The vapour passes out at a temperature of between 1,200°C. and 1,300°C. In order to procure perfect condensation, care has to be taken to regulate the temperature of the carbon and the rate at which the vapour is produced. If the carbon is too cold, condensation is too rapid, and the effect is bad; if too hot, the vapour passes quickly without giving up all its metallic contents. If all goes well, the zinc condensing on the carbon nodules trickles down to the bottom, and is there drawn off. In this way zinc oxide is produced rapidly, and without loss; it is pure, of excellent colour, and readily fetches a good price. During a trial run of 600 hours, 28,345 kilos of zinc blende were smelted, and for this purpose there were required 12,384 kilos of lime (both for flux and reaction) and 3,146 kilos of carbon. The current used was 3,800 amp. at 42v., with a power factor of 0·85. The possible amount of oxide obtainable was 13,193 kilos, the actual amount 12,370 kilos. Certainly a remarkable result. On analysis the oxide was found to contain between 98·6 and 99% of pure oxide of zinc, about 0·4 of moisture, 0·3 of iron, and from 0·5 to 0·7 of silica and other metals. The content of zinc in the slag and calcium sulphide ranged between 1·2 and 1·8%. It was found that both electrodes and the magnesia bricks resisted well, the latter required to be replaced only every two months. The cost of manufacturing the 12,370 kilos of oxide was close upon £184, and the price received a little over £244. Economies in manufacture are, however, quite possible if carried out on a larger scale, when electrodes could be made at the factory, and the establishment charges reduced. In any case, the results have been so far satisfactory that extensions are taking place, and we may see here a further and, very promising, advance in the application of electric furnace practice.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "THE EDITOR, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

LIGHTNING CONDUCTORS.

Sir,—As one deeply interested in the subject of lightning conductors, and familiar with the literature dealing with the subject, I have read with pleasure the note in your edition of October 1, 1909, and the subsequent remarks made by Mr. Alfred Hands, A. W. P., and Mr. W. Dalby, of Sparkhill, Birmingham.

I do not intend entering into the discussion as to value of, and methods employed, in preparing the report of the Lightning Research Committee—leaving that to Mr. Hands—but I have no hesitation in saying that the result of its publication has been to weaken the faith of many architects and property owners, in the security offered by lightning conductors.

And yet, without troubling about iron or copper for the conductor, the zig-zagged path, etc., there is no question as to the protection afforded by a conductor erected on sound, practical ideas by a competent engineer, and thoroughly examined and tested for continuity, and earth resistance, periodically.

In spite of the remarkable diminution of the damage caused by lightning, owing to the introduction of conductors and protectors, as stated by Sir Wm. Preece before the Institution of Electrical Engineers in 1889, there is no question that a large number of so-called protectors are unsatisfactory; as, even supposing they were all right when erected—probably many years ago—they have never been tested or even examined.

As an illustration of the work often met with, I may mention the case of a conductor on a church in Worcestershire I was called in to test.

The copper tape coming down the side of the tower, near which a footpath lead to the back of the church, was run into an iron pipe, which was fixed to the side of the tower, one end being inserted a few inches in the ground, and the other being some 5 ft. above the surface of the earth.

On making the examination, I found that the copper conductor terminated about 5 in. inside the iron pipe, and could be pulled out without the least trouble. Evidently the person who erected the *conductor?* (probably a plumber) based his idea of an earth connection upon an ordinary down spout for rain water. This is by no means an isolated case.

Yours faithfully,

W. H. WHITEHOUSE, M.I.E.E.

Charlcote, Graveley Hill, Birmingham.

QUESTION NO. 1205.

Sir,—I have just read the answer to the above by S.M.P. I hope the questioner will be very careful how he follows out the advice, otherwise I am afraid he will be in further difficulties.

S. M. P. states that "when D is run as a motor its field connections must be reversed in order to preserve the same direction of rotation." Now, this machine D is obviously a shunt dynamo, so as S.M.P. ought to know, by reversing the field the direction of rotation is also reversed, because a shunt machine will run in the same direction as a motor or dynamo, provided the same terminals are taken as positive and negative in each case.

When the engineer starts up the motor he will find that instead of helping the turbine as required it will be working against it; again, if he tries to bring the field down to zero while the machine is running and connected to the bus bars, he will find that by the time there is no field there will be no armature.

I should like to know if the case with an excellent load factor works on this principle.

If all the machines are running with the battery on charge, and it is found necessary to drive the alternator all that is necessary is to weaken the field of D to take off the load, then by further weakening the field it will take up a share of the driving with the turbine.

W. DANCER.

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ELECTRICAL PROPULSION OF WARSHIPS.*

By Engineer Vice-Admiral H. J. ORAM, C.B.,
Engineer-in-Chief of the Fleet.

The propelling machinery fitted on board our warships must be the best available; the Admiralty are always on the look-out for improvements, and they take note of everything suggested which may appear to have the probable effect of adding to efficiency, although they cannot afford to experiment on the machinery and boilers of our large warships. It is advantageous, therefore, that the question as to whether we are getting this best should be brought under review from time to time. I think it may be fairly claimed that we are, and that there is nothing better or more suitable for Naval purposes at present than the machinery recently fitted in the British Navy.

I shall briefly refer, however, to the competing systems for marine propulsion which claim to be suitable for that purpose. There is first the gas engine, which has been before us for many years; the oil engine, which for certain classes of ships is a competing propelling agent; the proposal to interpose between the engine and propeller, electrical machines for obtaining certain benefits, and for securing increased economy; and there are others. This electrical proposal, however, refers only to the means of transmitting the power generated and does not alter the type of engine.

The following remarks are made in the light of information at present available, but the conclusions stated are of course, not final, and any discussion which may result will be of value as tending to gradually clear up doubtful points. The good work being done by various engineers in working on these novel problems is recognised, and it is quite possible that future developments of these plans, and reliable information and experiments, may lead to modifications of present conclusions.

Referring to what is called the electrical propulsion of ships:—

An electrical drive has already been adopted in some ships of small power where the prime mover is an internal combustion engine, in order to overcome difficulties in starting, and to avoid complicating these engines with reversing gear. In one system, an electrical drive is adopted for reversing or slow speeds only; at other speeds, though the dynamo and motor are coupled to the engine shaft, no electricity is generated, and the internal combustion engine is working directly on the propeller. In this design the capacity of the dynamo and motor is limited to about one-half the power of the engine in order to save weight.

Since the introduction of turbine machinery in warships, proposals to supersede turbines directly coupled to the propeller shafting, by designs where electrical machinery is interposed between the turbines and the propellers, have been made several times.

The system, as proposed, consisted of the employment of economical turbines, at very high revolutions, similar to those in use on land electric light stations, with a dynamo and motor interposed between the turbine and shaft to reduce the speed of the latter to that which is most suitable from the propeller efficiency point of view. The turbines are always run in one direction and reversing can be effected by the change of the direction of the current at the motor.

The claims made for this system are that the loss due to the interposition of the dynamo and motor between the turbine and propeller shaft is more than counterbalanced by the gain due to the more economical steam consumption of high speed turbines, and that due to a higher propeller efficiency when working at more moderate speeds than is usual in ship turbine machinery.

It is also claimed that the radius of action of the ship will be increased due to an economy when working at low powers, dynamo machines being shut off altogether as required and the remainder worked at or near their economical power, and that although the high speed turbines and electrical machines are together heavier than the direct coupled turbines, this is more than compensated for by the lesser boiler power required, consequent on the higher efficiency of the fast running turbines and slower running propellers, so that a complete installation for the same speed of vessel is not only more economical, but no heavier. Further, that there would be an increased economy from working the auxiliary machinery by motors driven from the main generators.

The actual figures are the subject of considerable doubt and controversy, and would require much time for an adequate examination.

As regards economy at full power, it must be remembered that the claims are based on figures obtained from trials of electric light stations on shore, and it is somewhat doubtful if the same results will be obtainable when similar units are worked as a battery on board ship with the engines and boilers placed in from five to seven or even more separate water tight compartments.

It appears that the loss which results at the dynamo and motor is not less than 12%, so that not more than 88% of the shaft horse power given out by the turbine would be available as horse power at the propeller shaft.

The actual steam consumption in pounds per S.H.P. for the propelling turbines in the three ships of the "Indomitable" Class is only 12 lbs. at full power, and this without superheating. The figures guaranteed for the steam consumption of the electrical combination from experience in shore electric light installations were given in one case worked out in detail as 12·9 lbs. per B.H.P. at the propeller shaft without superheat, and 10·9 lbs. with 100° superheat, the vacuum being 28 in. It will be seen, therefore, that in the particular case of the cruisers mentioned, there is little margin of superiority at full power available for reduction of boiler power, even allowing for the probable improvement in economy of the electrical installation due to the larger units in these ships.

The claim to increased economy at low powers should be realised, as the generators then in use could be worked nearer their maximum output, but it must be remembered that the efficiency of the motor falls off with reduced powers, but the actual amount is doubtful. This feature of the system is the important one as regards machinery of warships. The claim as regards increased power for going astern is also justified.

As regards increased propeller efficiency, it must be remembered that the efficiency now obtained with the slower-runing propellers has been the result of many years' experience. The early turbine propellers had low efficiencies; experience has enabled these to be increased, but they do not yet reach the figures obtained with the slower running reciprocating engines. There is no doubt that as more experience with small fast-running propellers for such large powers as have only been recently introduced is obtained, the efficiency of the latter will be still further improved. In particular cases such as in the large cruisers of the "Invincible" Class, there has been no falling off in propeller efficiency of the faster running screws from efficiencies obtained in the slow revolution screws of older cruisers.

No doubt a large diameter propeller assists the manœuvring power of a ship, but the diameter is frequently limited by hull considerations, and electrically-driven ships, with the same number of propellers, driven slower, would in some cases be limited to practically the same dimensions as in direct-driven installations.

In one design in which the weights of the turbo-generator and motor were quoted, it was found that the increase of engine room weights would be considerable, and that the total increase of machinery weights would be about 15 to 20 %. The gain at low powers would require to be very substantial to balance such increases. The substitution of electric motors for auxiliary steam engines would also add to weight, and such auxiliary machinery as steering engines and distilling plant would for the present require to be steam-driven.

The electrical pressure proposed in the various plans, has varied from 1,000 volts in the lowest, to 2,750 volts in the highest, and these are all very high from the point of view of safety, for use in H.M. ships. Also, before any system could be adopted many necessary details would require to be carefully considered, such as freedom from danger of failure due to access of water to the electrical machines or to particular parts of them and the ventilation of the machines, as considerable heat is generated.

With the interposition of two electrical drives between the turbines and the propeller, in addition to special

* Inaugural address by the President, the Junior Institution of Engineers, London, Nov. 16.

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dynamos as exciters, it is not probable that the wear and tear would be less or that less staff would be required; but rather the reverse.

In the designs submitted to the Admiralty there has been no gain in the space occupied, but in some cases an increase.

It is essential for warship purposes that the small variations of speed required from the propellers when keeping station in a Fleet should be readily obtained, and in this respect the electrical systems which have been proposed to the Admiralty are far from satisfactory. The various firms have only proposed to provide for three electrical speeds, full, half, and quarter, and have suggested that if anything further were required that the speed of the generators should be regulated. This latter would detract from the economy of the system.

It is recognised that further attempts are being made to meet this condition, which is absolutely necessary as far as warships are concerned, provision for station keeping or the power of making gradual changes of speed throughout the whole range, both ahead and astern, being essential.

Finally, there appears to be considerable doubt as to the efficiencies of the various systems proposed, and the figures on which they are based, but speaking generally, the conclusion seems to be that the interposition of a dynamo and motor between the engine and its work, involving when on board ship considerable liability to accident and derangement of the electrical machines, in addition to present risks, has disadvantages such that the practicability of the details should be beyond question, and the gain by its adoption must be shown to be substantial before the system could be fitted in any important vessel. This has not, I think, been done at present. We must recognise, however, the skill and ingenuity with which this problem has been dealt with, and any further developments will naturally receive careful consideration, especially the actual results from installations which are about to be fitted on a small scale. The good work done by electrical engineers on board warships at present in respect to auxiliary machinery of all kinds is too well known to need any comment from me, and we should welcome their co-operation as regards the main engines if the resulting combination is likely to be beneficial.

CONGRESS OF RADIOLOGY AND ELECTRICITY.

BRUSSELS EXHIBITION, 1910.

An International Congress of Radiology and Electricity is to be held at Brussels on September 6, 7 and 8, during the run of the International Exhibition. There will be three sections, dealing respectively with (1) terminology and methods of measurement in radio-activity and subjects connected with ions, elections and corpuscles; (2) various subsections, dealing with fundamental theories of electricity study of radiations (including spectroscopy, chemical effects of radiations, and other allied questions), radio-activity, atomic theory, and cosmical phenomena (including atmospheric electricity and atmospheric radio-activity); (3) biological, devoted to consideration of the effects of radiations on living organisms, its subsections dealing with purely biological questions as well as with the use of various radiations for medical purposes, both for diagnosis and therapeutics. Dr. J. Daniel, 1, Rue de la Prévaté, Brussels, is the General Secretary, while the Congress is represented in England by Professor Rutherford and Mr. W. Makower, of the University, Manchester, and Dr. W. Deane Butcher, of Holyrood, Ealing, London, W.

ELECTROCUTED AT RANGOON.

The first case of electrocution that has taken place since the installation of the electric traction and lighting system in Rangoon in 1906 occurred last month. The wire snapped at the corner of Dalhousie-street and 63rd-street, Lower Pazoondaung, and the broken ends fell on a native of India, one striking him on the left side and the other on the left leg, and killed him at once.

ACCIDENT TO AN ELECTRICIAN.

An electrician named Edward Peck, employed by the Scottish Central Power Co., when at work making a connection at the sub-station of the Carrongrove Paper Works, Denny, accidentally fell and his face came in contact with a live wire of 3,000 volts power. Peck was thrown and came in contact with a second wire. He was badly burned about the head, hands, and feet.

WIMBLEDON ELECTRICAL EXHIBITION.

After a lapse of five years, during which the Corporation electricity undertaking has made very rapid strides, another electrical exhibition is being held at Wimbledon this week. Electricity supply was begun in the borough in 1899 with 360 kw. of plant installed and about 150 consumers. In ten years the plant at the generating station has been increased to 3,685 kw. and the consumers number 3,856, representing a total of 15,830 35 watt lamps and 862 h.p. of motors connected. A very extensive system of public lighting by electricity has been developed, and, as the Mayor (Councillor Bathgate) observed in opening the exhibition on Monday, the borough is one of the best lighted towns in the country. The electricity concern is on a thoroughly sound financial basis, and since its inception the department has made a nett profit of £18,309 2s. 2d., of which £6,378 9s. 9d. went to the relief of the rates. The price charged for current last year averaged 3½d. per unit. The tariff for supplies for power, cooking, and heating ranges from 1d. to 2d. per unit.

The exhibition, which has been admirably organised by Mr. E. Tomlinson Lee (the Borough Electrical Engineer), should do much to bring home to the residents of the district the advantages of electricity not only for lighting, but for cooking, heating, ironing, and other domestic purposes, and for driving machinery. Some of the leading electrical firms have exhibits of the latest developments in domestic electrical appliances, etc., and, in addition, there is an Enquiry Bureau, where representatives of the Electricity Department answer enquiries relating to electrical matters.

Shown by the Worthington Pump Co., Ltd., are various examples of the use of electric power in providing an efficient supply of water for domestic purposes.

The "Daisy" vacuum cleaners can be seen in operation at the stand of Wallach Bros., Ltd. The vacuum is worked on the bellow principle, driven by a small electric motor, and in very small machines by hand power. It is portable, simple, and efficient, and may be used not only for cleaning carpets and articles of furniture, but also for removing dust from domestic pets.

Electric cooking and heating apparatus on the "Quartzalite" system are displayed by Messrs. Thomas L. Scott & Co., *Ltd.*, and Messrs. O'Brien, Thomas & Co. have a fine assortment of electric heating appliances, including Boyds' patent electric radiators, electric convertors, and general fittings. Electrical grinding mills, root cleaners, and bone cutters for poultry keepers are exhibited by Messrs. F. H. Bentall, Maldon, Essex.

The Lux Candle Co., Ltd., put forward the merits of the Lux electric candles; the Dowsing Radiant Heat Co., Ltd., have a collection of electric radiators and a display of "Solarium" electric light baths; and at the stand of Messrs. Spagnoletti, Ltd., and Messrs. Doulton & Co., Ltd., can be inspected two examples of Therol electric water heaters, one connected to a Doulton bath and the other connected to two Doulton lavatory basins.

Tantalum lamps illuminate nearly the whole of the building proper, as well as the majority of the stands. But it is at Messrs. Siemens Bros.' stands that these celebrated lamps are displayed with special effect. Numerous artistic fittings are used, Majolica fittings being particularly prominent. A striking feature of one of the displays comprises a showboard, demonstrating the application of the O.S. Wiring System to economical house wiring, as described and illustrated in a recent issue of the ELECTRICAL ENGINEER. Other specialities of the Siemens' firm are also shown to advantage.

One of the novelties at Messrs. Stegmann & Co.'s stand comprises a transformer and automatic time switch for alternating current. Another interesting exhibit is a small time switch clock for extinguishing lamps at any hour, suitable for business establishments, etc.

The British Vacuum Cleaning Co., Ltd., show in operation their electrically worked vacuum cleaners, which are on the rotary pump principle, and enclosed in a mahogany case, forming a handsome article of furniture.

Flame arc lamps, the "Foster" transformer, and "Foster" automatic switches are to be found in variety on the stall of the Foster Arc Lamp and Engineering Co., Ltd. They are also showing a selection of metal filament lamps made at their works at Wimbledon. We understand that the firm are building new lamp works at Merton.

A novel device for demonstrating the advantages of metal filament lamps in comparison with carbon lamps is exhibited at the stall of Messrs. Parsons & Townsend. They have a very attractive display of Phœnix small cookers, Farabin electric hand lamps, and hand-wrought rust-proof, lacquered electric lamp fittings. "Tinol," a useful solder in a new form (no flux being required), of which Messrs. Nevill Williams & Co., of London, are the importers, is also shown at this stall.

Electroyl radiators are shown by Messrs. Purcell & Nobbs; and Messrs. Arthur & Co have a collection of electric cookers and heaters manufactured by the British Thomson-Houston Co., of Rugby.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

Three Indication Block Instruments.

We illustrate below Messrs. Moore & Powles' patent one-wire block instrument worked by momentary currents, but with the advantages of a three-wire instrument, inasmuch as three different visual indications may be obtained from either end of the line. This type of instrument, which has a very promising future, is being placed on the market by Walter's Electrical Manufacturing Co., Ltd., Kensal Town Telegraph Works, London.

Fig. 1 Block Instrument.

The current-sending portion of the instrument (Fig. 1) consists of a circular commutator with an external index finger which can be moved to point to a white, green, or red tablet, and in these three positions respectively denotes that if the plunger is depressed "Line closed," "Line clear," or "Train on line" will be sent to the cabin in the rear. This index finger does not have to be nicely adjusted by the signalman, to point to the desired coloured tablet, but the action is to turn the commutator smartly to the required position, where it is brought up by a dead stop. The commutator is then mechanically locked in this position until the plunger has been depressed, thus actually sending a visual and an audible signal to the distant cabin. It can also be made compulsory that when "Line clear" has been sent, "Train on line" must also be given before the normal position of "Line closed" can be again obtained. In a like manner, when "Train on line" has been sent, "Line clear" cannot be given until "Line closed" has been signalled; *but* "Train on line" can be immediately sent, from either the "Line clear" or "Line closed" positions. Two 8-cell ordinary Leclanche batteries are sufficient for working the instrument. These are joined up to the commutator so that one only, or the two combined, are used for sending currents to line. When the plunger is depressed the current goes out to line through the bottom or "Train coming" dial, and, according to its polarity, drops either the "Line closed" or the "Line clear" indication. If, however, a *strong* zinc current is sent, the "Line closed" indication is dropped, and this eclipses the "Train on line" indication, which also drops with either a weak or strong zinc current. Whichever indication is dropped remains in view until the commutator is turned to a new position, when it is mechanically replaced and the bottom dial shows blank until the plunger has again been depressed, and the desired signal actually sent to line, when the new indication comes into view.

The connections of the upper or "Train going" dial at the rear station are shown in Fig. 2.

The incoming line current passes through the electro-magnet which energises "Line clear" flag, through the

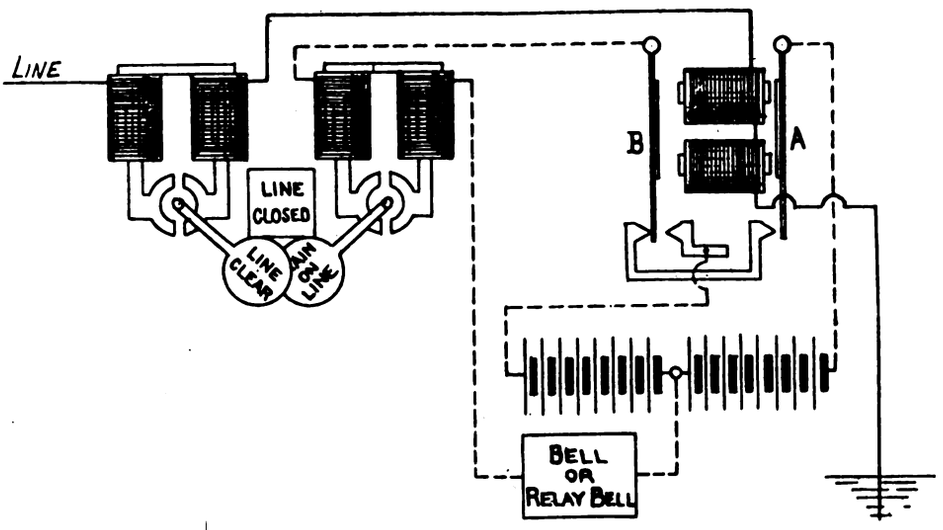

Fig. 2. Diagram of Connections.

double tongue circuit reverser and out to earth. The local circuit operated by this circuit reverser contains the electro-magnet which operates the "Train on line" flag. The "Line closed" indication is fixed but can be eclipsed by the "Train on line" flag, which in turn can be eclipsed by the "Line clear" flag.

The two armatures on the circuit reverser are so designed that, whereas A will readily respond to a weak current, B will only be attracted by a strong current. By following the connections on the diagram it will be understood that with a weak zinc line current (which only actuates armature A), the "Train on line" flag electro-magnet is energised with a certain polarity which brings into view the "Train on line" flag. With a strong zinc line current armature B is also attracted. The local circuit will then be of the opposite polarity, and "Train on line" flag electro-magnet being energised in the opposite direction, the "Train on line" flag is moved away and discloses the fixed "Line closed" indication. If, however, the line current is of copper polarity, then "Line clear" flag is brought into view, eclipsing any other indication. Thus, a line current of copper polarity brings into view "Line clear," whilst a line current of zinc polarity moves or keeps this flag out of view and shows "Line closed" or "Train on line," according to whether the zinc current is strong or weak. The three indications need not necessarily follow each other in the same cycle.

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ELECTRIC SHOW ROOMS.

NEW DEPARTURE AT PUTNEY.

In pursuance of their policy of opening local showrooms, the County of London Electric Supply Co., Ltd., whose district embraces an area of 54 sq. miles, with customers of every class, have opened showrooms at 206, Upper Richmond-road, Putney, with a view to afford the residents of Putney and district an opportunity of inspecting the latest improvements in lighting, heating and cooking by electricity. This is one of those practical steps towards popularisation which is to be highly commended, for the advantage to consumers (and possible consumers) in thus being able to obtain first-hand information on all matters connected with electric supply, and in a place readily accessible, is considerable.

The showrooms are in an excellent position in a busy thoroughfare, and everything inside and out has been designed in an effective manner to display the artistic possibilities of electric light.

For instance, the drawing-room aspect is carried out with moulded panelling in green and white, while the dining-room aspect is in the best style of oak. The fittings in each case are in keeping with the designs, and the whole effect is pleasing to the eye.

In the window facing the street various exhibits are shown, and these, we understand, will be varied constantly. At present the electric radiator in many designs is a conspicuous feature. Later on, an electric dining table will be shown, which in turn will give place to some other combination.

Various cooking and heating appliances are on view. The latest types of metallic filament and carbon lamps, irons, kettles, grillers, and everything that interests the good housewife, especially in the way of labour-saving devices, can be seen and tried. No one knows the requirements of the consumers better than the company supplying them, and it is well that this should be made plain to possible customers in a convincing way such as this, which shows how the company can assist the consumers in obtaining the fullest information and advice in all things electrical

SUBMARINE SAFETY SIGNALS.

The latest bulletin of the Submarine Signal Co. state that the United States Navy have recently given an order for the equipment with receiving apparatus of 14 ships, and for the equipment with sending and receiving apparatus of 14 submarine boats. This makes a total of 51 United States naval vessels already equipped, and the order is particularly gratifying as having had the sanction of the General Board. The company understand that it is but the beginning of the policy which the Navy has adopted of equipping with this system all the available vessels of the United States Navy.

A remarkable test on the English Bank lightship was obtained by the captain of the Hamburg-South American Line Steamer *Cap Vilano* on a recent trip in dense fog from Rio de Janeiro to Buenos Ayres with Saenz Péne, candidate for presidency of the Argentine, on board. The captain was notified by wireless that the submarine bell was installed and ringing on the lightship. Still in dense fog he got the bell and his direction at eight miles and was able to proceed. This being the first real service test of the first lightship installed off the coast of South America (a bell buoy at Rio de Janeiro, as previously announced, has been in service for some time), caused quite a sensation.

We understand that there are now 109 bells in operation in various parts of the world; the more recent of these to be completed are the South Stack for Trinity House, Tarifa Point in the Straits of Gibraltar for the Spanish Government, and the Kish and Coningbeg Light-vessels for the Commissioners of Irish Lights. The total number of vessels equipped with receiving apparatus is 550, being an increase since April 1 last of 24%. The company have on this side now completed the equipment of the Fleets of the London and North-Western Railway, the City of Dublin Steam Packet Co., and the Great Eastern Railway. As the result of an experimental equipment on the *Cervona*, Messrs. Cairns, Noble & Co., recently instructed the company to equip their new vessel, the *Tortona*.

ALL-MOTOR FIRE STATION AT CHARLTON.

The new Charlton Station of the London Fire Brigade, specially built as an entirely motor station, without stables or any accommodation whatever for horses, has been officially opened. The motor equipment consists of three machines, all of identical size and power, with all the parts interchangeable. Two carry the standard fire escapes of the London Fire Brigade, and have also the standard first aid equipment, consisting of a copper cylinder containing water, and compressed air appliances for giving pressure. About 1,000 ft. of inlined canvas hose is carried on each machine together with the necessary appliances for hydrant work. The third machine is a "Hatfield" fire engine of a capacity of 500 gallons per minute, upon which accommodation is provided for 600 ft. of inlined hose, together with a complete equipment of appliances for a "working" job. All these machines are by Merryweather & Sons, and have been built to the special requirements of the Chief Officer of the London Fire Brigade.

A CANADIAN BRANCH.

Messrs. Siemens Bros.' Dynamo Works, Ltd., of London and Stafford, Eng., announce the opening of a Canadian branch, under the management of Mr. A. S. Herbert, with offices in the Canadian Birkbeck Building, Toronto. It is the intention of this company to further extend their business connections in Canada by establishing a number of such branch offices, and also by opening a repair shop where a large stock of spare parts will be carried.

EXTENSION OF PREMISES.

We understand that Messrs. G. M. Boddy & Co., of London, Liverpool, Sheffield and Manchester, whose name in the metal filament lamp world has become so well known through the success of their "Metalik," are extending their London premises. The firm have taken over the building, 15, Grays Inn-road, lately occupied by the Electro Motor & Dynamo Co., which business has been taken over by Messrs. J. & H. Grevener, of Eldon-street House, E.C. With the increasing and enormous demand for their Metalik lamps, Messrs. Boddy & Co. will now be better able, with the additional facilities, to comply with this demand and give early deliveries to their export, country, and city orders.

USE OF ELECTRICITY IN MINES.

In a paper on "Recovery of Power from Exhaust Steam," read before the Midland Institute of Mining, Civil and Mechanical Engineers, at Leeds, Mr. W. M. Sanderson pointed out that successful installations were already in operation or construction at works connected with steel rolling mills, blast furnaces, ironworks, collieries, carriage and wagon works, textile and other electric supply stations and steamship propulsion, showing at once that the field for its employment is wide and varied. Apart from the problem of steamship propulsion, the best cases were presented at works connected with the iron and steel industries and at collieries.

The President (Mr. M. H. Habershon) drew attention to a recent discussion on the use of electricity in mines, following upon a paper read by Mr. Robert Nelson. Mr. Nelson, regarding the use of armoured cables, stated that the report of the Departmental Committee published at the time the special rules relating to the use of electricity were formulated, advocated the armoured cable. That, he said, was perfectly true, but the special rules now in use passed through many editions before they were finally accepted by the coal trade. In the first form in which they were issued they were not workable, and one reason for this was found in the difficulty they had in convincing those who had to do with the framing of those rules of the danger of the armoured cable. In a colliery working a thin seam by means of coal-cutting machines they might possibly, after a few years' time, get as many as six or eight machines, and probably so much as eight miles of cable in a pit, with 100 cable joints placed in roadways, the condition of which was always changing, and a cable which was quite right one day, might the next be subjected to a sudden strain. With armoured cables, the danger of such a circumstance would be apparent, and he urged that this question of electricity in mines should be seriously taken up by colliery engineers, who were fully acquainted with the dangers that existed.

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ELECTRIC POWER CONDUCTORS

BY

WILLIAM A. DEL MAR, A.C.G.I., A.M.Amer.I.E.E., A.I.E.E.,
Electrical Transmission Department, N.Y.C.R.R.

SUMMARY OF CONTENTS.—Wires and Cables.—Materials and Gauges.—Electrical Properties.—Insulation and Insulated Conductors.—Determination of Size for given Voltag Drop and Power Loss.—Determination of Size for given Stress in Spans.—Specifications.—Testing Wire and Cables.—Installation.—Depreciation and Deterioration.—Third Rail Circuits.—Rail Bonds.—Tables of Inductance, Reactance and Capacity.

London: CROSBY LOCKWOOD & SON,
7, Stationers' Hall Court, E.C., and 121a, Victoria Street, S.W.

CENTRAL STATION ECONOMIES.*

By W. L. ABBOT, Operating Engineer, Commonwealth Edison Co., Chicago.

Continued from page 629.

The most striking, as well as the most important, improvement in power house apparatus in recent years, and the improvement which, to a great extent, has made possible the reduction in the selling price of electrical energy since its introduction, is the substitution of the steam turbine for the reciprocating engine. The old and time-honoured piston engine, which has been the handmaid of industrial development through the past century, has probably reached its highest possible development and largest practicable size in the four-cylinder combined horizontal and vertical engine, and any further increases in the size of the unit would result in a prohibitive increase in its cost. This was in part because the weight and external dimensions of the apparatus must increase in a greater ratio than the power of the engine.

The ponderous mechanism, enormously expensive and requiring a huge building to house it, is uneconomical at loads above or below its rating, and, therefore, was a great charge upon the expense of the business, both because of the fixed charges and of the operating costs. The piston speed of these engines permitted only of a comparatively slow revolution of the shaft, not to exceed 75 per minute, necessitating a generator of great weight and dimensions. The advent of a steam turbine, with a rotor having a speed 10 or 15 times that of the shaft of the reciprocating engine, permitted a corresponding decrease in dimensions and weight and a material increase in the cost of the prime mover and of the electrical generator. This of itself would be sufficient to warrant its adoption in the place of the piston engine, but most fortunately the efficiency of the new prime mover was greater than that of its predecessor, and its economy was practically constant over a wide range of load.

As a steam turbine exerts its power through the effect of unconfined steam blowing against curved deflecting blades, it is not at once apparent why its efficiency should be greater than that of steam acting expansively in a cylinder against a tight piston, where no leaks exist. As a matter of fact, the piston engine is more efficient than a steam turbine, as far as it goes, but unfortunately it is not practical to expand the steam in a piston engine to more than, say, 25 times its original volume, and at that point it is exhausted into the condenser with the loss of that power which would result from all possible expansions below, say, 5 lbs. of absolute pressure.

With the turbine, however, its best efficiency only begins at the point where the piston engine stops. The turbine can and does get the full benefit of the expansion of the steam down to the lowest point obtainable by the largest condenser, and if this highest vacuum obtainable is one-half inch barometric pressure, or, say, one-fourth of a lb. absolute, it means that the steam has expanded to nearly 700 times its volume. The object, therefore, of getting a vacuum of the lowest pressure obtainable is that as the absolute zero of pressure is approached any slight decrease in pressure will make a great difference in the number of expansions which the steam undergoes. Thus with a vacuum of 28 ins., the volume of steam would be doubled, if the pressure were reduced to 29 ins., and would be doubled again if the pressure were reduced to 29½ ins., which is an attainable vacuum in winter, when the cooling water has a temperature in the neighbourhood of freezing.

One of the important economies which must not be overlooked in such a discussion as this is the economy of labour. I do not consider it highly important to get cheap labour, but it is essential in a modern central-station system, where equipment costing enormous sums is entrusted to employés, many of whom are miles from their supervising officers, that they be loyal to the employing company, have a fair degree of intelligence and in most cases of education, and, above all, that they be trustworthy.

The greatest of all extravagances in connection with the central-station business are the results of accidents which shut the system down in whole or in part for a longer or shorter period of time. The capital invested is necessary to build up and run the business, but without the confidence of the public invested capital cannot earn dividends. It is, therefore, imperative that the greatest diligence and foresight be exercised in guarding against all possible contingencies which may affect the continuity of the service.

To keep the equipment in prime condition and the operating force at the highest point of efficiency is, therefore, of the greatest importance. This means, therefore, the generous recognition of loyal and efficient service from the employés, or prompt discipline or removal for the opposite reason. It means the prompt and remorseless abandonment of equipment to the scrap pile, regardless of its first cost, the moment it can profitably be supplanted with newer and better designs; protective devices and methods to guard against probable and improbable contingencies. External vigilance and activity and unstinted, yet carefully considered, expenditures are the price of success in the manufacture and distribution of electrical energy, and are the prime factors in central-station economy.

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SHOP TESTING: DIRECT AND ALTERNATING MACHINERY.*

By J. W. ROGERS.

It will be generally admitted that the position occupied by the testing department of an electrical works is an important one, as on it depends the quality and satisfactory performance of the plant turned out.

In all modern electrical manufacturing concerns it is the custom to carry out an exhaustive series of "shop" tests to ensure that the machines attain their specified efficiency at various loads, and satisfy all other conditions, both electrical and mechanical. The object of a testing department is to supply the engineering department with information which will enable the design of a machine to be checked, and also serve as a guide to its "operating characteristics" when running under working conditions. The shop tests generally carried out on electrical plant may be classified under two distinct heads, viz.: Experimental and Commercial.

Experimental tests are made on all machines of new type for the purpose of obtaining information with reference to their performance under working conditions, and also to compare the actual with the anticipated performance. The tests required for this purpose are those of (1) Insulation, (2) Rating and Efficiency. As is well known, the rating of a machine is determined by (*a*) heating, (*b*) drop in voltage or speed, depending on the machine being a generator or motor, (*c*) commutation; a knowledge of these three quantities being obtained from temperature, regulation, and commutation tests respectively, under various conditions of loads. As regards the efficiency, this may be obtained (1) from the relation between input and output, (2) by calculation of the copper, iron, friction, and windage losses, as determined by the resistance, and iron loss and friction tests respectively.

It is the custom to record the results of the experimental tests carried out on new machines in the form of curves, which are systematically filed for future reference, and then in the subsequent testing of duplicate machines of the same design a few observations only are taken for comparison with these curves, and if they agree, the machine is passed as up to standard.

Commercial tests are made chiefly to locate faults in manufacture due to defective material, bad workmanship, or faulty assembling. Any defect in the iron circuit of a machine would show up in the saturations and temperature tests in the form of (*a*) excessive iron loss at normal excitation, and (*b*) excessive temperature rise of the iron circuit. Generally speaking, the commercial tests for machines of moderate output are (1) iron loss, saturation and friction, (2) temperature run at full load, (3) insulation, (4) overload and commutation test.

As already stated, it is generally found that all defects in manufacture are shown up in the temperature test, so that the most important shop tests are those for efficiency and temperature. The time taken by a machine to reach its maximum temperature depends upon its output and design, and as it is impossible to obtain a knowledge of the real efficiency until the C^2R losses reach a constant value, the data from which the efficiency is calculated should always be taken at the conclusion of a temperature test.

IRON LOSS, FRICTION, AND SATURATION TESTS OF SHUNT AND COMPOUND GENERATORS AND MOTORS.—These tests are most conveniently made by driving the machine to be tested as a generator by belting it to a shunt motor, and measuring the motor input when driving the machine at its rated speed at different voltages. Under these conditions, the total input to the driving motor includes the losses in the motor armature and field + iron loss, brush and bearing friction, and windage in the driven machine. The C^2R loss in the motor armature will vary with the excitation of the machine on test, but the C^2R loss in the motor field may be held constant by heating the field before commencing the test, and keeping the terminal voltage constant. The frictional losses may be considered constant if the speed is held constant throughout the test.

The iron loss and friction test consists in taking readings of the motor input under the following conditions: (1) no excitation on generator; (2) varying exciting current; (3) no excitation on generator with its brushes raised; (4) belt off, motor running at the normal speed of the machine on test. As a check on the correct position of the brushes, it is the custom to measure the motor input when driving the generator excited to give the normal voltage, but with its brushes raised, and if this reading is substracted from that representing the motor input when driving generator with same excitation and brushes down, the value of brush friction so obtained should correspond with that found with no excitation on generator. If the values of brush friction do not correspond closely, this proves that currents have been circulating in the armature due to the brushes having been wrongly set.

The iron loss in watts for any particular value of exciting current or terminal voltage on the generator is given by:

Motor input (gen. excited)—motor input (gen. unexcited).

Similarly, the friction loss is:

Motor input (gen. unexcited) – motor input (generator disconnected).

As the same readings are required, a saturation test is generally made in connection with the iron loss test. From the results of these tests, an iron loss curve is plotted having watts lost as abscissæ and volts as ordinates, and a saturation curve having field amperes or ampere turns as abscissæ and volts as ordinates.

IRON LOSS, FRICTION, AND SATURATION TESTS OF SERIES MOTORS.—As the series motor is not a constant speed machine, and the iron loss varies with a change in the speed, it is not advisable to employ the same method as that already described, as it would necessitate a number of tests being made at different speeds. A more satisfactory method consists in running the machine as a motor at different speeds and measuring the input which will represent the energy required to overcome the iron loss, friction, and windage for any particular value of speed and field current. Having found the combined losses at different speeds, it is necessary to obtain the friction loss at the same speeds, and from these two sets of readings, the iron loss at different speeds may be easily calculated.

As the speed of a series motor is very high when run light, it is necessary to shunt the armature by a low resistance, so that the field will carry the larger current and thus reduce the speed, which may be varied by altering the shunt resistance.

The friction and windage losses may be obtained by running the machine at a low voltage with no shunt across the armature, the voltage being gradually increased to get the same range of speeds as when the combined losses were measured. As the field strength under these conditions will be very small, the iron loss may be neglected, therefore the motor input will be a measure of the friction loss at each speed. From the results of these tests, curves are plotted having iron loss and friction, friction, and main amperes as ordinates, and speed as abscissæ.

REGULATION AND EFFICIENCY TESTS OF GENERATORS.—As is well known, the regulation of a generator may be defined as the maximum variation of voltage or current which occurs between "no-load" and "full-load" under normal working conditions, expressed as a percentage of the normal voltage. Generators may be loaded directly on a rack, or water, resistance in the case of machines of moderate output, but it is more economical to employ loading back methods when two similar machines are available. Although the Hopkinson test is too well known to need description here, it may be mentioned that when two compound machines are tested in this manner, the machine which is intended to generate the lower voltage and operate as a motor should have its series windings reversed, if the windings are connected to give a constant voltage when the machine is working as a generator under normal conditions. The readings taken for a regulation test are: (1) no-load reading, with field rheostat adjusted to give normal volts at no-load; (2) full-load reading, the diverter, if any, to the series winding in the case of compound machines being adjusted, if necessary, to give the normal voltage, without altering the shunt field rheostat. When taking intermediate readings between no-load and full-load, all adjustments should remain as when No. 2 reading was taken. The data obtained from this test enables regulation curves to be plotted, having values of terminal volts and shunt field amperes as ordinates, and load amperes abscissæ, the efficiency being worked up from

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these curves in the following manner, taking the case of a compound generator as an example. The values of terminal volts and shunt field amperes, corresponding to any particular value of external amperes are first read off the regulation curves, the various losses being then calculated separately for that particular load.

The total losses = C^2R losses in armature, series and shunt fields + C^2R loss in brushes + brush friction, bearing friction and windage + iron loss. The C^2R loss in the brushes is given by total amperes × volts drop in brushes, this drop in the case of carbon brushes being taken from a standard curve showing the volts drop at various values of amperes per sq. in. of brush section for that particular quality of carbon used for the machine on test, the current density in the brushes being calculated from

$$\frac{\text{total amperes}}{\text{total brush area.}}$$

It is the custom with some manufacturers to debit the engine with the friction and windages losses in the case of engine-type generators, but they are always taken into account in belt-driven machines. The various losses having been separated in the manner described above, the percentage efficiency is given by

$$\frac{\text{Watts output}}{\text{Watts input}} \times 100 = \frac{\text{Terminal volts} \times \text{external amperes} \times 100}{\text{Output} + \text{total losses.}}$$

Regulation and Efficiency Test of Motors.—The regulation of a motor represents the change in speed between no-load and full-load, a regulation test being made by (1) belting the motor to a generator run on water resistance load; (2) loading back on a similar machine; (3) loading on a brake, this being the most direct method of determining the speed regulation of a motor, which, however, can only be carried out on machines of moderate output. The regulation test on a motor is similar to that on a generator, the only difference being that in the case of a motor the speed will be the variable quantity, instead of the terminal voltage as with a generator. The connections for a loading-back test are also similar to those required for generators, but when compound motors are tested the series windings should be so connected that their effect is the same in each machine. The readings taken are those of shunt field amperes, armature amperes, speed and terminal voltage, and these results, when *plotted* with field amperes and speed as ordinates and armature amperes as abscissæ, will represent the regulation speed curve for different loads on the motor under test.

The regulation test of a series motor is made by belting it to a similar machine which is loaded as a generator on a water resistance. The test is started with about 50% overload, which is gradually reduced, the readings taken being those of terminal volts, field volts, main amperes and speed of the machine on test. As the characteristic of a series motor is such that its speed at any particular load decreases with an increase in the temperature, it is necessary to correct the speeds obtained from the regulation test for a certain standard temperature, which is usually 75°C. for enclosed, and 50°C. for open-type motors. This correction in speed must be taken into account in working up the efficiency, and may be obtained in the following manner: The armature and field resistances are first taken at a known temperature, their values at the standard temperature being then calculated. The speed corrected for the standard temperature will then be given by:

$$\text{Speed from curve} \times \frac{\text{Term. volts—total drop at standard temp.}}{\text{Term. volts—total drop at temp. of test.}}$$

The efficiency of motors may be obtained from (1) losses worked up in connection with data taken from the regulation curve; (2) directly from a brake test.

When the efficiency is worked up from the losses the values of speed and field amperes corresponding to any particular value of load amperes are read off the regulation curves, the various losses being then calculated in the usual manner. In the case of series motors, the efficiency is worked up from the losses in a similar manner, but the iron, friction, and windage losses must be read off the curves for the corrected values of speed, instead of terminal volts as with shunt and compound machines.

Temperature Tests.—The duration of a temperature run and the rise in temperature allowed varies slightly with different makers, but it is the custom to run a machine until the temperature of its various parts becomes stationary. Surface temperatures are taken with mercury thermometers, their readings being checked by calculating the mean temperature rise from the increase in the resistance of the windings. As the resistance of a copper conductor increases by ·428% per degree C rise in temperature, the mean temperature rise of the windings is given by—

$$\frac{\text{Hot Resistance—Cold Resistance}}{\text{Cold Resistance} \times \cdot 00428.}$$

Insulation Test.—As the insulation of a machine is more liable to break down when hot, this is always made at the conclusion of a temperature run. It consists in applying a high alternating current voltage between the armature and field win ings and the frame of a machine.

In the case of low voltage machines the testing pressure is generally double the working voltage, but, as the factor of safety of a low voltage winding is higher than that of a high voltage winding, the ratio of the testing to the working voltage should be less for high voltage machines to prevent the possibility of damaging the insulation of the windings.

The capacity of the testing transformer used for making dielectric tests is a point which requires due consideration, as it is governed by conditions affecting the testing circuit as well as the apparatus to be tested, and this question may be considered as follows:—In virtue of its static capacity, the apparatus to be tested may be considered as a condenser, the charging current of which may be represented by $C = 2\pi \times 10^{-6} \times V \times N \times K$ (assuming a sine wave of e.m.f. applied to its terminals) where C = current in amperes, V = terminal voltage, N = frequency, and K = capacity in microfarads. It follows, therefore, that the charging current taken by the apparatus to be tested is proportional to its static capacity, and varies directly as the frequency and testing voltage.

The apparent output of the testing transformer would be proportional to the square of the voltage, and may be calculated from the formula given above when the static capacity of the apparatus to be tested is known.

The C^2R losses in the insulation are generally very small compared with the charging current, and may, in the majority of cases, be neglected. The dielectric loss has, however, an appreciable effect on the output of the testing transformer when the testing pressure approaches the disruptive strength of the insulation, and as this loss varies directly with the frequency, it should be taken into account when calculating the capacity of a testing transformer to be used for disruptive tests. The frequency of the testing circuit also governs the size of the transformer for a given output, which varies inversely as the frequency.

It follows from the above remarks that (1) for a given output the lower the frequency the larger will be the transformer required; (2) for a dielectric test under given conditions the higher the frequency of the testing circuit the larger the capacity of the testing transformer.

An important test coming under the heading of experimental testing, which may be mentioned, is that known as a distribution or field-form test.

It is sometimes made on machines built to a new design for the purpose of determining: (1) the character and strength of the field; (2) the maximum difference of potential between commutator segments; (3) the variation in field strength, and whether it can be improved by altering any constructional details. The machine to be tested is first run light as a separately excited generator, to obtain a potential curve representing the field form with no current in the armature. It is then run on full-load as a generator or motor (as the case may be) at its rated output and speed, to determine the full effect of armature re-action under normal working conditions. The results of a distribution test may be shown graphically by making the horizontal scale represent the distance between the positive and negative brushes, and the vertical scale the volts generated at each point, and a comparison of curves so obtained will plainly show the effect of armature re-action on the field.

Having considered the shop-tests it is usual to carry out on direct current machines, reference will now be made to the testing of alternating current plant.

Alternating Current Generators.—The experimental tests carried out on alternators are those for: (1) iron loss, saturation and friction; (2) regulation and efficiency; (3) short circuit. As the first test has already been described in connection with the testing of direct current machines it will not be considered here.

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The regulation of an alternator may be defined as the percentage rise in voltage which takes place when full non-inductive load is thrown off, the speed and field current being held constant. The test consists in running the machine at its rated output and speed, with the current in phase with the terminal voltage, a regulation curve showing a varying field charge with a constant terminal voltage.

A full-load test can only be made on machines of small output unless two similar machines are available, in which case loading back methods may be employed. A loading back test is made by coupling the alternator shafts together, and also to a direct current motor of sufficient capacity to supply the power lost in both machines. The efficiency of motor being known, the power supplied may be easily calculated. The two alternator armatures are short circuited on each other through an ammeter in each phase, the load current being made to circulate between them by weakening the field of one machine, thus causing it to act as a motor and help to drive the other as a generator. The p.f. of the load may be varied by altering the connections between the two armatures, so that there is a phase difference between their e.m.f.'s, and when the relative position of the two armatures is such that their e.m.f.'s are in direct opposition, the power factor will be approximately unity. The efficiency is worked up from the losses in the same manner as with a direct current generator, the only difference being in the method of calculating the C^2R loss in the armatures of two and three-phase machines.

Short-Circuit Test.—This is made chiefly to determine the self-induction of the armature, and also the effect of armature impedance in reducing its terminal voltage when the machine is run at constant speed with various values of exciting current. A series of readings is taken connecting the armature current with the exciting current, and from the results of this test a short-circuit characteristic curve may be plotted, which is generally found to be a straight line. The connection between the short-circuit test and the regulation of an alternator may be considered as follows: When it is impossible to run a machine at full load, its regulation may be calculated from the data given by the open-circuit and short-circuit characteristics, in the following manner: The volts drop due to the armature resistance are calculated for a given load, and added to the terminal voltage on open circuit. The exciting current corresponding to this total voltage is then read off the no-load saturation curve, and its value added vectorially to the value of field current required to give the same load when the armature is short-circuited.

The voltage corresponding to this resultant field current is then read off the open-circuit saturation curve, and the difference between this voltage and the terminal voltage expressed as a percentage will represent the regulation of the alternator at that particular load. Perhaps an example of this method of determining the regulation, which is used to great extent in American practice, may be of interest? and the following data refers to a 150 kw. three-phase alternator. The total armature resistance of this machine at standard temperature = ·024^{w}; total amperes = 340; c.r. drop in armature = ·024 × 340 = 8·2 volts.

∴ The sum of the terminal volts and c.r. drop = 440 + 8·2 = 448·2 volts.

The exciting current required to give this voltage, as taken from the saturation curve = 42·5 amps. also, the field current required to give 340 amps. on short-circuit = 15 amps, as taken from short-circuit curve. The vector sum of these two values of exciting current = $\sqrt{42{\cdot}5^2+15^2}$ = 45 amps., and the volts corresponding to this resultant field current was shown by the open-circuit saturation curve to have a value = 470 volts.

∴ The regulation at full-load with a constant field current $= \frac{470-440}{440} \times 100 = 6{\cdot}8\%$.

Commercial Tests.—As regards the commercial testing of alternators, the tests generally made are those of: (1) polarity; (2) temperature; (3) insulation. With machines of moderate output, the temperature test consists in running the machine on full-load, but in the case of large machines it is the custom to run them on open circuit with the field current required to give the normal voltage at full-load, this test being followed by a run on short-circuit with the field adjusted to circulate the full-load current in the armature.

Induction Motors.—The tests generally made on induction motors to determine the iron loss, saturation, efficiency, etc., are those of (1) resistance; (2) saturation, running light; (2) torque, locked saturation and impedance, (3) power and slip, and these may be considered separately as follows:

Saturation Tests.—These are made for the purpose of checking the design of the magnetic circuit. The motor is first run light at various voltages, commencing with a voltage about 25% above the normal, the readings taken being those of amperes per phase, terminal volts and real watts. From the result of this test curves are plotted having total amperes and watts as ordinates and terminal volts as abscissæ. The amperes curve may be compared to the saturation curve of a direct current machine, and from it the magnetising or no-load current taken by the motor at different voltages may be obtained. Strictly speaking, the magnetising current is slightly less than no-load current, as a certain part of the latter is spent in overcoming the loss due to hystereses and eddy currents.

The primary current taken by an induction motor is the resultant of two components, viz.: (1) an energy component which is in phase with the terminal voltage and does useful work; (2) an inductive component, which represents the wattless part of the current, lagging 90° behind the terminal voltage. The apparent input to the motor = $\sqrt{\text{energy compon't}^2 + \text{inductive compon't}^2}$, ∴ the inductive compont. = $\sqrt{\text{apparent input}^2 - \text{energy compon't}^2}$ That is to say, the true magnetising current = $\sqrt{\text{total current}^2 - \text{energy current}^2}$; where energy current = $\frac{\text{Real Watts}}{\text{Terminal Volts.}}$

The watts curve represents the iron loss and friction at different terminal volts.

The information to be derived from the curves of locked saturation enables the inductive component of the volts, and also the effect of magnetic leakage to be calculated. A knowledge of the starting torque of the motor at different voltages is also obtained from this test, which is made by fixing a brake arm to the shaft and connecting the motor to the supply circuit in a similar manner to that required for a running saturation test, the torque being measured by means of a scales or spring balance. The motor is supplied with a low voltage which is gradually increased to its normal value (if the capacity of the generating plant and the design of the motor permits), the readings taken being those of terminal volts, amperes per phase, real watts, and torque. The results of this test may be shown in the form of curves having kilowatts, total amperes, and lbs. torque as ordinates, and terminal volts as abscissæ. A test sometimes made at the conclusion of the locked saturation is that known as the pulling out or maximum torque test, the voltage at which it is desirable to make it depending upon the output and characteristics of the motor. The resistance of the rotor circuit also has an important bearing on this point, owing to the fact that the pulling out torque is very much greater than the starting torque when the resistance of the rotor circuit is low. It follows, therefore, that the current taken by a large motor to give its pulling out torque at normal voltage, is liable to reach an enormous value, and for this reason it is advisable to take the pulling out torque at a voltage considerably below the normal. This test is made by adjusting the voltage to its required value, which must be held constant. The brake is then tightened and balance adjusted on the scales until the motor slows down rapidly without increasing the torque. The actual pulling out point is reached when the motor begins to slow down, at which instant readings of the terminal volts and scales are taken. In connection with the locked saturation test, it is the custom to take two sets of readings of terminal volts, amperes per phase and true watts, corresponding to the different positions of the rotor with respect to the stator, which give the maximum and minimum values of stator current, the terminal voltage being first adjusted to give the normal full-load current in that winding and then held constant.

Power and Slip Curves.—These consist of a series of curves representing the complete performance of a motor. They may be obtained either (1) directly from a brake test in the case of small machines, or (2) by calculations from

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the losses. The motor is run at various values of torque representing different loads, its full load torque being calculated from the output and speed at that point. A complete set of readings covering about 25% overload is taken at each point, consisting of terminal volts, amperes per phase, true watts, torque, motor and generator speeds.

When the power curves are to be worked up from the losses a speed curve is also required, and may be obtained by belting the motor to a generator of sufficient output to give it a 25% overload, the readings taken being those of motor and generator speeds, terminal volts, and amperes per phase, from which a curve is plotted, having total amperes as abscissæ and speed as ordinates. When a slip indicator is not available, the slip may be calculated from the motor and generator speeds by means of the formula—

$$\% \text{ slip} = \frac{\text{generator speed} - \text{motor speed}}{\text{generator speed}} \times 100.$$

This completes the series of shop tests from which are obtained the data required to work out the true performance of an induction motor.

Synchronous Motors.—The experimental tests made on these machines are those of—(1) resistance, (2) open and short-circuit characteristics, (3) iron loss, saturation and friction, (4) efficiency, (5) regulation and V curves.

These tests are practically the same as those carried out on alternators, and are conducted in a similar manner, with the exception of those for regulation and V curves, which may be considered as follows: As is well known, a synchronous motor may be made to operate at various power factors by altering its field strength, and when the excitation is such that the impressed voltage =

$$\sqrt{(C.E.M.F.^2 + C.R.\text{ drop}^2 + \text{reactive drop}^2)},$$

the armature current will be exactly in phase with it, and the power factor will be practically unity, the current input to the motor being then a minimum. Any further alteration in the exciting current will then give rise to a leading or lagging current, which will cause the current input for any particular load to increase. It follows, therefore, that every load has its corresponding value of excitation which enables the motor to operate with the smallest armature current. This variation of the armature current with the excitation is one of the most important characteristics of a synchronous motor, and the curve representing such variation is, owing to its shape, known as a V curve.

The data for these curves are obtained by running the motor on "no-load," "half-load," and "full-load" at different exciting currents, and taking readings of armature and field amperes.

A reference to the curves so obtained will show that the armature current varies to a greater extent, and that the angle of the V is more acute at "no-load" than is the case when a motor is loaded, the variation in armature current for any particular value of excitation decreasing as the load increases. There is consequently a wider variation in the power factor for different values of the exciting current when a motor is running light than when loaded. The regulation curve of a synchronous motor shows the relation between the excitation and the armature current at unity power-factor. This test is made by belting the machine to a direct-current generator of sufficient output to give it a 25% overload, and adjusting its excitation so as to obtain unity power factor at all loads. The wave-forms of the motor and the supply circuit should be similar, and the terminal voltage and frequency held constant during the test, the readings taken being those of armature and field amperes. The efficiency is worked up from the data given by the regulation curve so obtained in the same manner as with an alternator.

Rotary Converters.—The experimental tests carried out on converters are those of—(1) iron loss, saturation and friction, (2) short circuit, (3) efficiency and compounding, (4) commutation.

Iron Loss, Saturation and Friction.—This test is made in the same manner as with an alternator, but when taking the saturation it is necessary to measure both the alternating and direct-current voltages so that there will be two separate saturation curves from which the average value of the voltage ratio may be calculated by reading off the curves the values of alternating current and direct current volts for the same value of exciting current.

Short Circuit.—This test is made on the direct current side for the purpose of testing the commutation in a weak field; it also serves as a temperature test in the case of large converters. It is made by belting the machine to a shunt motor and short-circuiting the armature through an ammeter. The converter is then run up to its normal speed with its field separately excited, the excitation being gradually increased until the armature current reaches its full-load value. The readings taken are those of field and armature amperes, which, when plotted, will represent the short-circuit characteristic on the direct-current side of the converter.

A short-circuit test on the alternating current side is carried out in a similar manner, the readings taken being those of armature and field amperes, and kilowatts, the short circuit characteristic being represented by curves having armature amperes as abscissæ, and field amperes and kilowatts as ordinates.

Compounding and Efficiency.—A compounding test, which is really a form of regulation test, is made to show the relation between the kilowatts output and the terminal voltage on the direct-current side, and the most satisfactory method of making this test is to run the machine with a constant field strength, so that the generator voltage will increase with the load current.

The efficiency of a converter may be obtained (1) directly from a full-load test, (2) by calculation from the losses. The first method consists in running the machine on full-load at unity power factor, and measuring the alternating current input and direct-current output, the efficiency being the ratio of these two quantities. When the efficiency is worked up from the losses, these are calculated for different outputs on the direct-current side, the efficiency being given by $\frac{\text{Output}}{\text{Output} + \text{losses}}$. The copper loss in a converter armature is calculated for values of equivalent currents, and not the load current, as is the case with a direct-current generator.

The Commercial Tests made on converters are those of (1) polarity, (2) synchronising, (3) temperature, (4) insulation.

Synchronising.—The object of this test is to obtain data showing the conditions under which a converter may be synchronised with the line when started up from its alternating current side. Before starting the test the brushes on the direct-current side should be set on the neutral position, and the voltage and current required to start the starting motor should be taken with the shunt field of the converter open, so that the friction loss may be calculated. When the exact moment of synchronism is reached as indicated by the synchronising arrangement used for this test, readings are taken of the shunt field current, direct-current voltage, and terminal voltage on the starting motor, this data serving as a guide to the operation of synchronising the converter.

Temperature and Insulation Tests.—A temperature run on full-load is only possible with machines of moderate output, and in the case of large machines they are run short-circuited on the direct-current side with the field separately excited to give the full-load armature current. This test is followed by running the machine self-excited on open circuit, the exciting current being about 25% above its normal value.

Motor Generator Sets.—It is the custom to carry out the usual experimental and commercial tests on each machine separately when the set is the first built to a new design, the combination being then run on full-load either directly or by loading back when two similar sets are available.

The Electrical Engineers (London Division).—Orders for week ending November 27, 1909: Officer commanding, Col. R. E. B. Crompton, C.B. Monday, November 22, "A" Co., Technical Drill, 6.30 to 9.30 p.m.; Tuesday, November 23, "B" Co., Technical Drill, 6.30 to 9.30 p.m.; Wednesday, November 24, Gynasium, 6.30 to 9.30 p.m.; Thursday, November 25, "C" Co., Technical Drill, 6.30. to 9.30 p.m.; Friday, November 26, "D" Co., Technical Drill, 6.30 to 9.30 p.m.; Saturday, November 27, "C" week-end run at Coalhouse Fort. Parade at Fenchurch-street Station, 3 p.m. Tickets will be issued at the station.—P. H. Campbell, Capt. R.E., and Adj. for O.C., E.E., L.D.

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ELECTRICAL PROGRESS AT HOME & ABROAD

FROM OUR SPECIAL CORRESPONDENTS.

TYNESIDE NOTES.

NEWCASTLE.

The Newcastle and Gateshead Incorporated Chamber of Commerce have recently been taking up with the General Post Office the question of the advantages of printed or typed telegrams, and as a result a letter has recently been received from the General Post Office which indicates that the Postal Authorities are determined not to be behindhand in securing means of legibility in telegrams. This is a most important point, especially in connection with commercial dispatches. This letter states that the Postmaster-General recognises that the various typewriting telegram systems have their different advantages and disadvantages, and in this country, no less than abroad, trial is being carefully made to determine their usefulness. The letter explains that typed telegrams as delivered to the public are sometimes automatically printed by typewriting telegraph apparatus, such as the Hughes or the Baudot, and sometimes written upon the delivery form by an operator using an ordinary typewriter, and transcribing the message from sound or Morse slip. It states that about half the telegrams for delivery in Newcastle, passing over the wires from London to Newcastle, are being typed in this latter manner at the present time.

Electrification of Salt Works.

One of the most recent interesting applications of electricity to industries is to be found at the recent equipment at the Clarence Salt Works of the Salt Union, Ltd., of Middlesbrough. This has been accomplished by Messrs. Jarvis Bros., of Middlesbrough, and the work involved the changing over from steam to electric drive of the brine pumps, an operation which required a certain amount of experiment, as the power used in this process is somewhat indeterminable. The work also included the erection of a considerable amount of overhead cable transmission and the interior wiring of the salt works. As brine is known to be a good conductor of electricity, a considerable amount of care had to be exercised in completing this installation. Power is supplied from the mains of Cleveland and Durham Electric Power, Ltd., at a pressure of 440 volts between each of the three phases, at a frequency of 40 cycles per second.

Aluminium Industry on Tyneside.

Considerable satisfaction is expressed in electrical circles on Tyneside at the prospect of the resumption of operation of the Wallsend Works of the Aluminium Corporation, Ltd., owing to the probability of a re-construction of this company. It may be recalled that last year extensive works were constructed both at Wallsend and Dolgarrog, in North Wales, for the production of aluminium from refined bauxite, and, in addition, the construction of works at Hebburn was carried some considerable length for the purpose of refining the crude bauxite obtained from the south of France. As the capacity of the electrical plant installed at Wallsend is in the nature of 4,000 kw., and as the process is a continuous one, it will be seen that the resumption of work will mean a very much improved load and load factor for the Newcastle-upon-Tyne Electric Supply Co., Ltd., who supply the works from their station at Carville.

Electric Pneumatic Signalling.

An important system of electro-pneumatic signalling in connection with the North-Eastern Railway is rapidly nearing completion at the approaches of the Central Station, Newcastle-on-Tyne. The net work of points and crossings at this locality is among the largest and most intricate in the provinces, and special means have had to be devised in order to cope with the traffic conditions. As it is possible that Mr. Charles Harrison, M.I.C.E., the Civil Engineer to the North-Eastern Railway, will be describing this installation before the Institution of Civil Engineers, full technical details regarding the installation are not at the moment available.

Automatic Street Gas Lighting.

It will be of interest to electrical engineers to note that in Newcastle at the present time extensive experiments with regard to the automatic lighting and extinguishing of the street lamps, and various systems are being tried in the different districts. In connection with this matter public interest is being aroused, and a letter in the local Press has emphasised the danger which will accrue to householders if the lamps are automatically switched off at 12 o'clock midnight, as, apparently, is the case at present. This raises a point which is valuable in two ways. It not only shows that gas engineers are preparing by means of shortening the hours of illumination to meet the competition in cost of the metallic filament lamp for side street lighting, but it also shows to electrical engineers the limits which must be placed in the interests of public safety upon the time switching electrical device for side street lighting which are now upon the market.

MIDLAND NOTES.

BIRMINGHAM.

The third annual dinner of the Birmingham Local Section of the Institution of Electrical Engineers proved a most enjoyable function. The solidity of the speeches was frequently relieved by little flashes of humour. The Chairman (Mr. R. K. Morcom) proposed the toast of "The Institution of Electrical Engineers." Professor Gisbert Kapp (the President), in responding, held that this country was not really behind Germany in electrification In the latter country, the Professor had lived 11 years. Englishmen, he said, were not behind in the making of machines, but rather in the using of them. The Germans succeeded because their industries being new, had made larger use of electricity. Enormous reserves of power were available in this country in the heat running to waste from coke ovens, and he looked forward to the time when electricity would become the handmaid of all the staple industries of the kingdom. Mr. W. M. Mordey, proposing "The Birmingham Local Section," devoted his speech to an anticipation of the great advantage which would come to the Institution from the new premises on the Thames embankment shortly to be opened. The speaker also paid a local tribute to the enterprise of Sir Alfred Hickman in making use of electrical driving for steel rolling by means of waste gases, at his great mills at Bilston. They were, he said only just beginning the business of electric supply. Interesting speeches followed from Mr. J. C. Vaudrey, responding to the last-named toast, and from Mr. W. H. Pachell, in proposing the "City of Birmingham." In responding to the latter sentiment, Mr. Chattock, (Chief Electrical Engineer to the Corporation), spoke of the rapid increase in the use of power in Birmingham. He pointed out that under the Greater Birmingham Scheme now being promoted, the bringing in of adjacent towns, making Birmingham the second city in the United Kingdom, would find great scope for the use of electricity. In 1901, when the Corporation took over the concern, there was 900 h.p. for mechanical driving connected with the main; now there was 17,000 h.p., of which 7,400 h.p. represented high-tension supply. The toast of "The Electrical Industries" was proposed by Mr. J. F. C. Snell, Member of Council, and responded to by Mr. M. Ralling, Vice-Chairman.

Birmingham Electric Club.

The first paper of the session in connection with the Birmingham and District Electric Club was given by Mr. Carl de Hoedt, on "A Discourse on Problems of Power-Generation and the Transmission and Distribution of Electrical Energy." Eventually, the speaker postponed the latter division of the lecture to a future occasion. A number of lantern slides included an excellent view of the Indiana Steel Plant, Gary Co., the Newcastle-on-Tyne Electric Supply Station, and other large plants. The speaker anticipated a great future for electricity in household supply, as the price would become cheaper with larger output. He insisted upon the necessity of chemically examining the feed-water for the purpose of avoiding excessive hardening, and gave a number of methods by which this testing could be carried out. There was a danger that the softening process might be more harmful in its effects than the original hardness. Generally, the cheapest coal used was also the most economical in the long run. The waste gases going up the chimney should also be carefully analysed. As a rule, it was very wasteful to have long steam pipes in the boilers because of the condensation resulting. In the discussion which followed, Mr. Smith remarked that in some places very cheap coal was impossible owing to its emission of smoke. He had sometimes been appalled at the length of steam pipes in the Black Country ironworks. Mr. Roberts pointed out the impossibility of giving guarantees as to calorific values of coal, and Mr. Howell gave some interesting particulars of the Greenwich Generating Station where, he said, there was a system of paying for the coal on the basis of the heat units obtained. The price was increased or decreased according to any variation from 12,500 heat units. The system worked quite satisfactorily. It was possible to prevent excessive moisture at the engine by sloping the steam pipes so as to give it a drainage, and undue lengths of piping might be prevented by dividing them into sections with section valves. Mr. Vincent E. Walters (Vice-President) occupied the chair, in the absence, through illness, of Mr. George T. Wood. A letter was read from Mr. P. M. Baker, of Bombay University, acknowledging a complimentary expression from the club on his departure for India.

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LANCASHIRE NOTES.

MANCHESTER.

Trade here continues to be in a very bad state, and if it were not for foreign orders, more than one firm would probably have to close its works. As it is, reductions in staffs and men occur daily, and speculations as to who will go next exercise the minds of all. The only branch of the electrical business that seems to be really prosperous at present is the heating line. Manufacturers report that they could sell easily twice as much apparatus as they can make, in the season. The business in arc lamps, usually so good at this time, has fallen very flat, partly owing to the competition of high c.p. metallic filament lamps, partly to the field becoming exhausted, but largely to the general scarcity of money.

Electrolytic Bleaching.

The belief is current in certain places that the electrolytic bleach cannot, by reason of its price, compete with bleaching powder. Mr. Reuss, of Ernest Grether & Co., Manchester, shows in a recent letter to the *Manchester Guardian* that the electrolytic bleach is the best. Strength for strength, it will do 20% more work; or ·7 kilo of active chlorine will bleach 100 kilos dry weight of cloth (proportion quoted by Swiss works) in the same time and under the same conditions as 1 kilo of active chlorine made from bleaching powder. The power absorbed by this firm's electrolyser is 9,000 kw. hrs. per ton of chlorine. Taking ·33d. per kw.-hr. (a reasonable figure for, say, a 600 kw. plant, allowing for interest and depreciation), the cost of power per kilo of chlorine is 2·925d., or, adding 1d. per kilo for salt, 3·925d. This less 20% is 3·14d. per kilo total cost, as against 3·1d. per kilo for chlorine from bleaching powder. The strongest point, however, for the electrolytic bleach is the economy obtained in the after treatment. After the chemicking, there is the souring employed to get rid of the lime deposited from the bleaching powder solution. In the electrolytic, there being no lime to neutralise, the acid, if used at all, may be very weak. The strong alkali and acids necessary in the bleaching powder process harden the fibres of the cloth, and need considerable washing out. The electrolytic, being barely alkaline, leaves the cloth soft, brilliant in appearance, and unimpaired in strength; the brine, being exceedingly soluble, penetrates the fibres, and is very easily washed out. The ammeter and thermometer take the place of the twaddle glass (an imperfect indicator), and the results with the electrolytic bleach can thus be controlled with absolute certainty. Plant manufacturers may find a field for electrical machinery in connection with this bleach.

Rochdale Tramways Extensions.

Negotiations are proceeding between the Rochdale Corporation and neighbouring authorities for extensions of the system. The Whitworth extension is already arranged, but has not been commenced on. Before it is completed, authority is to be obtained for joining it with a southward extension from Bacup to Shawforth, which will form the last link (about 2 miles long) between Rochdale and Blackburn. Milnrow is applying next year for tramway powers. There is a prospect of a considerable sum being spent during the next two or three years in this district on traction and power stations. The work of extending lines from Healey to Shawforth is to be commenced in the spring.

Students' Section's Opening Meeting.

The local Students' Section of the Institution of Electrical Engineers held their opening meeting at the Moseley Hotel. About 80 members and friends were present, and the proceedings opened with the customary supper, which was followed by a smoking concert. Mr. C. S. Richards, B.Sc., who presided, congratulated the section on the splendid results of last session, when four of the eight papers read gained premiums. He commented on the poor salaries paid to young engineers in proportion to the training required for the work, and on the unsatisfactory state of the profession. He asked every member to think the matter over and send in his suggestions to the Hon. Secretary (Mr. L. H. A. Carr, M.Sc.) as soon as possible. In this way something definite might be done. Trade unionism had done well for the workmen (though it had gone rather too far in some directions), and he thought they should seriously consider what they could do on the same lines. Manufacturers did not sufficiently appreciate their engineers—particularly the younger men.

AMERICAN NOTES.

NEW YORK.

Further satisfactory tests have been made with the new electric locomotive intended for use in the New York Tunnel Extension of the Pennsylvania Railroad. The locomotive follows, in general type, the plan of mounting the motors above the drive wheels and transmitting the power thereto by connecting rods. There is a single motor for each two pairs of drivers, and it is claimed that by the arrangement of motor support and connection which has been adopted, the height of the centre of gravity closely approximates that in high-speed locomotive practice. The motor is located high up from the roadbed, secure from snow, dirt and water, and space militations are largely removed. In its design it possesses electrical features never before secured on an electric locomotive. The "Pennsylvania" type locomotive is built in two sections; that is, two independent units coupled together Each section has eight wheels, four of which are drivers, 68 in. in diameter, the other four being truck wheels 36 in. in diameter, constituting in wheel arrangement and weight distribution, the "American" type. The sections are permanently coupled back to back by a distinctive arrangement of Westinghouse friction draft gear and levers, so that the leading section effectually pilots the rear one. This obviates all necessity of turning the engine, as it runs equally well in either direction, and all manipulating levers are duplicated in each section, so the operator simply changes ends.

A Constant Drive.

It has to be noted that the two pairs of drive wheels are coupled to a jack shaft, in line with the driver axles, which, in turn, is coupled to a motor crank shaft, to which a single motor delivers all its power. The cranks are 90° apart, so there can be no dead centre position, and the motor crank revolves uniformly and at constant effort, differing therein from steam practice, and while the pressures on the connecting pins and rods vary throughout each revolution, the turning effort of the drive wheels is the same as for the motor, constant throughout each revolution. All rods and moving parts have pure rotaion only, and are thus counterbalanced for all speeds, thereby delivering no shock to the track and roadbed. The single motor weighs, without gear, 45,000 lbs., and in weight and power it is the largest railway motor ever constructed. The locomotive complete weighs 330,000 lbs., develops 4,600 h.p. (about three times as much as a large freight locomotive), and can pull a heavy freight train at a speed of 60 to 70 miles per hour. Twenty of these giant locomotives are to be put under construction at the Westinghouse Company's shops at Pittsburg.

Chicago Electrification.

A great amount of interest continues to centre round the question of railway electrification in Chicago. The uncompromising attitude of the Illinois Central has only whetted the zeal of the reformers, and a brisk correspondence on the subject is in progress both in the newspapers and in the technical press. Mr. B. J. Arnold, in a noteworthy interview, declares that at least three of the railroads in Chicago could advantageously convert their terminals to electric operation. "It is an engineering fact, now well established," he says, "that our great railway terminals, where traffic is constant, switch engines are shunting back and forth and suburban trains run at frequent intervals, can be operated more economically by electricity than by steam. On the lines of the Illinois Central conditions apparently exist which are most favourable to this change. To install electrical equipment you incur large fixed charges, but with constant use a large economy is effected. Heavy freight trains running at long intervals provide a poor field for electrification. The experience of Eastern roads in the abandonment of the steam locomotive has demonstrated the possibility of economy, but it has not as yet been fully realised. The maximum use is not now being obtained on the New York Central or on the New York, New Haven and Hartford. When it is, the full economy will become apparent."

The Cost of Energy.

The Illinois Central's chief argument against electrification is "the prohibitive cost of electric energy." This argument has been effectually dissipated by Mr. S. Insull, President of the Commonwealth Edison Company, of Chicago. In the course of an address at the Chicago Electric Club, he pointed out that the cheap electricity available in Chicago should have an important bearing upon the agitation in relation to electrifying the terminals of the steam railroads. There were, of course, vast problems to be settled before this electrification could be accomplished, but so far as the current-producing side of the argument was concerned, it was a mistake to say that electrification was impossible because of the cost of electric energy. If this objection was based on a knowledge of the cost of electric energy used for the electrification of steam-railroad terminals around New York, it was based on false premises if it was contended that the same cost of electric energy must apply in Chicago. It was a fact that electric energy could be bought in Chicago considerably cheaper than it was now being produced by the two great traffic lines with electrified terminals in New York. Mr. Insull declares that his company could take care of any two railroad terminal electrifications in Chicago, based on the present consumption of current by the roads running into Grand Central Station in New York, with the present capacity of the Edison stations. With additional equipment, which had been ordered to go into service within a year, two additional terminals of like capacity could be served.

Electricity in the Home.

The phenomenal business which is being done in this country by dealers in domestic electrical appliances is a source of perpetual surprise to English visitors here. A prominent member of a Midland manufacturing firm, who was over here for the Hudson-Fulton celebrations and the New York Electrical Exhibition, was tremendously impressed by the big and

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profitable trade which is being done in this direction. In the course of an interview before he sailed last week-end he said, "We are really only on the threshold of this business in England, and I am taking back with me a few facts which I think are calculated to considerably astonish the trade at home. I propose to begin a large advertising campaign in this direction, and to start it as your American manufacturers do—namely, in the electrical trade papers. I shall put systematically before all the electrical dealers illustrations of every domestic appliance it is possible to manufacture, together with full details as to current consumption, cost per hour, and so on, and in that way get them to push these things with their customers, and, if necessary, offer them special terms on a proportion of their sales. I shall also get out special literature for the use of these customers, pointing out the advantages of these appliances, their cheapness, cleanliness and safety, and especially the simplicity of the method of use. I am convinced that the business is worthy of a big campaign, and I don't think my partners will hesitate for a moment to back it up."

Systematic Campaigning.

Our English visitor was, of course, quite right in concluding that the big business in these articles in the United States did not develop spontaneously by itself. It is the outcome of persistent campaigning in the trade journals. The manufacturers have "enthused" the dealers, and they in their turn have "enthused" the public. And this campaigning spirit permeates the whole country. The subject crops up at almost every Electrical gathering. A week or two ago, at Colorado, Mr. H. McConnel read an extremely interesting paper on this question. He was dealing with the selling of electricity, and he laid great stress on the necessity for enthusiasm. He went on to point out that the increased number of electrical appliances on the market to-day is making the power salesman's path a smoother one than ever before, but few of them, in the endeavour to close down steam or isolated plants, realise what opportunities are being stumbled over." It is safe to say that in the average business block there is scarcely a business house which cannot be induced to install a motor of some kind. The druggist can use an electric drug chopper; the tailor an electric clothes cutter, and the baker an electric dough mixer; the butcher a meat chopper, and so on. A central station commercial manager should not be satisfied until he has the public educated to the fact that his company is no longer the electric lighting company, but the electric company, so that when a customer applies for electricity he realises that he is applying for something by which he is able to sew, wash, iron, clean, cook and heat as well as light his home. In this, as in all other business, judicious advertising is the keystone. "Get the dealer interested, and he will be keen enough to get his customers interested too."

Psychology and Advertising!

The psychological aspect of advertising formed the subject of a discussion in this city recently, in which Mr. H. M. Post, of the Western Electric Company, and other well-known New York business men participated. Mr. George French found a text in a recent aphorism of Hugh Chalmers's—"Every sale by anyone anywhere is made in a man's mind, the mind of the one to become the purchaser." Mr. French said advertising was only profitable when this one thing was considered, "The individual advertisers are the men who create, who place, who look at this. If I am to do anything, if I am to be effective, I have got to get the mind of the man to whom I am to sell goods. In order to sell goods there must be a salesmanship message in the mind of the customer. Every human mind is favourably inclined to receive a suggestion. This is a psychological fact with nothing whatever occult about it."

Art as an Aid to Publicity.

Mr. French went on to observe that the principles and fundamentals of art are a great help to advertisers. "You must think of your advertisement as a picture. The eye has to have something to attract it, or a person can't be impressed. The impression is dulled unless there is a distinctive something to attract the eye, like a picture. Certain elements or qualities go to make an advertisement attractive; These are the same that lie behind every piece of art; that is, true art. Some of these are form, proportion, balance, harmony, tone, symmetry perspective, colour. They are easy to get if in planning you have in mind their usefulness. The most common form in advertising is the oblong rectangle. This is a rule of proportion. It can't be varied without bad results. Three to five, broadly, are the proportions, which are those of a properly constructed cross. Radiating from the point of intersection of the cross, one may work out symmetry, harmony and tone." Mr. French also advocated some study of optics. "The power of the eye," he urged, "is extremely limited. It seeks to reject the printed matter we seek to impress upon it. It acts in a seemingly erratic manner in reading. It doesn't travel steadily, but it jerks and jumps. These are known as fixation points. The eye wants to stop; it goes on haltingly, painfully. The normal reading line is not over 3½ in. wide. This the eye can take in with five, six or seven fixations. It should be divided up so that the eye can read it easily. Catchlines should be of such a nature th a the eye can pick them up without conscious impulse—withou any effort of the will. There should be no obstacles. This is of the utmost importance to the advertiser. Type below 9-point is apt to be less agreeable than 9, 10 or 11. We must also consider the design. Only two or three designs of type face endure. Almost all that have lasted are of the pure Roman style, because it is more agreeable to the eye. Caslon type, now more than a century old, is just as popular to-day as when first put forth."

Welding Tungsten Filaments.

An ingenious writer in a semi-technical periodical expounds a method of saving "dead" tungsten lamps from the scrap-heap. The chief drawback to the tungsten lamp, he says, is its liability to breakage. This is more liable to happen while the filament is cold, for the material from which it is made is more brittle then than while lighted and in a state of incandescence. It frequently happens that a jar or heavy vibration parts the filament at one point, leaving two ends separated from each other by the springiness of the filament though not drawn apart endwise. With the old carbon filament lamp this meant a spoiled lamp, no repair of the break being possible. The ordinary user, basing his act on experience with the old type, when he finds his tungsten lamp similarly broken consigns it to the scrap-heap with a sigh and a quick mental calculation to see if what he has saved in his monthly bills has paid for the new lamp he must buy. Many times this replacement could be saved by repairing the broken lamp if the user would make the attempt. This is how it is done. "Leaving the lamp in the socket with current turned on gently, tap the bulb with one finger to make the broken ends vibrate and wave about, the idea being to make them touch one another. If the lamp is on a drop cord or on a portable stand, turn it at various angles while tapping, and a little patience will frequently reward the experimenter with gratifying results, for the instant the broken ends come into contact the current flows and the filament heats to incandescence, and a weld is effected. The lamp can then be turned off and on as before, and may be considered a new one, although the weld is probably not quite so strong as the rest of the filament."

Current Items.

The Kellogg-Dean Electric Company has been formed with a capital of $7,000,000 to consolidate the Kellogg Switchboard & Supply Company, of Chicago, and the Dean Electric Company, of Elyria, Ohio. Its head-quarters will be in Chicago. Of the capital, $3,500,000 will be 7% stock, preferred both as to dividends and assets, and $3,500,000 will be in common stock. The new company will have a board of directors embracing prominent men in the independent telephone industry in the United States.

The committee recently appointed at Plainville, Connecticut, to investigate the relative value of the tungsten electric lamp and the Welsbach gas lamp for street lighting purposes has reported in favour of the tungsten lamp. The Connecticut Company has submitted a proposition to the town offering to furnish 90 100-watt tungsten lamps for the annual appropriation of $1,800, and to furnish 10 lamps, free of charge, where it is now supposed to furnish 16 c.p. lamps under the agreement of its charter.

The city of Dallas, Texas, has passed an electrical ordinance which requires bonds of every person who handles electrical appliances in any manner, including contractors and the men employed by them, window decorators, stage employés, etc. Before a permit for an installation will be given plans must be submitted showing every connection, and when finished the work will be inspected to see that it corresponds to the plans submitted.

The Southern Power Company, of Charlotte, N.C., offers special inducements to large cotton mill and other manufacturing plants to build factories at or near the hydro-electric plants of the company along the Catawba River, in North and South Carolina, where electricity can be supplied without loss in transmission at a very reasonable rate. The first plant thus organised is a $600,000 cotton mill, which will be built near Great Falls.

A boiler of enormous capacity has been installed in the new Delray electric power station of the Detroit Edison Company. It has a capacity of 2,274 h.p., and has a grate 150 ins. wide by 11 ft. long, served by four mechanical stokers.

The largest stick of timber ever brought into California has been raised at East San Pedro by the United Wireless Telegraph Company, to serve as an aerial. This piece of timber, which is a selected stick of seasoned Oregon pine, is 146 ft. in length, 4 ft. in diameter at the base, and 1 ft. in diameter at the top, and weighs nine tons.

A church on wheels in the form of an electric Gospel automobile is being used extensively in Cincinnati's slum districts. The queer little church contains a pulpit and seats for 16 persons. It is run by powerful storage batteries which also electrically light the interior.

The Board of United States General Appraisers has decided that reflectors for electric lights are dutiable at 45%, either as manufactures of glass or of metal. Until recently, collectors had been assessing this class of goods at 60%, on the theory that the glass was silvered for the purpose of ornamentation.

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A record in the quick repairing of a telephone cable has been made in Nashville, Tenn. A large grain warehouse was destroyed by fire, burning a 50 pair cable. The cable department got a record of the damage at 22 minutes after four, and at seven o'clock the repairs were entirely completed, in the meantime a section of cable having been strung, tested and spliced, the total length of time occupied by the repairs thus being 2 hrs. 38 mins.

GERMAN NOTES.

BERLIN.

To replace the dissolved Westinghouse Elektrizitats A.G. a new company has been floated with a capital of 100,000 marks, to continue the work previously carried on by the old company.

Abbazia.

A narrow gauge electric railway is to be constructed between Abbazia and Lovrana.

Bielitz.

The electric station is to be taken over by the municipality after having been run for 16 years privately. The property is valued at 1,200,000 k., and the annual profit is about 10% on that. There is, however, at present some dispute as to the price to be paid for the undertaking.

Breslau.

The Schlesische Akkumulatorenwerke A.G., has called an extraordinary general meeting with a view to liquidation. The company was founded in December, 1907, with a capital of 1,070,000 marks.

Bruneck.

The electric station here will be carried on by the municipality after the end of the current year.

Crefeld.

The report of the Statische Elektrizitatswerk for 1908–9 states that the period showed encouraging development of electrical undertakings, although not so much as the year before. The kilowatt hours for 1907–8 exceeded those for 1906–7 by 19·6%, those for 1908–9 exceeded those for 1907–8 by 13% only. The least increase was in the use of current for electric lighting. The diminution of this increase was largely due to the extensive introduction of metallic filament lamps, to say nothing of the heavy rents charged to business firms and private householders. The gross profits were 499,994 m. (463,261 in the previous year), and the net profits were 289,680 m. (267,306 in 1907–8). The average price got per kw. hour was 17·42 pfennigs (say 2d.), at a cost of 5·72 pfennigs. The energy wasted in the year was 390,549 kw. hours, *i.e.*, 7·88% of that produced.

Deutsch Gabel.

The Town Council has borrowed 45,000 k. to enlarge the town electric station.

Koln Suss.

The capital of the Regina Bogen Lam-enfabrik, G.m.b.H., has been increased to a million marks.

Mannheim.

The last report of Brown, Boveri & Co., A.G., states that business was worse than in the year before, owing to diminished orders and stern competition, to say nothing of having to pay higher wages and more for materials. There was also a strike which kept the works idle for seven weeks. On the other side of the account, however, there is the great extension of electric drive which has set in during the last year in paper mills. Of this the company has had its full share, having taken over the whole of the electric installation for three of the largest paper mills in Germany. Some of this work is already finished, and the machines are in operation. The profit was 525,195 marks, out of which a 6% dividend will be paid.

Mautern.

The white lead works have decided to build their own power station on account of the inaccessibility of the works on the Liesing, to provide 50 h.p. ; the cost is to be 60,000 k.

Millstadt.

The Government has granted a concession to Dr. A. Purpovac, of Vienna, to make the preliminary surveys for a narrow gauge electric railway from the Spittal Millstätter See station on the Marburg Franzenfeste line to Millstadt. The time allowed is one year.

Nagyvard.

The Ungarische Eisenbahm und Verkehr A.G. has secured the contract for getting water power from the Draganbach. That stream is to be joined by an artificial channel with Jadbach, and a fall of nearly a thousand feet is expected. The Government will subscribe 5,000,000 k. towards the cost of the reservoir dam.

Pressburg.

The Town Council of Pressburg had decided that if the Austrian Minister of the Interior does not make up his mind to provide an electric railway from Pressburg to Vienna, they will take the matter in hand themselves, and form a company. The Supreme Count, however, succeeded in stopping this, and the town is now putting pressure again upon the Minister. Trieste and other Austrian towns are also fretting over the delays of the Minister of the Interior, who, it seems, will neither make electric railways himself or let them be made.

Rheydt.

The Kabelwerk Rheydt A.G. has issued its report for 1908–9, Referring to the small dividend paid for last year and the confident expectation of better things expressed in the last report the directors now announce that that expectation has been realised to a considerable extent, for the turnover increased by 25%. At the same time it is proposed to issue fresh capital to the extent of one and a half millions of marks, because the company owes 1,850,000 marks to its bankers. The net profit was 348,029 marks, out of which an 8% dividend will be paid on the capital of 3,750,000 marks. 5,000 marks are reserved for the expenses at the Brussels znternational Exhibition, and 4,518 marks are carried over.

Salzkammergut.

Three huge power stations are being built in the Gesautal, using the Gesaubach for driving turbines. The electrical h.p. expected is about 21,000, but the works will take two years from now to complete. In combination with the stations already at work at the Essensee and the Schwarzensee, the new undertaking will supply power to Upper Austria as well as to the Salzkammergut, and will be able to work the railways in the latter district when they are electrified.

Tarnow.

The municipality has accepted the tender of the A.E.G. Union Elektrizitats A.G., for installing an electric tramway and power station at a cost of 692,000 k.

Tyrol.

In order to get electric power for the Arlberg Railway, it is proposed to utilise the currents of the Lutzbach and Marulbach. These streams will be dammed and the water taken a distance of four miles to a reservoir near Thuringen. The power house is under the road from Thuringen to Ludesch, and contains six turbines, each of 3,500 h.p. Under favourable circumstances 15,000 h.p. can be brought into use. An older project is now cropping up again, viz., to get water power from the Achensee, or rather from the river Ache which drains it. A head of over 1,000 ft. of water could be obtained and an energy of at least 15,000 h.p. The river would be dammed and the water drawn up to a second reservoir to be kept at a constant depth. The difficulty to be faced by the supporters of both these schemes is the opposition of the vested interests in the Ache Valley.

Ujpest.

The Vereinigte Gluhlampen und Elektrizitats A.G., proposes to increase its share capital by 1½ million k., the increase to bear interest from November 1, 1909. This will bring the capital to 5½ million k. The new capital will be issued by a syndicate controlled by the Ungarische Kommerzialbank, of Budapest, and will be applied to increasing the output of Osram and similar lamps.

Vienna.

At the tenth ordinary general meeting of the Vereinigte Elektrizitats A.G., the report for 1908–9 called attention to the bad state of trade and things generally during the past year, whereby receipts fell off and expenses did not. Had it not been for a large increase in the turnover, the company would have not been able to hold its own. As regards the output, it had greatly increased. The profits for the financial year were 912,962 k., 22,452 more than the year before. The net profit was 599,104 k., and the dividend 6%, as in 1907–8. The retiring directors were unanimously re-elected, and the report was adopted without opposition.

Volderbach.

A Halle syndicate is building a 300 h.p. electrical power station here.

Weissenbach St. Gallen.

A canal has now been traced out for bringing water power to a power station at Wiessenbach. The cost has been subscribed jointly by the State, the Steiermark, and the municipality of Vienna, together with a few private capitalists. The results of the survey are unfavourable. A long tunnel will be necessary, and the geology of the district will offer considerable difficulties. No other route seems practicable, however. The proposed canal would be about 10 miles long, and underground for most of the distance. The difference of level between the two ends of the canal is about 75 ft. At Weissenbach itself the head of water available for turbine driving would be about 600 m. It is proposed to make a reservoir holding two million gallons for storage purposes.

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BUSINESS NOTES AND NEWS.

LIGHTING AND GENERAL—Home.

BELFAST (Ireland).—At the Corporation Tramways and Electricity Committee meeting Mr. Bloxam submitted a report as to the plant that he considered would be necessary to provide for the increased demands for electricity, both for lighting and power purposes. He stated that the total plant capacity at present available for these purposes was 5,800 kw., but of this a 1,000 kw. unit must be reserved as a spare for either tramways or lighting, and a 400 kw. unit as a spare for lighting. This reduced the available plant capacity to 4,400 kw., and he estimated that he would require for the winter of 1910 5,200 kw., and for 1911 5,900 kw. It was, therefore, necessary to provide 1,500 kw. additional plant to meet the probable demands for the next two years. He estimated the cost of this extension at £62,200. The Committee agreed that specifications should be prepared with a view to application being made to the Local Government Board for their sanction to the raising of the necessary loan. In connection with the tramways a resolution was passed in favour of changing centre-pole construction to side-pole construction in certain streets.

BODMIN.—The local Lighting Committee have under consideration a scheme by the Wadebridge Electric Light Co. for establishing an electricity station.

BRAUNTON.—The Parish Council accepted the provisional offer of Messrs. Crompton & Co., of London, to do the public lighting by electricity at a cost of £52 per annum, provided sufficient shares were taken up to float the venture.

CHURCH.—A provisional order enabling the District Council to supply electricity for lighting purposes will be applied for.

COLCHESTER.—On the recommendation of the Electricity Committee, the Town Council decided that application be made to the Local Government Board for sanction to borrowing £8,000, which was made up as follows:—Amounts overspent of previous loans, £933 13s. 8d.; new works, £6,992 19s. 7d.; contingencies, £73 6s. 9d.

COLWYN BAY.—To the Urban Council the Lighting Committee submitted a report dealing with the report of Mr. Hill with reference to the electricity department and the reply thereto of the manager, Mr. Tudman. The Committee recommended a reduction of the electricity department manager's salary at the rate of £30 per annum for the next six months. This was unanimously approved without discussion.

DARLINGTON.—The Electricity and Light Railways Committee received a report on the electricity works, showing that there had been an increase in the number of units generated for lighting and power of 15·3%. The number of consumers connected was now 735, and the number of 8-c.p. lamps totalled 83,505. Some discussion took place in regard to the present service of the tramways, and Mr. Lunn was instructed to prepare a report showing whether it could be improved, and whether it was possible to run the cars more frequently. The receipts from the cars for the four weeks ending October 23 amounted to £743 7s. 10d., and for the week ending October 30 to £180 14s. 0½d.

DUNDALK.—A sum of £20,000 is to be spent by the Town Council for electrical plant.

DERBY.—The Town Council resolved to apply for a Provisional Order to authorise the supply of electrical energy, for public and private purposes, within the Urban District of Alvaston and Boulton and the parishes of Littleover, Breadsall, Chaddesden, Normanton and Sinfin Moor in the Rural District of Shardlow, and Markeaton and Darley Abbey in the Rural District of Belper.

DUNDEE.—The Peter's Electrical Engineering Laboratory at University College is nearing completion. The Chatham (Ship) Telegraph Co., Ltd., Bootle, have promised to present a Torsion meter, as used for measuring the power transmitted from a turbine shaft.

FAREHAM (Isle of Wight).—Mr. Hawes (Messrs. May & Hawes, the advisers to the Council for the new electric light installation) reported to the Rural Council that, with reference to the new generating plant very substantial progress had been made, and that some of the machinery had been tested, being put to a very severe test, and with very satisfactory results, there being no perceptible vibration. They were now in a position to proceed with the erection of the engine parts. The connecting cables of the new system had been laid in position, and, as regards the public lighting, everything was completely ready for the arc lamp section. They hoped to get all the public lighting well in use before Christmas. There were 63 old meters which could not be altered except at a large expense, and it would be necessary to get a new supply of meters. The Council decided to purchase a supply of the Westinghouse meters.

FARINGDON.—The Rural Council received a letter from the Lechlade Electric Power Co., suggesting that electricity should be the motive power used at the Waterworks.

HUDDERSFIELD.—The demand for electricity during the past 12 months has been considerably more than in any previous year. According to the official report to the Corporation, the consumers connected were 302, bringing the total number to 3,107. The lamps and other consuming devices connected during the year equalled 68,910 of 8 c.p., bringing the total connections equivalent to 292,002 of 8 c.p. lamps. Owing to the introduction of the metallic filament lamp, the connections during the past year have risen to the highest point we have ever touched. Although this large increase in lamps has been made, the output of electricity for lighting purposes is still lower than it was last year, due to the high efficiency of the new lamps. The 3-phase system of supply, which was commenced in May, 1908, has run satisfactorily, and there are now 1,951 h.p. connected to this system, and several more important consumers have arranged to take a supply as soon as they can be connected. The total number of motors connected with the 1-phase system is 416, with a total of 1,403 h.p. At the Council meeting the Mayor (Alderman Holroyd) announced that the Corporation are seeking powers to extend the tramway system to Birchencliffe and other places.

LOWESTOFT.—The Town Clerk reported to the Town Council that at a conference with hirers of pickling plots a majority of the hirers expressed their willingness to light their plots with electricity, provided the roads on the plots are lighted, and it was referred to the Engineer to report on the matter at the next meeting. The Council decided to apply to the Board of Trade for consent to the extension of the period for the completion of the light railways from Lowestoft to Kessingland.

MIDDLESBROUGH.—A special private meeting of the Town Council was held to consider the draft Bill proposed to be promoted in the next session of Parliament to obtain further powers with respect to the supply of gas and electricity, to establish thrift and accident funds, etc.

PEMBROKE.—The Urban Council resolved to apply to the Local Government Board for sanction to a loan of £8,000 for electric lighting extension work, the approximate figures being: Service cables, £3,136; mains extensions, £1,900; meters, £1,800; fuse boxes, £300; joint and network boxes, £300; coal store and coal hauling apparatus, £500—total, £7,936. The salary of Mr. Newell Hosgood, chief assistant at the electricity works, was raised from £170 to £180 per annum.

REIGATE.—Like many other alternating current stations in purely residential areas, the Reigate station has felt very severely the effect of the introduction of the metallic filament lamp, and the Council have now instructed Messrs. Handcock & Dykes, of Victoria-street, London, to report to them as to what steps they consider necessary to take to improve the present position.

STALYBRIDGE.—At the meeting of the Joint Tramways Board, Alderman Ridyard stated that for the second consecutive year they had the honour of producing the cheapest electricity in England. The last monthly receipts were a record, despite the fact that the price was 3d. per 100 units less than last year. They were now generating 1,200,000 units of electricity per month, and two additional boilers were being put in the works. The Board resolved to make an additional halfpenny tramway stage between Stalybridge station and Millbrook.

TORQUAY.—The whole of the boilers at the Corporation electrical station on the Beacon quay are to be equipped with underfeed stoking apparatus, combined with mechanical draught. The total cost is estimated at £927. Three of the boilers will be equipped at once, at a cost of £615. The Electricity Committee believe that a considerable saving in fuel will be effected. The saving will amount, it is calculated, to £520 per annum, from which has to be deducted the cost of current for the electric fans to create the mechanical draught and maintenance, £230; leaving a net saving of £290 per annum. The expenditure will be a charge to revenue. It is considered that the scheme will obviate the emission of smoke, etc., from the chimney, and that there will consequently be no necessity to have the chimney raised in height.

TUNBRIDGE WELLS.—A large party of Town Councillors and burgesses paid a visit of inspection to the Borough Electricity Works. The Mayor (Councillor Caley, J.P.) referred to the success which had been attended by the undertaking, and expressed pleasure at the adornment of the streets by the transformers. He spoke in eulogistic terms of the work of Mr. Horace Boot, consulting engineer, and also paid a high compliment to Mr. Beauchamp, the resident engineer, and Mr. Bemrose, the second-in-command. The Chairman of the Lighting Committee (Alderman Woollan, J.P.) was unavoidably absent, but wrote pointing out that in his opinion "no revenue whatever should be expected from the electric Lighting undertaking for the benefit of the rates of the town, as every apparent profit that may be shown will be required for the maintenance and the keeping up-to-date of the plant."

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WEDNESBURY.—At the Town Council meeting, Councillor Griffiths referred to the extensions that were being made in connection with the electricity department, and emphasised the fact that they were necessary if they were to make the undertaking successful. Alderman Pritchard said that as Chairman of the Finance Committee he considered that the amount being spent in capital in connection with the electricity undertaking a serious item. They had already taken 2d. in the £ from the rates, and the way things were going on there seemed to be no likelihood, in his opinion, of them being able to meet the expenditure for some considerable period. Councillor Griffiths admitted that the expenditure on the capital account was rather serious, but urged that it had been accepted in the financial statement, and he held that the extensions were imperative if the concern was going to prove what they hoped it would be—a success.

YSTRADGYNLAIS.—A scheme for the electric lighting of Ystradgynlais, Swansea Valley, has been adopted. The offer of Messrs. Mills, English, and Co., Swansea, to carry out the work has been approved at a meeting of the ratepayers.

LIGHTING AND GENERAL—Overseas.

ARGENTINE REPUBLIC.—A decree has been issued authorising the Central Northern Railway to proceed with the installation of telegraph lines at a cost of 48,373 pesos paper (about £4,200) along various sections of the railway in question, viz., from Clodomira to Añatuya, and from St. Cristóbal station to the head offices at Tucumán.

BRAZIL.—A decree has been issued authorising Mr. Edward Dwight Trowbridge, the concessionaire for the telephone systems of the State of Rio de Janeiro, to establish a low tension submarine cable between Rio de Janeiro and Nictheroy. This cable will be used exclusively for telephone purposes.

RUSSIA.—The Russian War Department has begun the installation of a chain of wireless stations connecting Russia in Europe with the far eastern parts of the empire. It is proposed for this purpose to erect a number of intermediate stations between the Baltic and the Pacific Ocean, and it is calculated that from three to four stations would be sufficient to permit of messages being transmitted from the Far East to St. Petersburg. In the most recent trials which have been made in military telegraphy in Russia, it was found possible to exchange telegrams between wireless stations on the Baltic and the Black Sea, a distance of 1,240 miles. In these experiments the most favourable results were obtained in damp weather.

SPAIN.—A correspondent reports that a Swiss financial syndicate has under consideration a proposal to promote a joint-stock company with the object of exploiting the numerous cataracts existing on the Catalonian side of the Pyrenees, in the valley of the Palaresa River. The report of the engineers states that these cataracts will be able to supply the entire industrial district of Barcelona with necessary power.

TRACTION—Home.

YORK.—The work of laying the track of the new electric tram system is being pushed on with all haste. The bye-laws and regulations to be made by the York City Council for the good government of the new electric tram system now in course of construction have been drafted, under the powers conferred by the York Corporation Light Railways Order, 1908, and the Railway Clauses Consolidation Act of 1845. For the most part they are similar to those which ensure the satisfactory running of the cars in other towns, and provide for the infliction of the usual penalties in the event of any wilful breach of the prescribed regulations.

TRACTION—Overseas.

NETHERLANDS.—The British Consul at Amsterdam (Mr. W. A. Churchill) reports the notification of the withdrawal of the concession for the construction of a tramway from Amsterdam to Krommenie, from Zaandijk to Wijk-aan-Zee, and from Woomerveer to Purmurend, which had been granted to the North Holland Electric Tramway Co. on March 28, 1908. The Consul adds that in the event of these tramways being constructed in the future it will be necessary to obtain a new concession.

SOUTH AFRICA.—The local authorities of East London have decided to relay the track of their electric trams at a cost of £8,500. A municipal electric lighting scheme is proposed for the town of Potchefstroom, and the Council are now considering the question. The installation is estimated to cost £15,000. The engineer to the Pretoria Municipality has reported to the Council on the new electric tramway system which it has been decided to put down at a cost of £160,050. It is probable that the orders for the whole plant will be placed in Great Britain.

PERSONAL.

Mr. John Oldham, manager of the River Plate Telegraph Co., has left the River Plate for London to hurry forward the construction of the direct cable between Buenos Aires and Ascencion Island. The cable is already under way. The route for the land line between Ensenada and the Buenos Aires office has already been surveyed; this line will be underground. He hopes to have the line opened to service within a year's time.

Mr. H. G. Such, representing the Union Electric Co., Ltd., Park-street, Southwark, London, S.E., arrived in Melbourne, Australia, recently by the R.M.S. *Ophir*, to commence business on behalf of the firm. He has taken premises at 33, William-street. Mr. Norman Danvers Power, of 4, Yarralla-chambers, 109, Pitt-street, Sydney, is the representative of the company in New South Wales.

The Tunbridge Wells Town Council received a letter from the Board of Trade stating that they had appointed Dr. Russell, the Principal of the Electrical Standardising Testing and Training Institution, as Electric Inspector for the Borough, in the place of the late Mr. Hugh Erat Harrison.

COMPANIES' MEETINGS AND REPORTS.

ALLGEMEINE ELECTRICITATSGESELLSCHAFT.

This company has declared a dividend for the business year 1908 of 13 per cent., as against 12 per cent. in the previous year. The net profits amount to £815,000, as against £795,000 for the previous year.

SIEMENS HALSKE ELECTRICAL COMPANY.

The directors of the Siemens Halske Electrical Co. will meet in Berlin on November 23 to consider the balance-sheet and to fix the amount of the dividend. It is considered likely, says the *Financial News*, that the distribution will be increased from 11% to 12%.

RIVER PLATE TELEPHONES.

The following are the particulars of the new issue by the United River Plate Telephone Co.:—An issue of 30,000 Ordinary shares of £5 each is offered to holders of Ordinary shares on the register on September 17, in the proportion of one new share for every four held. The shares are payable £1 10s. on application, £1 10s. on or before December 13, and £2 on March 1, 1910. Payment in full may be made on acceptance or on either of the above-mentioned dates, interest at 2% per annum being paid on the amount prepaid.

BRADNINCH ELECTRIC SUPPLY COMPANY.

Dr. D. K. Muir presided at the first annual meeting of the Bradninch and District Electric Supply Co. The directors, in their report, stated that the total number of lamps now being served was 63; the customers, after a period of nine months' working, were 819; and current was also supplied to three motors during the day. The income for the nine months was £178 2s., and the sum of £34 6s. 11d. had been set aside to form a depreciation fund. The report was unanimously adopted.

COMPANIES REGISTERED.

A. A. RUPPRECHT & CO., LTD.—Registered October 15. Capital £1,000, in £1 shares. Objects: To carry on the business of mechanical, electrical, and general engineers, etc. Private company. Registered office: Carlton House, Regent-street, S.W.

BURFORD ELECTRIC LIGHT AND POWER CO., LTD.—Registered November 9 by Jordan & Sons, Ltd., 116-17, Chancery-lane, W.C. Capital, £400, in £1 shares (15 Founders'). Objects: To carry on the business of electricians, mechanical engineers, manufacturers and workers of electricity, motive power and light, etc. Private company. The first directors (to number not less than two nor more than five) are: E. R. Nash and B. P. Gibbons. Qualification, £20. Remuneration, one guinea each per meeting attended.

CARMARTHEN ELECTRIC SUPPLY CO., LTD.—Registered October 14. Capital £10,000, in £1 shares (5,000 5% Preference). Objects: To acquire from J. B. Saunders & Co. the benefit of the Carmarthen Electric Lighting Order granted to them under the Electric Lighting Acts, 1882 and 1888, for the supply of electrical energy in Carmarthen, and to carry on the business of electricians, mechanical engineers, suppliers of electricity, etc. Minimum cash subscription, 25% of the shares offered to the public. Registered office: Salisbury House, London-wall, E.C.

ELECTRICITY GENERATING CO., LTD.—Registered November 9 by Beale & Co., 16, Great George-street, S.W. Capital, £1,000, in £1 shares. Objects: To carry on the business of generators of electrical energy, producers, accumulators, transmitters and distributors of electricity and gas, manufacturers of and dealers in dynamos, lamps, globes, insulators, etc. Private company.

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The first directors (to number not less than two nor more than five) are: F. Henwood and A. C. Paine. Remuneration, as fixed by the company. Registered office: 16, Great George-street, Westminster, S.W.

KINETIC CO., LTD.—Registered in October. Capital £5,000 in £1 shares. Objects: To take over the business of electrical and general engineers, manufacturers of and dealers in electric, water, and other engines and apparatus for blowing organs, air compressors and exhausters, etc., carried on by E. J. Jackson and J. H. Swanton at Lincoln, as the Kinetic Co. Private company. Registered office: Rosemary-lane, Lincoln.

CONTRACTS OPEN.

HOME.

BIRMINGHAM.—Parochial Offices.—Tenders for maintenance of private telephone installation at Birmingham Workhouse, Dudley-road, for period of 12 months. November 20.

DUBLIN.—United Tramways Co., Ltd.—Tenders for supply of general stores for the year ending December 31, 1910. By November 29.

EDINBURGH.—Corporation.—Electrical installation at McLeod police station. November 23.

EDMONTON.—Board of Guardians.—Cables and switchboard in connection with new infirmary. November 23.

INVERNESS.—Corporation.—Tramway permanent way. November 24.

LONDON.—Port of London Authority.—Supplies of carbons, for electric lights, electric (incandescent lamps), etc. November 22.

LONDON.—London County Council.—Tenders for covering with asbestos tape about 2¾ miles of lead covered high and low tension cables in manholes. November 30.

SUNDERLAND.—Tramway foundations, tracks, etc. November 25.

WAKEFIELD.—Wakefield and District Railway.—General stores, comprising electric lamps, and fittings, insulating materials, overhead fittings, etc. November 25.

YORK.—North Eastern Railway.—Tenders for arc lamp carbons, electric lamps, wires and cables, electric lighting, etc. November 25.

OVERSEAS.

BELGIUM.—At the Town Hall of Waremme. For a concession to light the town with electricity. January 30, 1910.

HOBART (Tasmania).—Postmaster-General.—Telegraph and telephone material, etc. Part. as above. December 20.

LIEGE.—Electric lighting at Jupille. December 31.

LUCKNOW.—Municipal Board.—Tenders invited for a concession for the supply of electric energy, coal or oil gas, for house and street lighting, and other domestic or manufacturing purposes. December 31.

MELBOURNE.—Deputy Postmaster-General.—Two sets of accumulators. By 3 p.m., November 23.—Postmaster-General.—To supply coin attachments (for coins of different values) for telephones. Spec. No. 184. 370 50 c.p. metallic filament lamps, with bayonet cap fittings, for 110 volts A.C.; 630 25 c.p. ditto; 160 16 c.p. Linolite carbon filament lamps, 110 volts A.C.; 1,000 16 c.p. T.H. screw socket carbon filament lamps, 110 volts A.C.; and 100 32 c.p. metallic filament lamps, with bayonet cap fittings, 200 volts A.C. December 7.

MELBOURNE. — Railway Commissioners. — One single-phase turbo-alternator, etc. December 17.

RUSSIA.—Kaluga Municipality.—Public and private electric lighting. November 24.

SAMARKAND.—Municipality.—Electric tramways. March 14, 1910.

SOUTH AFRICA.—Johannesburg Municipal Council.—For the supply of tramway poles, overhead material, electric cables and joint boxes. November 29.—Hardwood sleepers, vignole rails and fastenings. November 30.

SYDNEY.—Postmaster-General.—Switchboard apparatus for subscribers' premises. Particulars of all Australian contracts, 72, Victoria-street, Westminster, S.W. January 10, 1910.

TURKEY.—Broussa Municipality.—For a concession for the installation of electric light and power, and for the construction of an electric tramway. December 13.

SOME CONTRACTS.

The London County Council Highways Committee passed a resolution in favour of extensions of the underground telephone system between the various sections of the tramways department. Last year the County Council accepted the tender of W. T. Henleys Telegraph Works for the supply of low tension electric cables and telephone cables, and the Committee now decided that the extra work should be carried out as an extension of the existing contract. The estimated cost involved will amount to about £2,200.

Messrs. McGuire & Gatchell, Ltd., of Dublin, to whom has been entrusted the electrical installation of Kilkenny Asylum, have placed the order for the necessary storage battery of 120 cells with the D.P. Battery Co., Ltd., of Bakewell.

We note that the Mines Power Co., Ltd., contract for switching equipment, lightning arrestors, cables and wiring for the Matabitchouan river generating station and for the Cobalt and Kerr lake sub-stations, has been awarded to the Canadian Westinghouse Co. The apparatus includes 44,000 volt automatic oil circuit-breakers and electrolytic lightning arrestors.

Mr. Frederick Adams, managing director of Messrs. Pearson & Sons, England, met the directors of the Mexican Northern Power Co., Ltd., in Montreal recently and signed a contract for the development of a large site in the northern part of Mexico on the Conchos river, to supply power and light to the mines in that territory. The contract involves an outlay of five million dollars.

The storage battery and automatic reversible booster balancer set required in connection with the electrical equipment of the Northampton Polytechnic, Clerkenwell, are being supplied by the D. P. Battery Co., Ltd., Bakewell.

The Canadian Light & Power Co. have closed contracts with the Eugene F. Phillips Co. and the Wire & Cable Co. for the copper requirements of their transmission line which will be erected between St. Timothee and Montreal.

The Western Canada Power Co., through their purchasing agents, the Montreal Engineering Co., awarded the contract for their complete requirements of water wheels and turbines to the Escher-Wyss Co., of Zurich, Switzerland. The Allis-Chalmers-Bullock Co., Ltd., will supply a 450 kw. generator to be installed in their temporary construction plant.

The contract for 60 transformers in sizes of 160 K.V.A. and less for the Cobalt Power Co., Canada, has been awarded to the General Electric Manufacturing Co., of Sweden, through their representatives, Kilmer, Pullen & Burnham, Toronto.

The undermentioned contracts have been awarded for the Verdun, Quebec, electric light plant: Electrically driven sewer pump, capacity 10,000 gallons per minute, Gouls Pump Co., of Montreal; two 300 h.p. compound condensing steam engines, Belliss & Morcom, Ltd., Birmingham, England, Laurie & Lamb, Montreal agents; two 235 K.V.A., 3-phase engine type generators with direct connected exciters, also complete switchboards, Canadian Westinghouse Co., Ltd. Tenders are being called for boilers, condensers, crane, etc.

The Hydro-Electric Commission, Toronto, Ontario, awarded the contracts for electric cranes and hand cranes to Royce & Co., Ancaster, England, and the Mussen Co., Ltd., Walkerville, respectively.

Messrs. Hamilton Bros., of Glasgow, recently secured an order for 36 of their "W.H." motor control panels for the Glasgow Corporation main drainage scheme, Outfall Works, Shieldhall, Glasgow. Each panel consists of slate 1¼ in. thick, having ammeter, ironclad switch, bell push, and "W.H." ironclad motor starter mounted thereon. The apparatus on several of the panels has to be damp, dust, and gas proof, and all the "W.H." starters are fitted with hinged covers, no asbestos being used in their construction. This installation of motor panels is one of the largest in this country, and it is interesting to note that all the apparatus is of British manufacture throughout, being made at the firm's Edinburgh works.

TENDERS ACCEPTED.

COLCHESTER.—The Corporation accepted Crompton & Co.'s tender to supply the plant necessary for the proposed sub-station at Lexden, for £374.

LONDON.—The tender of Messrs. Johnson & Phillips, Ltd., Charlton, Kent., £230, for electric lighting of Buxton-street School, Whitechapel, has been accepted.

SUNDERLAND.—The Town Council accepted the following tenders:—Crompton & Co., Ltd., London, and Mayer & Co., Ltd., London, arc lamp carbons for the ensuing half-year; the Indiarubber, Gutta-percha & Telegraph Works Co., Ltd. Silvertown, indiarubber gloves; Morris & Sons, Manchester, fire hose; J. W. White, Sunderland, dismantling iron cooling tower uptakes in Dunning-street; Warren, Beattie & Co., Middlesbrough, automatic regulator for turbo-generator.

CATALOGUES AND LISTS.

We have received from the Edison and Swan United Electric Light Co., Ltd., a copy of their latest catalogue dealing with electric light accessories. While a number of the goods listed have been improved in various details, and in many instances prices reduced, there are at the same time a very great number of additions. Reference may be made to a new

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type of counterweight with specially heavy brass parts, together with several different types of combined well sockets and plugs. The well-known Phlatta switch is also listed in several ornamental designs, and there are a number of strikingly handsome patterns of fancy switch plates included. Worthy of particular notice is a new push pattern pear switch, with key holder movement, together with other designs. The heavier type of quick make and break knife switches, double pole house service or motor switches, and special ironclad switches are also included, together with battery regulators, etc. A variety of designs of Ediswan switchboards are given, and there are also several pages dealing with small accessories, such as jointing materials, insulators and iron work, wiring cleats, casings, cable sockets and connectors, and fusible wires.

POSTAL TELEGRAPHS AND TELEPHONES.

The Postmaster-General reports that during the year 1908-9, 84,825,000 telegrams were transmitted, a decrease of 1·3%. The total number of telegraph offices is now 13,490. The number of foreign telegrams, inward and outward, was upwards of 9,421,000, an increase of more than 274,000. Twenty-eight licences, covering 48 installations, were granted for experimental wireless stations. The trunk telephone exchanges open numbered 598, an increase of 47; during the year 141 trunk circuits were opened, making a total of 2,526. The capital expenditure on the trunk Telephone system was increased by £736,138 to £4,682,796. the total number of conversations over trunk lines was 23,502,024, an increase of 6·86%. The gross revenue from inland calls was £573,883, an increase of 7·25 %, and the average receipts per conversation were 5·86d. Continental calls brought in a revenue of £22,125, an increase of £938. The telegraph revenue of the year was £3,099,724, a decrease of £1,216, and the expenditure, including interest on purchase capital was £4,218,659, an increase of £44,776. The telephone revenue was £1,522,442, an increase of £139,262, and the expenditure was £1,567,570, an increase of £133,219, leaving a net deficit of £45,128. There are now 25 commercial, 11 private, and 164 experimental wireless stations in the United Kingdom. The underground telegraph line between Glasgow and Edinburgh is practically complete; the line running south from Newcastle has reached Stockton-on-Tees; that to the west, Penzance; and the extensions from Birmingham and Bristol have reached Worcester and Berkeley. It is intended to provide underground connections with the landing places of the principal submarine cables to the Continent.

The total number of British merchant ships now equipped with wireless apparatus is over 100, most of them being Atlantic liners. The International Radio-Telegraphic Convention has worked smoothly, and its effect has been distinctly advantageous to the Marconi Co., which has co-operated loyally with the Government in carrying out the provisions of the convention. The number of outward radio-telegrams dealt with during the year was 1817, and inward 22,732.

During the year 102 P.O. telephone exchanges were opened in the provinces, and 55 public call offices connected with the trunk system. Numerous additions have been made to the rural call offices, which are served by adapting existing telegraph wires for local telephone working. The total number of subscribers to the P.O. provincial telephone exchanges at the end of March, excluding Glasgow and Brighton, was 12,618, as compared with 11,579. The number of subscribers in Glasgow was 8,525, and the number of stations 15,595; at Brighton the numbers were 1,211 and 1,721. At Glasgow a new P.O. central exchange of the latest type is being constructed at a cost of £100,000, to accommodate 10,000 lines; when this is opened, the present exchange purchased from the Corporation will be closed, as it is worked on the call-wire system, and cannot meet the increasing requirements of the service with efficiency or economy. The Hull municipal telephone system has 2,445 telephones (1,850 lines) connected, and that at Portsmouth 2,566 telephones (1,987 lines).

The rental of private wires provided by the Post Office amounted to £195,243. The London P.O. telephone service comprised 55,125 telephones and 682 call offices, with 2,417 miles of underground pipes, and 447,797 miles of wires; 124,571 miles of wire were rented by the National Telephone Co. Royalties for telephone licences amounted to £293,828 from the National Telephone Co. and to £2,618 from other sources. The mileage of wire in the Post Office system now amounts to 304,562 for telegraphs, 548,694 for telephones, and 193,656 for private lines—total 1,046,912 miles—of which 412,434 miles are aerial, 623,930 underground, and 10,548 submarine.

ELECTRICAL OPPORTUNITIES IN TURKEY.

In the course of a long article on "Prospects in Turkey," a correspondent of our contemporary *The Financier*, writing from Constantinople, says:—"It is in electrical enterprise that the greatest development will be seen in this Rip van Winkle of a city. Considering that in the olden days, when it was called Byzantium, and when it represented all that was wonderful in civilisation's last word, it is extraordinary enough that it has slipped so far backwards; but its renascence is still more marvellous. Imagine a city—so far as population is concerned—like Manchester and Liverpool combined. Imagine it with a paving that calls forth curses from the man used to decent asphalt and flagstones and square setts; with no drainage system worth mentioning; with trams like prehistoric bathing machines, pulled by South African remounts and a boy walking in front blowing a horn; imagine a city of this size positively virgin so far as electricity goes; imagine this moribund city waking up and crying out for all the refinements of the other capitals of Europe. Remember to what uses you and I put electricity every day, and then, knowing that the money is there, and that the people are willing to spend it, you will begin to get an idea of the trade to be done. There is nothing—except carpets and Turkish Delight—that we cannot give the Turk; there is nothing that he will not buy at a fair price; there is nothing he does not want except missionaries and spirits.

"The new Constitution is making good; its officials are approachable, and it is for the English manufacturer to strike whilst the iron is hot."

LIGHTNING CONDUCTORS.

Apropos of the question on "Lightning Conductors," discussed in our correspondence column, Mr. W. Dalby, Hillside, Sparkhill, Birmingham, writes: "Your correspondent 'A. W. P.' could not do better than see the books and papers by A. Hands, F.R.M.S., W. H. Whitehouse, M.I.E.E., and Sir Oliver Lodge; then get in touch with one of those gentlemen and he will acquire a good understanding."

DIARY:

FRIDAY, NOVEMBER 19.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—At Sunderland, general meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Glasgow Students' Section).—At 8 p.m., at Glasgow Technical College, "The Localization of Breaks in Submarine Cables," by W. H. Young, B.Sc.

INSTITUTION OF MECHANICAL ENGINEERS.—At 8 p.m., at the Institution House, London, paper by H. A. Humphrey.

SATURDAY, NOVEMBER 20.

JUNIOR INSTITUTION OF ENGINEERS.—At 3 p.m., visit to foundation work of the new County Hall of the London County Council, Belvedere-road, Lambeth, S.E.

MONDAY, NOVEMBER 22.

MUNICIPAL AND COUNTY CLUB.—At Whitehall-court, London, S.W., house dinner, Col. Hughes, C.M.G., ex-Lord Mayor of Sheffield, guest of the evening. Lord Alverstone, G.C.M.G., P.C., will preside.

TUESDAY, NOVEMBER 23.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Students' Section).—At 7.30 p.m., Municipal School of Technology, "The Testing of Electrical Machinery," by R. F. Blackmore and V. W. Newman.

WEDNESDAY, NOVEMBER 24.

ROYAL SOCIETY OF ARTS (London).—At 8 p.m., at John-street, London, W.C., "Photo-Telegraphy," by T. Thorne Baker, F.R.G.S.

THURSDAY, NOVEMBER 25.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—At 8 p.m., at Great George-street, Westminster, S.W., "The Present Aspects of Electric Lighting," by H. W. Handcock and A. H. Dykes, members.

FRIDAY, NOVEMBER 26.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—At Northampton Institute, London, "Single-phase Electric Traction," by T. A. Collett, Dr. C. V. Drysdale, M.I.E.E., in the chair.

PHYSICAL SOCIETY OF LONDON.—At 5 p.m., at the Imperial College of Science, South Kensington, "The Effective Resistance and Inductance of a Helrial Coil," by J. W. Nicholson, M.A., D.Sc.

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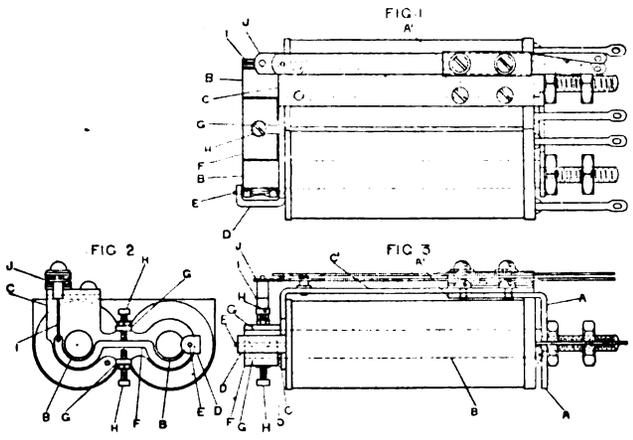
PATENTS.

Electrical Relay.

5145.—1909. M. S. Conner, Hale, Cheshire. This is an improved electrical relay of the 2-pole type, whereby compactness, facility in construction, and adjustment are obtained. Fig. 1 is a plan, Fig. 2 is an end elevation, and Fig. 3 is a side elevation of the relay. The yoke A A^1 of the relay connecting the two cores B is formed with a rectangular extension, going for a short distance alongside of, and parallel with, one of the cores, as shown at A^1. An L-shaped metal piece of frame C C^1, having holes in one limb for the purpose, is slipped over the ends of the cores B, and the other limb C^1 overlaps the extended piece A^1 of the yoke AA^1, and is secured to it. The limb C is bent up at the end, and arranged to form journals D to receive the pivots E of the armature F, and at the sides of the limb lugs G are bent up, which receive stop screws H, one on each side of



the armature F, for adjusting its play in either direction. The armature F is placed near the cores, and its ends are curved to conform to the protruding poles, as shown clearly in Fig. 2. They partially embrace these, this disposition permitting the acting surfaces to be of good area, so as to keep the reluctance of the magnetic circuit low. The armature is linked by the piece I to a suitable retractile spring J, which may also serve for a contact spring if suitably insulated, the spring being supported together with any other springs or contacts which may be required, by the limb C^1 of the L-shaped piece C C^1, which is fixed to the yoke extension A^1. Windings to suit the requirements of the relay circuit are arranged on the cores in the usual manner.

Electric Traction Systems.

1078.—1909. E. M. Munro and The Railless Electriction Co., Ltd., London. This is an improvement in electric traction systems, in which the vehicles are supplied with current from two overhead conductors. One of the conductors has a guard, which co-operates with another guard attached to one of the current collecting members on the trolley head, so as to prevent that member from making connection with the conductor.

Telephones.

1548.—1909. International Telephronometer Co., New York, U.S.A. The invention provides an arrangement whereby the length of time occupied in transmitting messages by a subscribers' telephone. A meter associated with the subscribers' telephone circuit is operated in conjunction with an apparatus at the central office, whereby records are indicated upon the subscribers' meter.

Arc Lamps.

17448.—1909. T. L. Carbone, Charlottenburg. The walls of the globe at that portion which has to remain clear are approximately at right angles to the rays of light, whilst at the portions where the products of combustion are to settle they are at an inclined angle to the direction of the rays. The walls of the globe thus being alternately inclined outwards and inwards, several superimposed chambers are produced, and the heat produces in the central chamber the highest temperature, whilst the upper and lower chambers are comparatively cool. In this way the gases are forced upwards, but the walls of the central chamber are prevented from burning owing to their being conical. This arrangement results in the gases which rise settling in the upper chamber, whilst the descending gases settle in the lower chamber. No residue forms in the central chamber owing to its high temperature.

Electric Ironclad Switches.

1675.—1909. T. Birchall, Manchester. This is an improvement in ironclad switches of the double pole type, in which a fixed casing, carrying contacts, fit in a telescopic manner over one another. The invention comprises the provision of means for causing a rapid movement of the cover for making and breaking the electric circuit to prevent arcing

Flame Arc Electric Lamps.

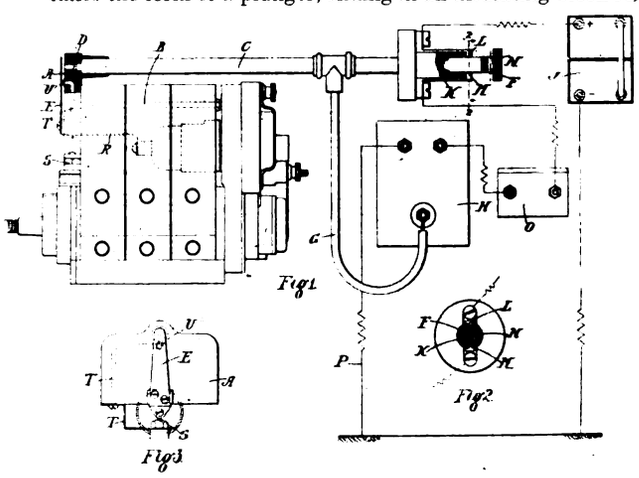
18328.—1909. Siemens Schuckertwerke, G.m.b.H., Berlin. This is a flame arc electric lamp of the kind having three carbons downwardly inclined to each other, two of which are of the same pole, and support each other at the burning end. These two carbons contain large proportions of added vaporisable material, in order to make a flaming arc. The third carbon is almost entirely devoid of vaporisable matter. By this choice of carbons a steady arc is obtained, which performs oscillations between the two carbons of the double electrode very easily and steadily.

Electricity Rectifiers.

21366.—1908. T. J. Murphy, Rochester, U.S.A. This rectifier, which is used for alternating or fluctuating current, comprises a pair of electrodes: a source of current of high amperage connected to the electrodes, a synchronizer, a source of current of high voltage, means for causing the current to pass across the electrodes, and means for controlling the synchronizer by the current of high amperage passing through the electrodes.

Dual Ignition for Internal Combustion Engines.

195.—1909. J. D. Bell, Coventry. In the electrical ignition of internal combustion engines, such as are fired by magnetos, the object is to provide a simple method of combining with the magneto a battery system to facilitate starting and provide slow running. Fig. 1 is a diagrammatic view, showing the parts required, some of the parts being in section. Fig. 2 is a transverse section on the line 2–2 of Fig. 1, and Fig. 3 is an end view of the secondary switch. To the magneto magnets is attached an insulating block A by the bolt B, which serves as an abutment for the outer member C of a Bowden wire. This outer member is heavily insulated, whilst the inner member D is a conductor, and is adapted to be moved axially, so as to project through the insulating block and make contact with some part on the magneto, such as the blade, which is in connection with the distributor arm. The other end of the Bowden mechanism takes the form of a switch button F, or the wire may be duplicated so that a button may be arranged at both places. To the Bowden wire D is attached a high tension lead G from the high tension terminal of an induction coil H, which operates in conjunction with a battery J. Thus, assuming the battery circuit to be complete, when the Bowden wire D is operated, the secondary system from the induction coil H is put into electrical connection with the magneto distributor arm, ignition taking place in the proper cylinder in the well-known manner. Directly the engine starts, the distributor arm rotates, supplying the current to the successive cylinders. Thus starting on the switch and slow running are easily obtained without the need of a complete battery system. The switch button F takes the form of a plunger, sliding in an insulating block K,



and it may at the same time form a primary switch in the battery circuit. For this purpose the insulated block may carry two contact segments (L and M) in the electrical circuit, which are adapted to be short circuited by a conducting connection N carried by the switch. Thus when the switch is pressed to connect the Bowden wire, the primary circuit is completed. It is preferred to incorporate in the primary circuit an auto-trembler O, which has the effect of slightly retarding the time of firing in the cylinders. For instance, the primary circuit may be wired up as follows: The negative terminal of the battery may be connected to earth, whilst the other is connected to one switch segment L, the other switch segment M is connected to one terminal of the auto-trembler O, the second terminal of the latter being connected to the coil H. The second terminal of the coil is earthed by the lead P. The alterations to the magneto itself are as follows: The conductor R, which usually couples the magneto secondary terminal S the distributor arm, is turned upside down, as shown, and

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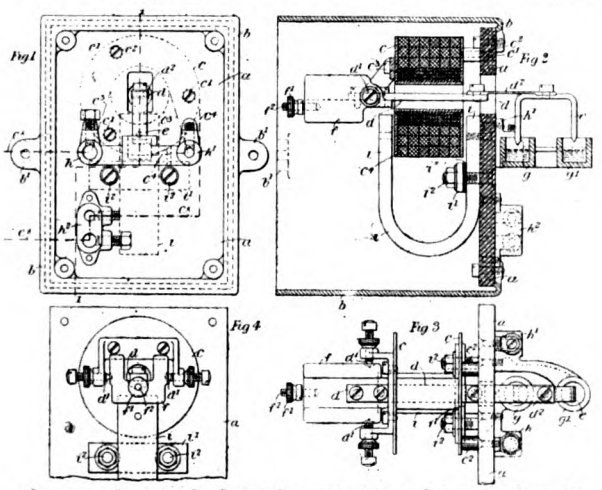
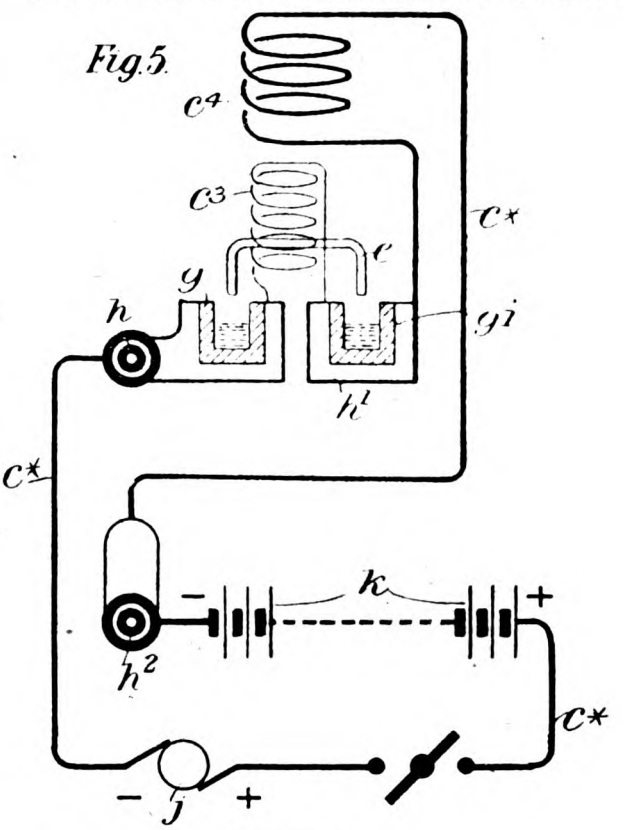
connected to the spring blade E. The magneto secondary terminal S is connected by a lead T to a contact stud U on the block A. The blade E normally rests against this, putting the magneto armature into communication with the distributor arm by means of the parts S, T, T, U, E, and R. Thus the magneto high tension circuit is normally completed. But when the Bowden wire is operated by pressing the button F, not only is the primary battery circuit completed by the connection N, but the blade E is moved out of contact with the stud U, breaking the magneto secondary circuit. The battery secondary circuit is, however, completed owing to the wire D making contact with the blade E. The actual magneto illustrated is of the Bosch type, but by slight modification the invention may be applied to any magneto. Further, a contact maker, forming part of the battery primary circuit, may be attached to the magneto shaft, or other convenient part, enabling the battery system to be used permanently, and enabling a separate high tension distributor for the system to be dispensed with. In this case, the blade E would be held in the required position by any means, which may or may not be actuated by means of the Bowden wire. This would, of course, be retained so as to enable either the battery or the magneto to be used as desired.

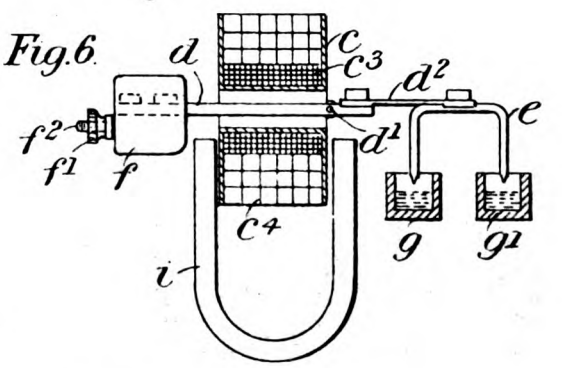
Automatic Switch for Electric Batteries.

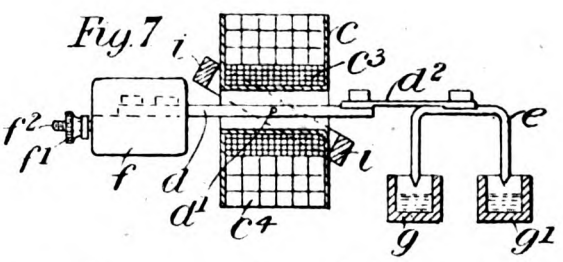
23118.—1908.—Nalder Bros. & Thompson, Ltd., London. In the well-known type of automatic switch for electric batteries having a high resistance coil between the dynamo and the battery, which is automatically short circuited by a low resistance coil when, and as long as, the conditions are suitable for charging, as usual we place a rod of soft iron through the hollow centre and pivot it, the hollow centre of the coil being of sufficient diameter to allow the soft iron bar sufficient movement. The soft iron bar being magnetised by the current passing through the coils, changes its polarity according to the direction of the current. The improvement is the provision in combination with an instrument of this type of a permanent magnet placed external to the bobbin so that it acts on the soft iron bar, and the latter is thus caused to move in one or the other direction according to its polarity and, therefore, according to the direction of the current in the coils. Fig. 1 is a front elevation of the instrument; Fig. 2 is a vertical transverse section taken in the line 1-1 of Fig. 1; Fig. 3 is a plan, but with the coils and case omitted. Fig. 4 is a rear elevation of parts, with the case omitted. Fig. 5 is a diagram of the connections. Fig. 6 is a sectional side elevation of parts illustrating a slight modification, and Fig. 7 is a similar view illustrating a further slight modification. In Figs. 1 to 5 a is a base plate of insulating material on which the various parts are mounted. This base is carried by



the case b, attached to the switchboard by the lugs b^1; c is a bobbin fastened to the base plate by screws and distant pieces. This has two windings, c^3, c, the one c^3 being of fine wire and of such resistance as to stand safely the whole voltage of the dynamo, and the other c^4 of large wire or strip of sufficient cross section to carry the maximum charging current. d is a bar of soft iron passing through the hollow centre of the bottom c, and pivotted at d^1 and carrying at the end of an arm d^2 a dipper e. f is a counterbalance weight fixed upon the bar d, and f^1 is a small weight for fine adjustment which screws upon a stud f^2 fixed to the weight f. g, g^1 are two mercury cups, g being cast in one with a terminal h, and g^1 cast in one with a connecting block h^1. i is a permanent magnet clamped on to the base plate a by the plate i^1, and screws and nuts i^2 a plate of vulcanised fibre or the like i^* being interposed between the parts. The windings c^3, c^4 are arranged in the main circuit c^*, and are joined up as shown in the diagram Fig. 5, the fine winding c^3 between the terminal h and the block h^1, and the large winding c^4 between the block a^1 and a second terminal h^2. When the magnet is in position, the whole moving system d, d^2 and e is approximately counterbalanced about the centre d^1 by the counterweight f, and finally adjusted by the additional weight f^1 so as to swing free, and so that the dipper e is out of contact with the mercury in the cups g, g^1. The coil c^3 is so connected that when the dynamo j is stronger than the battery it magnetizes the iron bar d so that it will be attracted by the magnet i and *vice versa*. The coil c^4 is so connected that when a current passes from the dynamo j through the cells k in the charging direction, it magnetizes the bar d so that there is attraction between d and i, and *vice*







versa. The instrument then works in the well-known way. When the E.M.F. of the dynamo j is less than that of the battery k the dipper e rises. When the E.M.F. of the dynamo j exceeds that of the battery k by a small amount, the dipper e falls, short circuits the cups g, g^1 and the coil c^3, and the charging current passes through the cups, the dipper e and the winding c, and keeps the dipper down. Should the current reverse, the dipper e is raised and the short circuit on the coil c^3 is broken again. Fig. 6 shows a slight modification, from which it will be understood the exact place of pivoting the bar d is not material; in this case it is pivoted at the other side of the bobbin c, and in this case it is necessary to alter the position of the permanent magnet i so as to bring the two poles, one above and the other below the bar as shown. Alternatively, the directions of the currents may be reversed through the coils, and the magnet placed above instead of below the bar d, thus closing the circuit by repulsion and opening it by attraction.

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COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last prices. £
British Insulated and Helsby Cables, Ord. 1-100,000	5	7-7¼
—— 6 p.c. Cum. Pref., 1-100,000	5	6¼-6¾
—— 4½ p.c. Mortgage Debentures	100	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100	89-94
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 1-200,000 and 275,001-475,000	3	¾-⅞
—— 4 p.c. Mortgage Debenture Stock	100	48-52
Callender's Cable, Debentures	100	105-107
—— Ordinary	5	10¼-10¾
—— 5 p.c. Pref.	5	5¼-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1	¾-⅞
Dick, Kerr, and Co., Ordinary, 1,200,000	1	1-1⅛
—— 6 p.c. Cum. Pref., 1-305,000	1	1-1⅛
—— 4½p.c. Debenture Stock.	100	100-103
Edison and Swan United, "A" Shares, 1-99,261	3	3⅛-3⅜
—— "A" Shares, 01-017,139	5	1-1⅛
—— 4 p.c. Deb. Stock, Red.	100	68-73
—— 5 p.c. 2nd Debentures	100	82-85
Electric Construction, Nos. 1 to 112,100	2	¾-⅞
—— 7 p.c. Cumulative Pref.	2	1⅛-1⅜
—— 4 p.c. Perp. 1st Mort. Deb.	100	62-67
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100	68½-74½
General Electric Company (1900) 5 p.c. Cum. Pref.	10	8-8½
—— 4 p.c. 1st Mort. Deb. Stock	100	83-87
W. T. Henley's Telegraph Works, Ordinary	5	12½-13½
—— 4½ p.c. Preference	5	5½-5⅝
—— 4½ p.c. Debentures	100	106-108
National Electric Construction Co., 1-170,000	1	⅝-¾
Telegraph Construction and Maintenance	12	34½-36
—— 4 p.c. Bonds	100	101-103

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Bournemouth and Poole, Ordinary	10	9½-10
Brompton and Kensington, Ordinary	5	6½-7¼
—— 7 p.c. Preference	5	6¾-7⅛
Canadian General Electric Co., Common Shares	$100	114-119
—— 7 p.c. Cum. Pref. Stock	$100	116-119
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5	3½-4
—— 4½ p.c. Cum.. Pref., 1-80,000	5	4¼-4⅞
—— 4 p.c. Debenture Stock, Red.	100	98-101
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5	3¾-4⅛
City of London, Ordinary	10	10 10¼
—— 6 p.c. Cumulative Pref.	10	11¾-12¼
—— 5 p.c. Debenture Stock	100	121-124
—— 4½ p.c. 2nd Deb. Stk. Red.	100	100-103
County of Durham Electrical Power Distribution Co., Ordinary, 1-50,000	5	1½-2
—— 5 p.c. Preference, 1-50,000	5	2¾-3⅛
County of London Elec. Supply, Ordinary	10	7⅜-8¼
—— 6 p.c. Cum. Pref.	10	10¾-11¼
—— 4½ p.c. Debentures Prov. Certs. Al pd., Rd.	100	105-108
—— 4½ p.c. 2nd Debentures, Red	100	98-101
Edmundson's Electricity Corporation, Ord., 1-80,000	5	½-5/16
—— 6 p.c. Cum. Pref.	5	⅛-¼
—— 4½ p.c. First Mort. Deb.	100	57-60
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100	91-94
Kalgoorlie Electric Power and Lighting, 6 p.c. Non. Cum. Pref., 1-150,000	1	7/8-1 1/16
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000.	5	7-7½
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100	95-98
London Electric Ordinary	3	1⅝-2
—— 6 p.c. Pref.	5	4¾ 5¼
—— 4 p.c. 1st Mortgage Debenture Stock, Red.	100	93-97
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	73¼-77½
Metropolitan Ordinary, 100,001-300,000	5	3¾-4¼
—— 4½ p.c. First Mortgage Debenture Stock	100	106-109
—— 4½ p.c. Cum. Pref.	5	4⅝-5
—— 3½ p.c. Mortgage Debenture, Red.	100	83½-86½
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,050 ($500) M 1-4,400 ($1,000)	—	80½-82½%
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb. Red	—	98-100
Newcastle-upon-Tyne Electric Supply, Ord., 1-50,000 and 57,010 to 137,500	5	4-4⅛
—— do. 50,001 to 57,009	5	4-4⅛
—— do., 5 p.c. Pref., 1-137,500 Non. Cum.	5	4¾-5⅛
Notting Hill Electric Lighting	10	12½-13½
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	6-6½
—— 4 p.c. Debenture Stock	100	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1	1⅜-1⅝
—— 6 p.c. Non-Cum. Pref., 1-100,000	1	1 1/16-1 3/16
—— 5 p.c. Debenture Stock, Red.	100	103-106
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5	5⅜-5⅛
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5	6¼-6½
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	—	105½-107½%
Smithfield Markets Electric Supply, Ord., 1-12,000	5	1/2-1/8
South London, Ordinary	4	2¼-3
South Metropolitan Electric Light and Power Ord.	1	5/16-9/16
—— 7 p.c. Cum. Pref.	1	1 1/16-1 3/16
—— 4½ p.c. 1st Mort. Deb.	100	100-103
St. James's and Pall Mall, Ordinary, 101-20,080 and 40,081 to 60,100	5	8½-9
—— 7 p.c. Pref. Non. Cum.	5	7-7¼
—— 3½ p.c. Deb.	100	84-88
Urban Electric Supply Co., Ordinary	5	⅝-¾
—— 5 p.c. Cumulative Preference, 50,001-100,000	5	1¼-1⅜
—— 4½ p.c. First Mort. Debenture Stock, Red.	100	78¼-78½
Westminster, Ordinary	5	8⅛- 8⅜
—— 4½ p.c. Cum. Pref., 110,101-191,379	5	4¼-5¼

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 5 p.c. Cum. 1st Pref., 1-640,000	5	4¼-4⅜
—— Debenture Stock, Red	100	90½-92
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1	¼-⅜
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1	¼-⅜
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	87-90
British Columbia Electric Railway Co., Ord. Def.	100	147-152
—— Ord. Pref.	100	122-126
—— 5 p.c. Cum. Perpetual Pref. Stock	100	108-111
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	102-104
—— 4½ p.c. Vancouver Power Deb.	100	102-105
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10	¾-1
—— 6 p.c. Cm. Pf., 30,001-60,000	10	2¼-2½
—— 5 p.c. Perpetual Debenture Stock	100	83-86
—— 4½ p.c. 2nd Deb. Stock	100	58-62 xd
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100	97-99
Calcutta Tramways, Ord., No. 1 137,610	5	4¼-5
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5	4¾-5
—— 4½ p.c. 1st Deb. Stock, Red.	100	101-104
Cape Electric Tramways, Nos. 1-491,222	1	3 16-7 16
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5	4¾-5⅛
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100	96-100
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5⅛-5⅞ xd
—— 4 p.c. Deb. Stock, Red. (1985)	100	98-101
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12¾-13¾
London United Trys (1901) 5 p.c. Cum. Pref.	10	2¼-2⅜
—— 4 p.c. 1st Mt. Db. Stock, Red.	100	67-70
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	1/32 3/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1	1 1/16-1 3/32
—— 4½ p.c. Deb. Stock, Red.	100	93-96
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100	100½-103½
Provincial Tramways Co., Ordinary, 1-24,912	10	4-4¼
—— 6 p.c. Cum. Pref., 1-10,000	10	9½-10½
San Paulo Tramway, Light, and Power Co.	$100	151-154
—— 5 p.c. 1st Mort Deb., Red. (1929) 1-12,000	$500	102 104
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1	¾-⅞
—— 4 p.c. Deb. Stock, Red. (1940)	100	69-73
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5	¼-⅜
—— 6 p.c. Cum. Pref., 1-46,261	5	1¾-2¼
—— 4½ p.c. 1st Deb. Stock, Red.	100	81-85

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100	60-62
—— 4 p.c. Pref.	100	85-87
—— ,, ,, deferred	100	43-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	101-103
City and South London, Consolidated Ordinary	100	30-31
—— 4 p.c. Debenture Stock	100	100-102
—— 5 p.c. Pref. Stock '91	100	108-110
—— ,, ,, ,, '96	100	104-107
—— ,, ,, ,, '01	100	100-103
—— ,, ,, ,, '03	100	96-100
Underground Electric Railways of London, 5 p.c. Prior Ln. Bds.	—	100-101 xd

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10	3-3¼
—— 5 p.c. Debs., Red., within 1-1,609 Red	100	99-102
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000	96-98
Anglo-American Telegraph Co., Ordinary	100	61-63
—— 6 p.c. Preferred Ordinary	100	101½-102½
—— Deferred Ordinary	100	22½-22⅝
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100	87⅛-89½
Direct Spanish Telegraph Co., Ordinary	5	3-3¼
—— 10 p.c. Cum. Preference	5	8-8½
—— 4½ p.c. Debs., 1-600	50	100-102
Direct United States Cable Co.	20	13-13½
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 p.c. Mort. Debs., within 1-8,000 (1913)	25	99-101
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	—	—
Eastern Extension, Australasia and China, 1-300,000	10	11¾-12¼
—— 4 p.c. Mort. Deb. Stock, Perp.	100	102-104
Eastern Telegraph Co., Ordinary Stock	100	126½-126¾
—— 3½ p.c. Preference Stock	100	83¼-85¼
—— 4 p.c. Mortgage Debenture Stock	100	102-104
Great Northern Telegraph Co. (of Copenhagen)	10	28½-29½
Marconi's Wireless Telegraph Co., Nos. 1-394,190	1	⅜-½
National Telephone, Preferred	100	107-108½
—— Deferred Stock	100	120-122
—— 6 p.c. Cum. First Pref.	10	10¾-11
—— 6 p.c. Cum. Second Pref.	10	10¼-10⅞
—— 5 p.c. Non. Cum. Third Pref.	5	5¼-5⅜
—— 3½ p.c. Deb. Stock, Red.	100	98-100
—— 4 p.c. Deb. Stock, Red.	100	100-102
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100	100-102
West Coast of America, 1-30,000 and 53,001-53,008	2½	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	100-102
West India and Panama Telegraph Co., Ordinary	10	⅜-½
—— 6 p.c. Cum. 1st Preference	10	8¾-9⅛
—— 6 p.c. Cum. 2nd Preference	10	8¾-9⅛
—— 5 p.c. Debs., Red., 1-800	100	102-104
Western Telegraph Co., 1-207,980	10	13½-14
—— 4 p.c. Debenture Stock, Red.	100	103-106

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NOTES.

SMALL INSTALLATIONS.

There was room for the capital little paper on small installations read by Mr. H. W. Handcock and Mr. A. H. Dykes before the Institution. We are all more or less given to megalomania, but although it may be well for us to "think imperially," still it does not do to neglect smaller matters. Undoubtedly the authors are right in pointing out that recent advantages, bringing about higher efficiency and greater economy, has made it feasible to contemplate much greater extension in the sphere of electric lighting. To many consultants, as well as to young contracting engineers, and not least to manufacturing firms, the paper will be very welcome. It shows what a wide field there is for exploiting, for it only requires energy and a little missionary zeal to gradually dot the country over with these small installations in modest boroughs and ambitious villages. The authors are able to give many practical hints from out of their own experience.

FLAT RATE v. CONTRACT SYSTEM.

While holding that the economy of current resulting from the use of metallic filament lamps means a steady popularising and extension of electric lighting, they recognise that the improvement entails difficulty. Their solution is to do away with flat rates, wiring and meter rents, in fact, to discard meters (and their attended expenses) altogether, and resort to a novel contract charge, fully explained in the paper printed in another column. In an appendix they give a comparison of figures of an existing undertaking on the flat rate and on the contract system, assuming that the same machinery and mains were used and the same total sum spent on services. Here are the summaries: The flat rate is taken approximately at 5d. per unit and the lamps at 54,000 30-w. (equivalent); the maximum load being 560 kw., and the units sold 600,000. The expenditure on services and meters comes to £7,800, or 2·9 shillings per 30-w. lamp. Of the lamps 23,000 are "free wired" at an average cost of £1.

THE NEW SYSTEM.

The authors, for the sake of comparison, fairly enough assume that all the customers being small long-hour consumers, as many as 80% of all lamps come on at the peak (which is certainly erring on the safe side), and that the lamps are run on an average of 1,500 hours per annum (which is again rather overstating it, for this works out at nearly 4 hours per day). The capacity of the station may be stated thus:

$$\frac{560 \times 100}{80} \times \frac{1}{30} = 23{,}300 \text{ 30-w. 25 c.p. wire lamps.}$$

The revenue at 12s. per lamp is £13,980 for the year. As no more lamps have to be wired than before, the only additional cost is that of producing, with the same maximum load, the additional units, the output being:

$$\frac{23{,}300 \times 1{,}500 \times 30}{1{,}000} = 1{,}048{,}000 \text{ units,}$$

an increase of 448,000 units, which at 0·44d. equals £821. This gives a net increased profit of £159, plus the saving by the abolition of the meter department. This is, indeed, throwing a new light on the problem.

ELECTRIC TRACTION.

In his presidential address before the Institution of Engineers and Shipbuilders in Scotland, Mr. C. P. Hogg did not speak enthusiastically of railway electrification in this country. He said that the suppression of what was, after all, a very efficient machine, the steam locomotive, was still a long way off. While electric traction had practically captured the whole of the tramway traffic (of the 2,464 miles of tramways 2,286 are electrified and only 52 worked by steam) only 200 miles (single track) of railways in the United Kingdom were partly worked by electric traction, and only 204 (single track) wholly worked by electricity. Abroad progress in this direction had been much greater, a fact he attributed partly to their hydro-electrical installations and partly to the fewer legal restrictions on high voltage lines. For tramways, Mr. Hogg says, electricity is specially adapted.

ATTENTION TO DETAIL.

Speaking before the students of the Institution of Electrical Engineers, Mr. J. H. Rider dwelt upon the importance of attention to detail. He well said "There is no place for the careless man in the engineering world." He told his attentive audience that relative importance of detail had to be borne in mind, and went on to say that "plenty of illustrations of the failure of large plant on account of defects in small auxiliaries could be given from actual experience." He therefore held that "the engineer should inspect his work from all sides and from all standpoints, taking care, even before attending to details, that his main design were properly worked out." In fact, Mr. Rider's address was a plea for thoroughness, and he advocated that the man who was responsible for designing machines should have a practical experience in their running, for that was the only infallible way of finding out their faults. He argued that manufacturers should make a practice of sending out their designers to work, and so actually test, new types of machines under normal running conditions.

THE CANADIAN MARKET.

In another column there will be found an interesting letter from the Electrical Engineer of the city of Winnipeg. His thesis is well borne out by what is at present taking place in Eastern Canada. While the Hydro-Electric Commission (practically a Government body, as explained quite recently in these Notes) is giving its contracts for machinery, equipment and wire chiefly to local manufacturers, the municipalities are in many instances seeking their supplies from England. Thus, Guelph is purchasing motors in Manchester, and London, in the province of Ontario, like Toronto itself, is seeking pumps in England. The vastness of the field makes it all the more incumbent to pay attention to such friendly advice as is given in our correspondence columns from our subscriber in the go-ahead capital of rich Manitoba.

VOTING BY ELECTRICITY.

Apart from its utility in reducing adipose tissue and keeping members awake, little can be said in favour of our Parliamentary method of recording votes by periodical perambulations through the lobbies. In the French Chamber of Deputies voting used to be performed by depositing counters in urns. Now a still more practical, time and labour saving method is to be adopted. Deputies are to vote by means of electricity. Close to the Secretaries' table will be a huge screen bearing every Deputy's name. As the Deputy reaches his seat he will press a button in the desk before him, and the word "Present" will be recorded on the screen in front of his name. When it comes to voting he can press either of the other electric buttons before him, one being marked "Oui," the other "Non," and thus his vote is visibly recorded, and easily checked off by the tellers.

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ILLUMINATION.

Although by no means an electrical body, we cordially welcome the Illuminating Engineering Society, which held its inaugural meeting last week. The energetic honorary secretary, Mr. Leon Gaster, announced that already the Society could boast of possessing 164 members, though only started in February. The President, Professor Sylvanus P. Thompson, in his address, said that the object of the Society was to bring together all those who were interested in the problems, practical and theoretical, connected with the art of directing and adapting light to the use of mankind, and also with its utilisation without waste. He said one of their first duties was the creation of units for the measurement of light on surfaces, and then to get such units recognised both nationally and internationally. Certainly the Society has useful work before it, and electricity has no reason to fear such scientific investigation, but rather every reason to assist it.

A GOOD EXAMPLE.

While somewhat belated, the annual report of the Colchester Corporation Electricity Department is an example to be studied. We find here, as in so many other places, an increase in the number of lamps connected, with a decrease of units sold, and a decrease of revenue, but here, unlike so many other places, there is an increase of profits. The increase of lamps was from 47,376 to 51,595, the decrease of units sold was 37,665 to a total of 344,177. The total revenue was £14,301, a decrease of £104. On the other hand, the total costs was reduced from £9,467 to £8,153. The cost per unit was reduced from 1·41d. to 1·21d., worked out thus: Fuel (including cartage) ·56 (·85), oil and stores ·07 (·07), wages ·27 (·24), repairs and maintenance ·31 (·25). It is an excellent showing in the face of difficulties.

A PROMOTING ORGANISATION.

The Société Centrale pour l'Industrie Electrique has just been registered in Paris with a capital of five million francs, one-fourth paid up. It is of special interest, because its object is to promote in France and abroad any suitable project for the generation of electricity, electrical transport, or any form of electrical industry. It will work mainly by taking a financial interest in other companies, promoted for specific purposes. Its Board consists of M. Charles Laurent, M. Ullmann, Director of the Comptoir National d'Escompte of Paris, M. Poirier, Managing Director of the General Society for Favouring the Development of Commerce and Industry in France; M. Turettini, General Manager of the Banque de Paris et des Pays-Bas; Messrs. Burrell & Pavie, managers of the French Thomson-Houston Co.; M. Walch, Manager of the Banque pour Enterprises Electriques, Zurich; Hampsohn, Managing Director, and Oliven, Director, of the Gesellschaft fur Elektrische Unternehmungen, Berlin; and Heinemann, Managing Director of the Société Financiere de Transports et Enterprises Industrielles, Brussels. Evidently a very powerful international organisation. We want something of the same kind in England, in order to promote British electrical enterprise both in the Near and Far East, notably Turkey and China. Who will make the move?

COLLIERY SIGNALMAN ELECTROCUTED.

Robert Hall, a signalman employed in the electrical department at Denby Colliery, while at work underground on the 10th inst., met with his death by electric shock.

At the inquest Daniel Taylor, employed at the colliery, stated that on the day of the accident deceased came down the incline with an empty tub out of which he took some tools and entered the haulage house. Witness was 15 yards away at the time, and had only gone another 7 yards when he heard a lamp fall in the haulage house, and on getting no reply to his shout he hurried to the door, and there saw deceased just falling down, with the appearance of clutching at something. At the same time some sparks and a bright flash were twice in quick succession emitted from the ammeter. Witness hailed the deputy, and then ran to get the power cut off. Deceased lay with his head close to the wall of the engine-house, which was 8ft. wide, with his feet on the engine bed and his lamp underneath him. His cap was lying on the ground near the entrance to the house. Deceased would only be in the house half a minute before witness heard the lamp fall, and would have had no time to do any work there.

William Hannah, of Belper, electrician at the colliery, said the accident happened in the bottom haulage. The plant was new, and had only been worked for trial purposes. They had earth plates in the ground, to which the cables were connected, on purpose to carry away any leakage of current, and as far as he knew at the time of the accident they were satisfactory, frequent tests having lately been made. On the 15th, whilst examining the system after the accident, he found a loose connection on the earthing at the top haulage between the end of the bottom haulage cable and the end of the main cable, which came from the transforming house. There was no other fault on the system of earthing. A nut which tightened the earthing wire on the connection box was loose, and he could just move the wire. He tightened the nut up, as it affected the earthing. The day after the accident an examination was made of the engine-room, and it was found that the installation on the ammeter coil was punctured. This was held by three screws, 1½in. long, and the bottom screw was half out, whilst the other two were loose. Witness could not say that this being loose was the cause of the accident, but in his opinion the fault on the ammeter was the primary cause of the accident. The defect would show itself by the flashes. It was witness's duty to see that the nut was kept tight, and he had tested it and got a satisfactory test through.

Robert Nelson, electrical inspector of mines, said he had inspected the scene of the accident, and it was most probable there was an intermittent, but not continuous fault in the ammeter. He found no fault in the construction of the electric plant, and thought the accident was due to excess of zeal on deceased's part.

The jury returned a verdict of "Accidentally killed."

ELECTRIC TRACTION IN JAPAN.

Latest reports from Japan indicate that the construction of electric tramways in various parts of the country, undertaken during the business boom after the war and afterwards shelved owing to the financial stringency, is being revived now that the money market has become easy. The Hiroshima Electric Tramway Co. has decided to reduce its capital to ¥3,000,000, postponing the construction of the Miyajima and Ujina lines, and confining its undertaking to Hiroshima city, Yokogawa and Kibi. The company has decided to call up the first instalment of the share money shortly and begin operations. The Fukuhaku (Fukuoka-Hakata) Electric Tramway Co. is pushing on the work of constructing its line with a view to opening the service by March next. All the other electric tramway companies undertaken in Northern Chikuzen (Fukuoka prefecture) remain in abeyance.

The proposal by the Kumamoto Light Railway Co. to transform its line into an electric railway has almost been realised. The Harima and Tatsuno Electric Tramway Cos. are pushing on preliminaries for the opening of the work of construction on their lines. The Kochi Electric Tramway has succeeded in negotiating a loan from the Mitsu Bishi. A syndicate formed to lay a tramway from Sasayama (Hyogo prefecture) to Sasayama Station on the Bantan Railway, has decided to construct a light railway.

The Hatsuse Light Railway Co., of Yamato, intends to extend its line from Sakurai to Oji, but as it is intended to run parallel with the Government railway a charter may not be granted. The company has already filed an application with the authorities for a charter to construct a line between Yoshino and Kuzu (Yamato), and is pushing on investigations into a plan for constructing a line from Tamabashi and Horyuji (near Nara). The promoters of a scheme to construct an electric tramway from Yamasaki (on the Government railway between Osaka and Kyoto) to Uji by way of Hachiman, with a capital of about ¥700,000, are negotiating the connection of services with the lines of the Uji and Kinjo (Omi-Yamashiro) electric tramways. The Arashiyama Electric Tramway is hastening the work of constructing its line in order to open the service by March next. The formation of the Keishin (Kyoto-Otsu) Electric Tramway Co. is being revived, and more than 50 capitalists are said to have agreed to become promoters.

The work of constructing the line of the Keihan (Kyoto-Osaka) Electric Tramway Co. is progressing apace. The land required for this line in Osaka from Noda Bridge to Bizen Bridge has already been purchased, this completing the necessary land purchases for the whole line, and the rails have been laid for a distance of six miles out of the 26 miles between Osaka and Fushimi. It is expected that the company will be able to make trial trips on the whole route by February next. The Mino-Arima Electric Tramway will, it is believed, be running trucks on the line north of the Yodo River by the end of this month for the transport of materials, and it is anticipated that trial runnings of cars will be opened between Osaka, Mino, and Takaradzuka by March next. This line starts from Umeda Station at Osaka, and runs to Mino *viá* Minoguchi, and from Minoguchi to Ikeda, Takaradzuka, Namase, and Arima on the west. Subsequently the line will be extended from Takaradzuka to Nishinomiya, where it will connect with the Hanshin Electric Tramway.

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THE PRESENT ASPECT OF ELECTRIC LIGHTING.*

By H. W. HANDCOCK, M.I.E.E., and A. H. DYKES, M.I.E.E.

When we wrote our paper on "Electricity Supply and Metallic Filament Lamps," which was read before the Institution in April, 1908, the wire lamp had but recently appeared on the horizon, and there was general uncertainty as to what was likely to be its effect on the electric lighting industry. The first thing that strikes one is the extraordinary progress made by the lamp makers in the interval.

The manufacturing difficulties which led to blackening and premature failure have been almost entirely overcome, the methods of attachment and of supporting the filaments have been improved, and apart from mechanical damage, the useful life of the lamps has now been proved to be, on an average, about double that of carbon filament lamps. It is not always easy to get exact figures as to the life of lamps under ordinary working conditions subject to the variations in voltage which occur on public supply mains, but we are fortunately able to give the figures for an installation of 653 lamps, one of the first to be fitted with transformers and 25-volt lamps. The change was made in April, 1908, the original 100-volt carbon filament lamps being replaced by 10 c.p. 25-volt tungsten lamps. Careful note has been kept of the number of lamps renewed since then, from which it appears that, including breakages, the average life has been 1,280 hours, although they are frequently overrun.

In another case, a large building in the West End supplied from the mains of the Charing Cross Supply Co., Ltd., 105-volt lamps of 25 and 32 c.p. were substituted for the original carbon lamps. At the end of 1,083 hours of actual use, out of 980 lamps installed 70% were still burning. Lamps by various leading makers were put in, so that this may be taken as a fairly representative figure. Individual lamps under test conditions have shown far better results, but the above figures are a fairly reliable indication of what may be expected under ordinary conditions. The price of wire lamps has also been reduced and the 100-volt 25 c.p. lamp which two years ago cost 4s. is now listed at 3s. Having regard to the longer life of the new lamps, they are thus but little more expensive than carbon lamps, a fact which cannot fail to accelerate their adoption. Two years ago the best that a consumer on a 100-volt circuit could do was to replace an 8 c.p. 33-watt carbon lamp with a 25 c.p. wire lamp taking about the same amount of energy and costing 4s. each. To-day he can—if he wishes—replace the 8 c.p. 33-watt carbon lamp by a 14 c.p. wire lamp, taking only half the energy and costing 2s. 9d.

So far, continuous-current stations supplying at 200 volts have not been much affected, but at least one well-known maker has now succeeded in producing a 16 c.p. 24-watt lamp for 200 volts which we are informed will be on the market very shortly at the price of 5s. We have had some of these lamps in actual use for some months past with very satisfactory results. When it is stated that the diameter of the filament is only $\frac{1}{2500}$ of an inch and its length nearly 40 in., one cannot fail to be struck by the skill of the lamp makers. Even this does not represent the limit, as we have seen in operation a 10 c.p. 200-volt lamp taking only 15 watts. Past experience suggests that the price will before long be reduced, when there will be nothing to prevent consumers on direct-current 200-volt systems from following the example set them by those on alternating-current systems and obtaining the same candle-power as with carbon filament lamps, but with a consumption of less than one-half of the energy. It is evident that whatever has been the effect of the wire lamp on supply stations during the last two years, it will be greatly intensified in the near future.

The results of the past two years have only served to strengthen us in our belief that the flat rate system fails to meet the conditions that now obtain, and that only by the adoption of some system which secures to the undertaking a definite minimum return from each consumer based on the rate at which he contracts to take energy can purely lighting stations be profitably run. We are gratified to learn of the great successes that has attended the introduction of the system by Mr. Seabrook into the St. Marylebone district, although possibly, as we suggested in 1908, the use of the maximum demand indicator is open to the objection that the limit may be exceeded and the contract rental thus increased without the consumer being aware of the fact until he obtains his bill. It will probably be found better in our opinion to let the consumer fix the contract demand in advance and to give him some visible signal when he is likely to exceed it.

There is probably scarcely a single alternating-current station supplying a purely lighting load which has, within the past year, sensibly increased its output, although it may have considerably increased its lamp connections, except possibly in the case of those in competition with a direct-current station in the same area. Experience has shown that on the average consumers have reduced their consumption even where they have somewhat increased their illumination, and the revenue received by the station per lamp connected has consequently fallen very considerably. In one station of this kind serving a London suburb, a large proportion of the consumers were "free wired." The price of current was 5½d. per unit for this class of consumer, and a deficiency charge was made in addition of 1d. per unit for every unit by which the consumption was less than 18 units per lamp per annum. Last year it was decided—whether rightly or wrongly—to allow such consumers to have transformers and metallic filament lamps, it being stipulated that no lamps of less than 16 c.p. would be supplied. At the same time the terms were altered to a fixed wiring charge of 2s. per annum per lamp installed and 5d. per unit for energy consumed. It is, of course, early days to judge of the effect, but the results up to date are instructive. In the case of those consumers who have taken advantage of the new arrangement it is found that formerly their lamps averaged 12 c.p. and their consumption per lamp installed was 15·6 units per annum. This gave a revenue *per lamp connected* (averaging 12 c.p.) of :—

	s.	d.
15·6 units, at 5d. (as for privately wired consumers)	6	6
Meter rent		4½
Wiring rental (deficiency charge +½d. per unit)		10½
	7	9

Some of them have not been changed over for a complete year yet, but assuming that the uncompleted quarter of the year will bear the same ratio to the earlier part as in previous years, the results due to the change will be :—

Average candle-power per lamp, 16.

	s.	d.
Average consumption, including transformer losses, 9·8 units..	4	1
Meter rent	0	3
Wiring rental	2	0
	6	4

In spite, therefore, of the wiring rental being increased, in spite of an increase in the illumination of 33%, the inclusive receipts per lamp have fallen from 7s. 9d. to 6s. 4d. The reduction in consumption is obviously greater in the case of privately wired consumers on whom no restrictions can be placed as to the minimum candle-power of the lamps they use, and it may be taken as certain that in future the consumption per lamp installed amongst this class will be of the order of 6 to 7 units, whilst in many cases it will fall to as low as 3 or 4. Even at 8d. per unit a 10-light consumer having a total consumption of 30 units per annum cannot be remunerative. In the district from which the above instances are taken the price of gas is 2s. 6d. per 1,000 cu. ft., and efforts were made to ascertain some typical returns per gas burner installed for lighting only, exclusive of any heating or cooking.

Such figures are not very easily obtainable, but a number of gas consumers occupying *small premises* were kind enough to allow their accounts to be inspected and general particulars taken. Naturally the consumption varied considerably, depending on the habits of the household, but taking the whole of those obtained, the cost for lighting only, exclusive of cooking, but including the meter rent, averaged 12s. 2d. per burner per annum, whilst many were as high as £1. It may be contended that it all depends on the type

* Abstract of paper presented before Institution of Electrical Engineers, London, Nov. 25.

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of burner in use. Naturally, but what we have to concern ourselves with in this case is not what the gas burner can do under test conditions, but what is the average cost per burner actually used in an average small London house. We often speak as though every gas burner in use had a mantle. This is far from being the case, even in the better-class houses. Surely there is something wrong when, in the same district, electricity yields only 4s. 4d. per lamp and gas 12s. 2d. The reason for this, however, is easily seen. One of these gas consumers previously used electric light: at present he has 12 incandescent gas points, and his bills are £12 4s. per annum for 98,000 cu. ft. of gas, including 8s. meter rent, or £1 0s. 4d. per burner per annum. Assuming a consumption of 5 cu. ft. of gas per burner, this gives an average of 1,630 hours per annum per burner. Had he required the same *effective* illumination for the same number of hours with carbon lamps he would probably have used 25 c.p. lamps consuming 150 units, which at 5d. per unit would have been £3 2s. 6d. per annum. Now, however, that the 25 c.p. 30-watt wire lamp is available, his consumption would be reduced to some 50 units for 1,650 hours, costing £1 0s. 10d. per lamp per annum, to which has to be added meter rent, thus bringing the cost on the flat rate still slightly above that of gas. A consumer of this class, however, can and should be charged on a different basis, as he would otherwise be yielding an abnormal profit to the undertaking. It will be noted that we assume that in most cases a 25 c.p. 30-watt metallic filament lamp will satisfactorily replace an ordinary gas burner such as is normally in use. It is true that with a photometer a mantle when new will under certain conditions show possibly 60 c.p., nevertheless experience shows that with few exceptions the average man is quite satisfied with the 25 c.p. metallic filament lamp for indoor domestic purposes.

The cost of lighting is judged by the every-day user, not by the nominal candle-power of the illuminant, but by the total cost of obtaining a satisfactory effect in a room. If, for instance, a 25 c.p. lamp lights a room adequately for a given sum per annum, a consumer would not thank you for saying to him, "I cannot give you a steady 25 c.p. lamp for that sum, but for a somewhat higher figure I will give you a gas lamp fluctuating from 60 c.p. downwards." For domestic purposes the 25 c.p. electric lamp is a satisfactory unit of illumination, and if it is more economical than the so-called 60 c.p. gas-light, the consumer will take it. Given a proper method of charging, we are of opinion that not only can this be done, but in such a way as to prove very remunerative to the electric light undertaking. As in the case mentioned above, with the flat-rate system of charging the long-hour consumer at present uses gas. One reason for this is that owing to the loss made by the electric light undertaking on the short-hour consumer it is necessary to keep up the price all round, and the competitive illuminant benefits.

In our opinion the very short-hour consumer, from the nature of the problem, can never be a remunerative one to an electric light undertaking on the present flat rates, as the capital outlay to supply him is very nearly the same as for a long-hour consumer. Let, therefore, such a consumer go if he will not pay his fair contribution to the cost of supplying him; let him use gas or candles, and let us concentrate our efforts on the long-hour man who gives us a greater number of working hours over which to earn interest on our capital. At the moment it is generally the other way round, and electricity is given the unremunerative short-hour lamps *because the present tariffs make the cost of long-hour lamps too high.*

Under an equitable tariff the cost of short-hour lamps to the consumer might possibly be increased, but long-hour ones would be greatly reduced. This might perhaps result in the loss of some consumers who at present do not pay their proper contribution, but would be no detriment to the undertaking, which could then utilise the plant thus freed in supplying the great influx of long-hour gas consumers who would be attracted on the score of economy, apart from any other advantages. In the case of the suburban station mentioned above, the standing charges per kilowatt of consumers' demand amount to £17, and the running costs 0·4d. per unit. Assuming that under a system devised to attract a different class of consumer as many as 80% of the lamps installed come on the peak (the average in the district at present is 30%), the standing charges per 30-watt lamp would be :—

	s.	d.
$\frac{£17 \times 20 \times 30}{1{,}000} \times 0{\cdot}8 =$	8	2
If the lamps were used for 400 hours the running charges would be $\frac{400 \times 30}{1{,}000} \times 0{\cdot}4 =$	0	5
Total	8	7

If they were used for 2,000 hours the running charges would be :—

$$\frac{2{,}000 \times 30}{1{,}000} \times 0{\cdot}4 = 2\text{s.}$$

or a total of 10s. 2d. Whether the lamps be used for 400 or for 2,000 hours, therefore, only makes a difference of 1s. 7d.

The difference in cost is so little, and the business advantages, from the point of view both of the station and the consumer, of a fixed charge are so great, that we consider it preferable to make a fixed charge per lamp per annum, irrespective of the number of hours during which the lamps are used. It obviously does not pay to go to the expense of putting in a meter, providing a staff to read it and keep it in repair, and a staff of clerks to make out the accounts, in order to check such small variations in revenue, more particularly if the relative importance of the standing charges be still further increased by the station supplying the interior wiring. It may be objected that if there be no meter and no restrictions, the consumer will waste the commodity. If the objection were valid the present system of water supply in London would be an impossibility. It must not be forgotten further that the longer the lamps are used the greater the cost to the consumer of lamp renewals, which thus acts to a certain extent automatically as a check. As the station is charging per lamp, it must obviously also have some check on the consumer in order that he may not, for instance, substitute a 100 c.p. lamp for the 25 c.p. lamp allowed for. We prefer to do this by using special lamp-holders such that only lamps which are sold by the station or its agents can be used. The consumer who comes back too often for lamp renewals will thus be detected and dealt with accordingly if it be found that he is wasting current.

Taking the average life of the lamps at 1,200 hours, they would use in that time, say, 36 units per 25 c.p. lamp. This at 0·4d. per unit represents 1s. 2½d., and where the station sells the lamps, the profit on their sale would to a great extent automatically compensate for the wastefulness of any of its consumers.

It is obvious, therefore, that even with a wasteful consumer the station could not lose much, and a meter can, if desired, be put in to check in special cases any consumers suspected of wilful waste. For the reasons above set forth we believe that all stations having normally low running costs could, with great advantage to themselves, supply the long-hour consumer, who at present generally uses gas, at a fixed charge per lamp per annum, which would be well below what he is at present paying. The price will naturally vary for each district, but a fair average, inclusive of wiring rental, appears to us to be 12s. per 30-watt lamp per annum for a continuous supply, and 10s. per annum for a "dusk to dawn" supply. This system we call the "Contract" system, to distinguish it from the Contract Demand system. The proposal is, of course, by no means new, but it was practically an impossible one as long as we were restricted to the carbon filament lamps. The introduction of the wire lamp and the great reduction in the running costs during the past few years have, as we endeavour to show, entirely altered the position.

Credit must be given to Mr. Wilkinson of Harrogate for being one of the first to appreciate the altered position of affairs, he having introduced into his district the principle of charging small consumers by a fixed sum of 11s. per lamp per annum. The Contract system does more than simplify the clerical work of the station. It is one thing to go to a prospective consumer and explain that at the price you are charging electricity is cheaper than gas. In nine cases out of ten he will be sceptical and will want until he sees his neighbours' bills before he will come on.

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It is quite another matter when you can go to him and say, "Come and look at this room lit electrically; you can have your house lit with the same lamps and can use them as you like for a fixed charge per lamp per annum." If you can get over the difficulty of the first cost of the wiring, you have in all probability secured that man as a consumer. We are of opinion that in the future purely lighting stations will, in order to secure the necessary large number of new consumers, be absolutely forced, either directly or through a subsidiary company, to undertake the wiring of houses and to supply lamps—in fact, to sell *light*, and not electrical energy. By this means any improvement in the efficiency of the lamp will be of benefit to the stations and not, as at present, a loss to them. It will be in their interest to do all in their power to encourage the lamp makers and to seek to give the maximum illumination for the minimum of current. At present, what do we see? Half the electrical world counting their losses due to an invention which should have proved, and may yet prove, as great a benefit to the industry as it undoubtedly is to the consumer. To bring this about, however, other innovations must follow the introduction of the wire lamp. Among others, it is all-important that the cost of wiring should be reduced, and as many of the new consumers will have only a few lights, that the cost of services be brought down also.

On alternate-current systems some form of concentric wiring with earthed outer is not only the cheapest, *per se*, but enables considerable economies to be effected in other directions. Only single pole switches and fuses are required, and the insulation of the one pole can be abolished or reduced to a very small amount. Since the advent of the wire lamp a large number of concentric wiring installations with earthed outer have been put in, using a double-wound transformer, so that the supply mains are absolutely distinct and separate from the interior wiring. Some might object that, as lamps of 25 c.p. are now available for 200 volts, the use of a transformer is unnecessary. It must not be forgotten, however, that even if nothing less than a 25 c.p. lamp is required, the price of the 200-volt lamp is 4s. 3d., and of the 50-volt, 2s. 9d., or 16 c.p., 2s. 6d., to say nothing of the greater durability of the lower voltage lamp. The cost of a double-wound transformer is now so low that the saving on the first cost of the lamps is sufficient in most cases to cover it, whilst the saving in renewal of lamps, coupled with the efficiency of the lower voltage lamps, amply suffices to meet the cost of the magnetisation units. Hence the difference in cost of wiring due to the use of one wire instead of two is pure gain. The great majority of small consumers, the men who burn their lamps long hours and pay the gas company anything from 12s. to £1 per lamp per annum, live in terrace houses. There is nothing to prevent a whole terrace of houses from being wired from a single transformer fixed on the outside wall of the building, thus making one service supply a large number of houses, a tapping from the high-tension main being run up the front or back of one house of the terrace to a transformer fixed in a cast-iron case just below the first-floor windows. The transformer reduces the pressure to 50 or 100 volts on either side of a 3-wire circuit, the neutral of which is earthed. From the transformer the concentric wires can be neatly cleated to the outer wall just below the window line and lopped into each house in turn. As only a single cable is needed, which is cleated direct on to the wall and neatly painted, permission can in most cases be readily obtained from owners of property for it to be run from house to house, so that one service does for a whole terrace or colliery row.

In this way it is possible in many districts to make the service charges per kilowatt of consumers' demand no more for this class of long-hour consumer with few lamps than for existing consumers, more particularly as the cost of the meters is saved. The wiring can, by adopting one or other of the new systems, be brought down to 10s. to 12s. per light, or, say, 1s. 3d. per annum for upkeep, interest, and sinking fund. We have seen above that even where the standing charges amount to £17 per kilowatt of consumers' maximum demand, a figure which is not likely to be exceeded by many stations, and allowing for 80% of the lights installed being on at once, a 30-watt lamp can be supplied for from 8s. 7d. to 10s. 2d., or, including the free wiring, for 9s. 10d. to 11s. 5d. per annum. It is not likely that the average burning hours will be as high as 2,000, so that it is evident that an ordinary long-hour consumer can be supplied under these conditions for a sum not exceeding 10s. to 12s. per 30-watt lamp. As it is not proposed to put 30-watt lamps in the smaller rooms, a 10s. inclusive charge would in many cases be amply justified. In suburban and country districts, for which the foregoing system is particularly suited, there is generally very little demand for current during the daytime. At any rate, for the present one may very well leave methylated spirit or gas to heat up an occasional tea-kettle or to light a cellar lamp. Particularly with a small alternating-current station, great economies can be effected if a supply be only given from dusk to dawn, the station being shut down during the daytime, and provisions are made under the Board of Trade Regulations whereby consent to this may be obtained.

In addition to the saving in labour at the station, the limited hour supply reduces transformer losses, and also prevents any waste of current during the daytime. By using internal combustion engines current can be quickly turned on in the case of fog or unusual darkness, under which conditions a supply is given.

In three districts for which Provisional Orders have been recently obtained, it is proposed to work on this plan, and the necessary consents have in each case been given by the local authority on pointing out that, for the sake of one or two who wished to burn an odd light in the daytime, it would be necessary, if a continuous supply were insisted on, to increase the price to the great majority who only require light during the hours of darkness. Of course, there is not quite so much gain from this source if the station be run with steam plant as if gas or oil engines be used. Whilst in most districts it will pay a man with only a few lights, which he uses in consequence for fairly long hours, to use electricity at the above price per 30-watt 25 c.p. lamp per annum to cover wiring charges and the use of current as required, the man with fifty lamps would find the charge too high. Nor, indeed, would it be justified, as we have assumed so far that 80% of the lights installed are turned on at once, whilst the consumer with a greater number of lamps will probably never use at one time more than a small proportion of his lights, the great majority of which will only be in use for a comparatively short time per annum. To meet this difficulty, we put in a limit indicator, ask the consumer to switch on the maximum number of lamps he wishes to use at once, and charge him, say, 12s. per 30-watt lamp, calculated on the number to which the limit indicator is set, and 2s. per lamp on the remainder to cover the wiring charges. He thus settles his own diversity factor and is charged accordingly. This enables him to put in lamps where he naturally would not use them if he had to pay full price on all lamps, and at the same time obviates the absurdity one so often sees, viz., a station providing capital for free-wired lamps which do not even pay the annual wiring charges. Another plan which has been adopted is to charge, say, 10s. per lamp for the first five lamps, 8s. per lamp per annum for the next five, 7s. 6d. per lamp per annum for the next ten, and 5s. per lamp for all above that number, the exact figures depending on the size of the average installation in the district.

Such a scale is, in most cases, however, not so satisfactory, as the first plan as it assumes that the habits of all consumers having an equal number of lights instaled are the same, which is generally far from being the case. We venture to think that the future of electric lighting lies more especially amongst those consumers whom gas has hitherto claimed entirely as its own. No gas company can afford to lay on gas, make a fixed charge per annum dependent on the number of burners, and allow the consumer to use as much gas as he pleases. We believe that an electric light company can deal with the consumer on this basis and make a profit out of it. Comparing the present proposals with the conditions obtaining only three years ago, what do we find? The standing charges of the station and mains per unit of candle-power capacity have, by means of the wire lamp, been reduced by nearly two-thirds; by using double-wound transformers interior wiring becomes single wire instead of double; a main cable consisting of a single No. 18 wire can, at 100 volts,

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supply all installations of twenty 16 c.p. lamps or under; the old double-pole distribution fuseboard is replaced by a single 5-ampere fuse; the meter becomes a memory of the past; a single service supplies a terrace of houses, and electric light commends itself to all long-hour consumers on the score of price independently of other considerations.

Probably in a very few years supply mains will be extended into most districts which till now have been neglected because they only contain small houses. The generating stations will use internal combustion engines, which, in many cases, will only work during the hours of darkness, the supply being alternating-current single-phase at about 2,000 volts. Scattered houses will be supplied from transformers fed by tappings direct off the 2,000-volt mains, and the more thickly populated districts off the low-tension networks. The interior wiring will be put in by the supply company or their agents, and will be "earthed return." The lighting of the living rooms will be by means of single 25 c.p. lamps with plain white opal or similar shades fixed direct on the ceiling, thus giving a well diffused light and avoiding risk of mechanical damage to the lamps.

Book-keeping and collection duties will be reduced to a minimum, as there will be a fixed inclusive charge of about 2s. 6d. to 3s. per lamp per quarter, paid in advance, and the first quarter's charge might with advantage be made to become due as soon as the house is wired.

The authors give in an appendix estimates for a 10,000-light station working on these lines. The estimate allows for expenditure as follows:—site, £400; buildings, foundations, and overhead crane, £1,000; three 100 kw. gas alternator sets, and suction gas producers, £5,200; switchboard, connections and accessories, £500; 12 miles high-tension, 0·05 sq. in. concentric mains laid complete, at £500 per mile (the mileage of mains and cost of services obviously depends entirely on the characteristics of the district), £6,000; services and transformers (assuming that each service supplies more than one house), £3,000; and wiring for 10,000 lights at 10s., £5,000; making a total of £21,100, and adding for contingencies, 10%, £2,110, an aggregate of £23,210.

The working expenses are calculated on running the station from dusk to dawn only with 10,000 lights connected and generating 300,000 units per annum. The receipts for 10,000 lights at 10s. per annum, including wiring rental, are placed at £5,000. The expenditure is estimated as follows:—coal, oil, and waste, £500; wages and salaries, £584; repairs and maintenance, £200; and rates, taxes, insurance, office, and collection expenses, £612; total £1,896; adding 3% for sinking fund, £696, the expenses come to £2,592, leaving a net result (on outay of £23,210) of £2,408.

SINGLE AND STRANDED LOW-TENSION FUSES.*

By WILLIAM TOLMÉ MACCALL, A.M.I.E.E.

For a single-wire fuse the usual formula is that due to Sir William Preece, viz.:—

$$C = k.D^{\frac{3}{2}},$$

where—

C = fusing current in amperes;
D = diameter of wire in inches;
k = constant for any particular metal or alloy,

its value being about 10,244 for copper, 1,642 for tin, and 1,379 for lead.

These constants are proportional to—

$$\sqrt{\frac{T\,E}{P}} \text{ (see Appendix)},$$

where—

T = rise of temperature to fuse the wire.
P = resistivity at temperature of fusion.
E = emissivity " "

Now T and P are constant for a given material, but it is well known (though not apparently by the suppliers of fuse wire, who generally give Preece's table) that E varies with the size of wire. Consequently, we must either adopt a different formula or alter the "constant" for different sizes. Further, the form, material, and size of the fuse-holder will affect the fusing current.

When we come to stranded fuses, no such simple theory is applicable, because the wires will diminish each other's emissive power to an extent which can be determined only by experiment. All we can predict is that a two-strand fuse will carry less than twice the fusing current of either of its equal wires, and probably more than 1·41 ($\sqrt{2}$) times this current, since its emissive power should be greater than that of a single wire; similarly, for a three-strand fuse, the current will lie between thrice and 1·73 times that of the single wire, and so on.

The objects of these experiments, then, is—

1. To determine the variations in Preece's "constant" (or in the emissive power) with change of diameter.
2. To determine the effect on fusing current of house-service fuse-holders.
3. To find the ratios of the fusing currents of single and stranded fuses in the open and in fuse-holders.

Method of Experimenting.—The normal fusing current for a given wire and environment is the minimum current to fuse the wire when sufficient time has elapsed for it to reach its maximum steady temperature.

This was usually obtained by slowly increasing the current, starting with a current well below the N.F.C., which was allowed to flow for 3 min. and increasing by 0·1 ampere increments (smaller for the smaller fuses, and larger for the larger stranded fuses), with pauses of 1 min. Occasionally the alternative method of Schwartz & James was employed, in which the times taken to blow the fuse with various currents above the N.F.C. are determined and plotted, when the N.F.C. is the current line to which the time-current curve asymptotically approaches.

When a closer approximation was desired this was obtained by making an allowance according to the fraction of the last minute which elapsed before the fuse was blown.

The current was obtained from a battery of Tudor accumulators, seven-plate cells giving 18 amperes on a 10-hour discharge, the number of cells used being varied to suit the current required and a wire rheostat being used for approximate adjustment, with a carbon rheostat for exact adjustment.

The ammeters were calibrated by a Kelvin balance, and the one used for the smaller currents was further checked by a standard low resistance, a standard cell, and a potentiometer.

The diameter of the fuse wires was obtained by weighing a measured length in air and in water.

The wire was then divided up and shorter lengths weighed to test the uniformity of gauge. An example will illustrate this:—

Tin wire 28 S.W.G., nominally 14·8 mils diameter.
Length 3,021 mm.
Weight in air .. = 2·654 grams.
Weight in water = 2·294 "
Difference .. = 0·360 "

$$\therefore \text{ Specific gravity } = \frac{2{\cdot}654}{0{\cdot}360} = 7{\cdot}37.$$

$$\therefore \text{ Area } = \frac{0{\cdot}360}{302{\cdot}1} \times 100 = 0{\cdot}1192 \text{ sq. mm.}$$

$$\therefore \text{ Diameter } = \sqrt{\left(\frac{4}{\pi} \times 0{\cdot}1192\right)} = 0{\cdot}389 \text{ mm.}$$

$$= 15{\cdot}3 \text{ mils.}$$

Three separate metres weigh in air—
0·878 grams, 0·883 grams, 0·875 grams.
∴ Variation of diameter from mean value—
= − 0·01 mils, + 0·035 mils, − 0·035 mils.

These variations are so small as to be negligible, and similar results were obtained for the other sizes, the percentage variations never exceeding, and usually being less than, the above.

The earlier experiments were made with the fuse horizontal, as these are the conditions for which Preece's constant is usually stated; it was found, however, that even in air the results were somewhat irregular and considerably affected by vibration, a small amount of this reducing the fusing current by over 5% in the case of 28 S.W.G. tin wire single strand. When the fuses were in a porcelain holder, the results were high and very erratic, varying in the above case from ·7 amperes to 8·3 amperes. Consequently the later experiments were made with the fuse vertical, as is usual in practice.

* Abstract of paper read before Institution of Electrical Engineers, Leeds Local Section, Nov. 17.

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Trouble was further experienced owing to the cooling effect of varying air currents, and this was surmounted by protecting the fuse by a short wooden board on one side and at right angles to this a wooden box with a glass cover, the latter facing the fuse, the distance from the fuse being about 2 in. in each case.

For the experiments in air large terminals, $\frac{7}{8}$ in. diameter, with screws 0·44 in. diameter, were employed, with centres placed 3 in. apart. The fuse-holder employed was of porcelain, with copper end-pieces, to which the fuse was attached by nuts and washers.

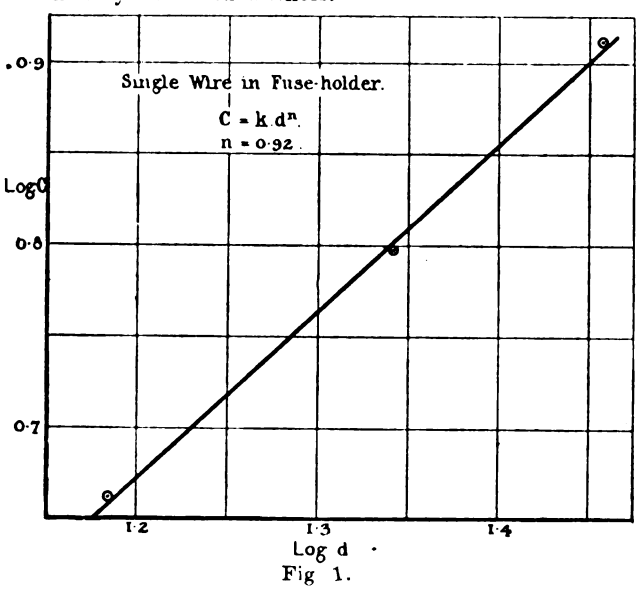

Fig 1.

The present series of experiments is confined to tin fuses in air and in this one type of fuse-holder, and deals chiefly with single and two-strand fuses, a few three-strand experiments being made, but insufficient to obtain general conclusions.

To allow for variations in air temperature, a standard of 16° C. was adopted and the actual currents multiplied by the following numbers :—

Air temperature	14°C.	15°C.	16°C.	17°C.	18°C.	19°C.	20°C.
Multiplier ..	0·995	0·998	1·000	1·002	1·005	1·007	1·00

This table is derived from the fact that the fusing current— $\propto \sqrt{T - t}$,

where—

T = fusing temperature ;

t = air temperature (see Appendix).

These corrections are usually almost negligible.

Experimental Results.—The fuse wire contained 99·6% tin. (For this analysis I am indebted to Mr. Smith, head of the Chemistry Department, Halifax Municipal Technical College.)

The number of experiments made in obtaining each of the results to be given, varied according to the amount by which they differed among themselves ; the range is from 5 to 20 experiments per result. To give an idea of the accuracy in the various cases, the " probable error " is usually stated ; this is equal to—

$$0{\cdot}67 \sqrt{\frac{d_1^2 + d_2^2 + d_3^2 + \ldots}{n(n-1)}},$$

where d_1, d_2, d_3, etc., are the differences of the observed values from the mean, and—

n = number of observations.

SINGLE WIRES.
(Air temperature 16° C.)

Diameter Mils.	S.W.G.	In Air or Fuse-holder.	N.F.C. Amperes	Probable Error.	$10^3 \times E$.	$k \div 10^3$.
15·3	28	Air	3·58	± 0·05	2·60	1·89
21·9	24	,,	5·26	± 0·05	2·42	1·66
28·6	22	,,	7·53	± 0·03	1·77	1·56
15·3	28	Holder	4·58	± 0·04	4·27	2·42
21·9	24	,,	6·28	± 0·02	3·44	1·94
28·6	22	,,	8·17	± 0·02	2·08	1 69

The value for 28 S.W.G. in air is with fuse horizontal, all others with fuse vertical.

The values of E can be calculated either from the actual fusing currents or from the values corrected as above to an air temperature of 16° C. ; the results are identical, since the air temperature is taken into account in the calculation (see Appendix). Preece's constant (k) is given for the diameter in inches.

It will further be seen that the values of E and of k decrease with increasing diameter, especially for fuses in holders, in fact, in the latter case the N.F.C., instead of varying as $d^{\frac{3}{2}}$ does not vary even as rapidly as the diameter but about as its 0·92 power (Fig. 1).

Again, in all cases a wire carries more current before fusing in a holder than the same wire in the air, but the increase is most marked for the smaller wires, the respective increases being 28%, 19%, and 8%.

This is only natural since the holder itself will radiate at about the same rate for each wire, which means a smaller percentage the larger the wire. To test this supposition we may calculate $C_H^2 - C_A^2$ where—

C_H = N.F.C. in holder

C_A = N.F.C. in air ;

the values obtained are 9·2, 11·8, and 10·0 respectively, a very fair agreement.

Passing on to two-stranded fuses the question arises as to the effect of more or less twist of the wires. As a first approximation we may consider this to be that the resistance is increased owing to the greater length of wire per centimetre of fuse while the effective surface is not increased. Further experiments are required on this point ; those done up to the present give a much greater effect, but are insufficiently complete to be quoted. To avoid complication from this source, the amount of twist in the experiments of which the results are given was kept moderate and approximately proportional to the diameters of the wires.

TWO-STRAND FUSES.
(Air temperature 16° C.)

Diameter Mils.	S.W.G.	Twists per In	In Air or Fuse-holder.	N.F.C. Amperes	Probable Error.	$10^3 \times E$.	$\frac{k}{10^3}$
15·3	28	$3\frac{1}{4}$	Air	5·37	± 0·03	1·47	1·42
21·9	24	3	,,	8·85	± 0·06	1·37	1·37
28·6	22	2	,,	13·0	—	1·32	1·34
15·3	28	$3\frac{1}{2}$	Holder	6·37	± 0·04	2·06	1·68
21·9	24	$2\frac{3}{4}$	,,	9·38	± 0·07	1·53	1·44
28·6	22	$2\frac{1}{4}$	,,	13·4	—	1·52	1·39

The same general results are seen here as for the single fuses except that k varies less especially in air, probably because the results for 28 S.W.G. are less affected by its being placed horizontal than they are in the case of single wires. The increase in N.F.C. when fuse is placed in holder are 19%, 5%, and 3% respectively, again showing a diminishing effect with increasing size, and smaller effects than for the single wires. These are both due to the same cause already stated—viz., the radiating power of the holder being fixed, for again calculating $C_H^2 - C_A^2$ we obtain 11·7, 9·7, and 10·6, which agree among themselves and with the values for single wires.

Comparing the two sets of results we obtain the following :—

RATIO OF N.F.C.'S FOR SINGLE AND DOUBLE FUSES.

S.W.G.	In Air or Fuse-holder.	N.F.C. for Two-strand. / N.F.C. for Single.
28	Air	1·50
24	,,	1·68
22	,,	1·73
28	Holder	1·39
24	,,	1·49
22	,,	1·64

The first figure is affected by the position of fuse being horizontal, so that probably the ratio is fairly constant in air. Some experiments on 29 S.W.G. gave a ratio of 1·62, but owing to the conditions being somewhat different the separate figures are not given. The increasing values with increasing diameter for wires in the holder are due again to the diminishing effect of the holder, so that these values gradually approximate to those for fuses in air.

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A few experiments were made on three-strand fuses which give a N.F.C. of a little over twice that of single wires of the same size. It is hoped to complete these and to extend the results to fuses of other materials.

APPENDIX.

Theory of Fuses.

Let—

C = Normal fusing current in amperes.
P = Resistivity of material at fusing temperature in ohms per centimetre cube.
D = Diameter of fuse in centimetres.
d = Diameter of fuse in mils.
T = Fusing temperature in °C.
t = Air temperature in °C.
E = Emissivity in calories per sec. per sq. cm. per °C. excess of temperature.

Then—

$D = 0{\cdot}00254\, d$.

The heat produced per centimetre length per second—

$$= \frac{C^2 P}{\frac{\pi}{4} . D^2}$$

The heat emitted per centimetre length per second—

$$= (T - t)\, \pi\, D\, E \text{ calories}$$
$$= J\, (T - t)\, \pi\, D\, E \text{ joules.}$$

Under steady conditions these are equal whence—

$$E = \frac{4\, C^2\, P}{\pi^2\, J\, D^3\, (T - t)}$$

For tin—

T = 230° C.
P = 26·4 microhms per cm. cube.

∴ Taking J = 4·19 and expressing diameter in mils we have—

$$E = \frac{156\, C^2}{d^3 (230 - t)}$$

For two strands the area of cross-section is doubled, and the surface is doubled if we take the cross-section as consisting of two circles touching only at a point.

Hence—

$$E = \frac{39{\cdot}0\, C^2}{d^3 (230 - t)}$$

where d = diameter of each wire in mils.

Similarly for three strands the area of cross-section is trebled and the surface is $2\frac{1}{2}$ times that of a single wire, taking it as that of three circles each touching the other two.

Hence—

$$E = \frac{10{\cdot}8\, C^2}{d^3 (230 - t)} \quad (d \text{ as above}).$$

DEVELOPMENT OF THE TELEPHONE INDUSTRY.*

By L. E. WILSON.

In the early days, only a few of the large business concerns made use of the telephone service, but nowadays the necessity for telephone service has spread so that every class of the community uses it, and every day finds the telephone supplanting more and more letters, telegrams, and other means of communication.

Twenty-one years ago, when Manchester was not connected telephonically with London, and pioneers were busy anticipating the difficulties of communication owing to the process of inter-switching, etc., there were 1,400 subscribers here and about 5,000 subscribers in the Metropolis. A night service was inaugurated in London about this time, but with indifferent success, and from 10 o'clock at night until 6 o'clock in the morning there were only 40 calls per week, and it was estimated that each one cost 10s. Now at the present time some 18,600 calls are originated on the National Telephone Co.'s system in London nightly, between 8 p.m. and 8 a.m., and the 103,287 exchange stations as at January 1 this year originate 590,000 calls per day. In Manchester the number of exchange stations have increased to 20,000, giving 138,000 calls per day.

All will recognise that speed is essentially the telephone engineer's maxim, and a few seconds saved on each call approaches gigantic proportions in the aggregate; consequently, even the expressions employed by the operators are regulated, and co-operation, or team-work as it is called, is now used extensively, and reacts favourably on the service. An example of the wastage in words, no doubt fresh in the memory of not a few, existed in the local custom of saying "Right" after repeating a demand for a number. When this practice was discontinued, the improvement was soon appreciated, as the saving effected by omitting 100,000 unnecessary words per day is not the only feature involved.

In spite of the strides made, full advantage is not yet taken by the public of all the facilities a telephone service offers, and this is not due to any technical difficulties. In some quarters discrimination is exercised as to the nature of the business involved before the telephone conversation is permitted, with the erroneous idea of reserving the telephone for more important business. The policy of preventing people reaching a correspondent quickly and freely is no more justified than leaving an accumulation of letters unopened and unanswered. It happens, however, that this indispensable means of communication is not only starved and undeveloped, but occasions much annoyance. A tendency to stagnation and disregard is very noticeable in other respects, but improvements are making headway, although the educational process is a very slow one. The telephone service is the most rapid, cheapest, and most direct channel for information, and this channel should be open both ways, and the intelligent study of the best method of handling telephone calls is of wide importance.

The "engaged number" question is open to great misunderstanding, and a glance at a characteristic curve showing the number of calls which have to be dealt with during the various hours of the day will, in a measure, convey the reason.

The rise and fall in calls, as shown by this curve, indicates a tendency to crowd the day's work into about two hours in the morning and about two in the afternoon, and this tendency is more pronounced in exchanges serving strictly business localities. This characteristic explains many engaged numbers, but engaged calls are chiefly caused by an insufficient number of lines. The subscriber is usually only interested in outgoing calls, and for this reason it is difficult to get the inward traffic recognised, although it is not at all in his interests to neglect his inward traffic. The demand during the busy times often concentrates some unfortunate interest round one particular number, and even with the best of conditions it can happen that two or more operators are testing the same line simultaneously, and as it tests disengaged to each operator, a double connection occurs. In up-to-date switchboards this irregularity is reduced to a minimum.

The "engaged number" provides ineffective work at the exchange on some 23% of the total number of calls, to the subscriber it means lost time and lost or delayed business.

For some reason, telephone engineering has not always been given its proper status and classified as an important branch of the electrical industry, and, curiously, when the development has now reached a stage approaching perfection, the most important branch of the telephone service is not electrical in character, and the engineer who has persistently devoted his life to what may be termed the higher side of the art, finds it necessary to also acquire considerable commercial knowledge.

The introduction of 24 volts pressure on telephone lines brought prominently to the front the question of insulation, and taking 1,000 lines under old conditions, on a wet day 40% tested under 100,000 ohms; the use of Sinclair-Aitken leading-in insulators, which introduces a dry section between the leading-in cable and the outside wire, raised the insulation considerably, and under the same atmospheric conditions, only 23% proved to be under 200,000 ohms. An investigation of low insulation and the cause sub-divided the responsibility, as follows:—Outside lines, including the leading-in wire, 37%; window terminals, 37%; office wiring, 19%; instruments, 7%. After receiving individual attention, no line tested under 7 megohms. It does not necessarily follow that speech transmission was inferior under the old conditions, although with the transference from open to underground wires, insulation difficulties almost disappear.

* Abstract of paper read before Institution of Electrical Engineers, Manchester, Nov. 16.

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Touching on the change from overhead wires to cable, Manchester possessed one of the first paper cable systems, and it is interesting to note the increase in the number of wires per cable. In the first installation there were 153 pairs of wires in a 2½ in. cable, and now cables containing 800 pairs of wires in the same diameter are used.

The determination of the standard of transmission is practically of recent date. Using the words of an eminent telephone engineer, the telephone engineer is now able to measure telephone currents with the same ease as the lightning engineer employs the voltmeter and ammeter. The question of handling and providing for a large number of wires has always been present. Was it advisable to bring all the lines into one exchange or split them up into several and connect with junctions? In the first instance, the operator's reach and the space requisite were practically the controlling features, and the time lost in transferring a call was also a contingent question. Reduction in the dimension of various switchboard apparatus, and the introduction of automatic signals and common battery working, brought the standardisation of plant within reach, and the latter system places all complication at the exchange, where a skilled staff is available, leaving a minimum amount of work for the subscriber to accomplish with simplified equipment. The less the subscriber has to do, the better for the service, for he is strikingly incompetent as an operator.

Among the innumerable modifications of the original apparatus connected with the public service, the subscriber's instrument has also made a real progress, and the general excellence of the design and workmanship makes it difficult to suggest further improvements, although trouble, of course, does occasionally occur. The same progress is not so generally noticeable in the domestic or private telephone; the retention of the obsolete types of instrument is unfortunate, and whether this is due to inexperience or the borrowing ideas, the same errors are perpetuated, and the consequent difficulty of maintenance brings the industry into disrepute.

The practice of designing or specifying instruments equipped with four-magnet generators and 1,000-ohm bell coils for internal use, where the maximum line resistance does not exceed 3 or 4 ohms, is absurd. In fact, for ringing currents, exactly the same rule applies as with direct currents from batteries, viz., the resistance or impedance of the piece of apparatus operated should be something about the resistance or impedance of the operating apparatus plus the lines, but in the case of lines of negligible resistance one might, very well, use even a 50-ohm generator and corresponding bell. In some switchboards on the market the indicators are placed in series with the line, and series indicators, unless of very low impedance and used on short lines, are, of course, worse from a transmission standpoint than the bridging apparatus, and another point is that with series apparatus, by keeping down the impedance of the indicators, the sensitiveness is generally decreased, so that trouble is experienced owing to the fact that a more powerful source of signalling supply, whether battery or generator, is required. For some reason, also, most trembling bells are wound to 5 ohms resistance, and trouble is experienced when it is necessary to work the bells in conjunction with a cable line of, say, two or three miles, with a resistance of, say, 250 ohms. This should obviously be wound so as to have the same resistance as the average type of line, and there appears to be no reason why the rule of thumb work should apply to the design of local service apparatus any more than it should to the design of long-distance apparatus.

When attention is once aroused, no doubt the ingenuity and enterprise of the manufacturers will speedily find methods to increase the efficiency of this class of telephone. It should be remembered that manufacturers do not, as a rule, instal and maintain installations, which probably explains the foregoing shortcomings; so the following analysis of faults, taken over a long period and a large number of instruments, given in relative order of importance, may be of interest:—

1. *Wiring.*—Much trouble can be traced to the practice of leaving at each terminal a spare length of wire in the form of a helix which is easily broken. The wire should be stapled direct to the terminals. Faulty design and the placing of cotton-covered wire in unsuitable positions or in steel conduit, where moisture and condensation in time break down the insulation.
2. *Primary Batteries.*—The life of a battery varies according to circumstances, but they are often needlessly changed. The correct way to test is to leave the receiver off the hook for at least five minutes before making the necessary observations.
3. *Bell Troubles.*—After being adjusted correctly, the chief trouble is caused by cleaning gongs. Intermittent faults in the coils, often due to acids used in the manufacture of the bobbin fibre end, it is a difficult fault to localise even with a weak current. A generator circuit will oftentimes overcome the interruption to the circuit.
4. *Instrument Cords.*—The cord represents the weakest part of any system, and is known as the telephone man's scourge. It is, therefore, wise to reduce the cords to a minimum; for this reason, the hand combination instrument is really the most inefficient and, consequently, the most expensive instrument to maintain. Its popularity is due to the convenience offered.
5. *Transmitters.*—Damage by pencils and the packing of granulated carbon. These troubles are largely overcome by the use of the solid back microphone chamber with perforated mouthpiece.
6. *Generators.*—Cut-out troubles. Short-circuiting the generator due to breakdown of insulating pin, oil and metallic dust is generally responsible, especially in certain types of instruments where the frame is used as a common connection.
7. *Receiver.*—Represents the first telephonic apparatus invented, and left the hands of the inventor in an almost perfect condition; it offers very little scope for improvement. The change from bar to horseshoe magnets is, perhaps, the most important A diaphragm too close to the magnet is a trouble which can be ascertained by the sound emitted when flicked with the finger, the sound should be hollow. Freedom from dirt is essential.
8. *Lightning Arrestor.*—Generally of the serrated type, open and exposed to dust and foreign matter, which causes short circuits. Terminals left exposed to the atmosphere will, in a short time, cause trouble.
9. Fixing instrument to damp walls introduces various trouble.
10. *Cradle Switch.*—Such causes as poor springs and contacts, and the accumulation of dirt interfere with the regular working of some types of instrument switch-hooks.

A glance at the common battery standard instrument will show the great improvements and modifications in favour of low maintenance costs, and there is apparently no reason why these features should not be introduced in other types. For small installations it is not always advisable to instal a common battery equipment, but the time has now arrived when the advantages of a common battery system should be universally appreciated; but unless manufacturers take in hand the necessary educational work, opportunities will, for the time being, be lost, and obsolete systems installed.

The advantages a common battery system offers may be sub-divided under the headings of Line, Instrument and Switchboard:—

(*a*) The common battery instrument dispenses with the local battery and generator. The simplified instrument consisting of bell, receiver, induction coil and transmitter, with the addition of a condenser, supplies all requirements, and the act of taking off and replacing the receiver gives a definite call and clear by making and breaking the circuit for direct current from the exchange battery.

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(*b*) *Line.*—The line is practically under permanent test, and faults are automatically recorded.

(*c*) *Switchboard.*

1. Responsibility is concentrated to quite 80% efficiency.
2. Automatic calling is provided.
3. Automatic supervisory signals are provided for both the calling and called subscriber, showing the operator the state of the connections.
4. Uniformity of speech is provided by eliminating the local battery's variation in voltage.
5. Saving in space on the switchboard is of great importance.

In a common battery system, accumulators are usually employed, but there is no reason why suitable primary cells of low resistance should not be used for small plants.

Generally speaking, the telephone has yet to be properly developed in connection with floor-to-floor messages. The cost of installing a private telephone apparatus may amount to anything from £1 to £8 per station, depending upon the type of installation and the quality of the apparatus, but the cost of maintenance should amount to a small item, provided the apparatus be carefully selected and installed.

The system to be adopted should be carefully considered, and where a reasonable number of lines are available the switchboard system is undoubtedly the best. The cost of an operator is certainly an item, but it must be remembered that the telephone and the operator save the time of important and highly paid officials and increase business. Extensions can be added from time to time with no difficulty and little expense; also, should one instrument be out of order, the trouble is restricted to that line and the remainder work as usual.

The inter-communication system differs chiefly from that already explained, in that it throws the operating on the caller and is necessarily limited in scope. The expense of bringing the total number of wires to each instrument is considerable, and the general practice of adopting a single-line system to reduce expense produces overhearing and cross-talk, which depreciates the value of the system generally, and if manufacturers desire to retain this principle they might, with advantage, devise some method of at least minimising the trouble. Assuming that the induction coil transforms up to 20 times, 3 volts alternating potential difference on the primary would mean 60 volts on the secondary and on the lines, and as cross-talk is directly proportional to the line potential, it is possible that some reduction in the impressed potential on the line might be advantageous.

It is not unusual for the average number of calls per station to exceed 10 calls per day, and if we consider a typical equipment where 50 instruments are installed, this means 500 calls and conversations daily. Reckoning the value of the conversations at the very low rate of ½d. each, it follows that the actual value of the traffic in the installation amounts to no less than £312 10s. per annum, the actual cost of the installation being slightly over £200, and the cost of maintenance about £15 annually.

When we consider, in addition, the great saving in time and improved discipline, it is easy to see how the telephone call may be made a most valuable money saver, but the equipment must be suitable for its work, efficiently installed and efficiently maintained.

DISCUSSION.

Standardisation and Automatic Working.

Mr. Aitken: Standardisation would not come yet, for while the manual operator system had now been brought very near to perfection, there was still much to be done in the work of an automatic system. Automatic working, without special operators, would come, and be a great advance on present methods. Then there would be no need of bringing 30,000 lines into one exchange, and as the system is essentially a trunking one, sub-division into small sections could be carried out, reducing possibility of the disorganisation of the system in case of fires, etc. Regarding hand combination instruments, their popularity was due to their convenience in use, but cords are the bugbear of telephone engineers. In the automatic system there would be no cords.

Merits of the Post Office.

Mr. Brodrick: There are certain services in connection with Post Office telephones not generally known to the public. It is possible to telephone a message to a Post Office at any hour; the message will be written down there and delivered to any address within a mile's radius. The charge is 30 words for 3d. Similarly if desired, the message will be posted from the Post Office. This arrangement is very convenient in country districts, with an early collection, as by telephoning to the Post Office a letter can still be got through later than the last local collection. More trunk calls come into Manchester than to any other exchange in the world. Between 10 and 11 a.m., 10,000 such calls is the average. The Post Office had been making experiments lately in connection with the loading of cables. On a trial line, 38 miles long, the loading improved the speaking about 3 times. There had been some slight trouble with the insulation of the loading coils. On the new cables between Liverpool and Manchester, inductances were being put in at 2½ mile intervals.

Number of Wires to a Cable.

Mr. Latimer: According to National Telephone Co.'s specification, 1,200 pairs of 6½ lb. wires could be easily got into a 2½ in. cable. Between Liverpool and Birkenhead was laid in 1891, the very first dry core air space cable ever put in in Europe. It was 2½ in. in diameter, and had only 41 pairs of wires. Thirty-four of these were in use to-day, and the cable had been very successful in operation.

British *v.* American Practice.

Mr. Whalley: Five years ago most of the exchange equipments had to be bought abroad. Now there were several firms in the country able to supply the whole equipment. The standards set by the G.P.O. and the National had set a very high value, and practically everyone works to them. Two years ago at an exhibition of telephone makers at Chicago, he asked for a guarantee from American firms, that their stuff would meet the standards, but not one would give such a guarantee, as the requirements were so much greater than for American practice. Regarding the measurement of telephone currents, he did not think the present methods very satisfactory, and remarked that correct current strength was not a guarantee of high speaking efficiency.

LONDON TUBE RAILWAYS.

Notice has been given of a Parliamentary Bill enabling the Great Northern, Piccadilly, and Brompton to absorb the Baker-street and Waterloo and the Charing Cross, Euston, and Hampstead lines. The issued capital of the three companies is £15,920,000 and that of the London Electric Railways Co.—the name to be adopted for the amalgamated concern—will be £16,800,000. An important feature of the scheme is that the Underground Electric Railways Co. of London, which has built the systems, will be relieved of its liability to gurantee the interest on some of the capital issued. A new loop-line at Charing Cross of about half a mile will connect with the Bakerloo tube at Trafalgar-square and with the District system on the Embankment.

ELECTRICITY IN PRINTING WORKS.

About thirty students attending Mr. Kilburn Scott's lectures at the Northampton Institute, London, were, by permission of Messrs. Lloyd, shown the engineering features of the large printing establishment in Salisbury-square. In the absence of the Chief Engineer, Mr. Mascord, the party was received by the Electrical Engineer, Mr. Blake, who explained in detail the various features of interest.

ELECTRIC RAILWAY FATALITY.

As a train was about to start on the London District Railway the motorman noticed that a cable was on fire, and asked a conductor named Charles Sergent to get the passengers out in order that the train might be shunted into a siding. Shortly afterwards, Sergent was found unconscious on the floor of the motor-room, and he died in St. Mary's Hospital, Paddington. It was stated at the inquest that death was probably due to electric shock, but no explanation of the manner in which Sergent came into contact with the electrical apparatus could be given, and the inquest was adjourned.

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CONTENTS.

	PAGE
Notes	743
Colliery Signalman Electrocuted	744
Electric Traction in Japan	744
The Present Aspect of Electric Lighting	745
Single and Stranded Low-Tension Fuses	748
Development of the Telephone Industry	750
Electrical Production of Diamonds	753
Correspondence	754
Development of Radiotelegraphy	754
The Magnetic Testing of Iron	756
Pillar Type Motor Panels	757
Simplex Heating and Cooking Apparatus	757
Long-Distance Telephone Transmitter	758
Personal	758
Electric Projects for 1910	759
Southport Electricity Works Fatality	762
Technical Problems, with Solutions by Practical Men	763
Leicester Model Electric Home	763
Tyneside Notes	764
Midland Notes	764
Lancashire Notes	765
American Notes	766
German Notes	767
Lighting and General Notes	768
Traction Notes	769
Companies' Meetings and Reports	770
Companies Registered	770
Contracts Open	770
Tenders Accepted	770
Educational	770
Publications Received	771
Obituary	771
Electric Rules for Mines	771
Patents	772
Companies' Stock and Share List	774

ELECTRICAL PRODUCTION OF DIAMONDS.

On the Continent of Europe, especially in France and Italy, the late Wernher-Lemoine *cause célèbre* has had the effect of directing the attention of scientific men to the mysteries of the artificial production of diamonds.

One of our Italian contemporaries says that although the manufacture of diamonds appears to belong more to the domain of alchemy than of commerce, many experts think otherwise. Certainly M. Moissan, of the French Academy of Sciences, had great faith in his powers to produce diamonds with the help of electric furnaces, and though he was reticent as regards his methods (not having perfected them) he showed diminutive crystals, perfect miniature diamonds, which he had produced. But his premature death, robbing science of a most promising worker, put an end to these researches, for nobody knows how Moissan set to work, what was the initial mixture he dealt with, or what were necessary reactions he looked for in order to manufacture the precious crystals.

However, both chemists and electricians agree that actually, in certain electro-metallurgical operations, diamonds are produced accidentally, just as of old calcium carbide (the raw material of acetylene gas) was produced incidentally long before Bullier gave to the world the definitive method for the commercial production of these useful salts. It is a common-place of science that we are daily carrying out processes, often of incalculable value, unknowingly. The attention is directed in special directions, and the accidental is generally overlooked, because, as a rule, these unexpected results are of too slight a character to be recognised and require to be carefully studied before their usefulness becomes apparent. Thus it is that many believe that if all the products of the electric furnace were analysed, if all the scoria, small pieces of iron and other residues were accurately examined, one day or other there would be discovered the few grains of

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pure carbon, the precious material, which some day, when the requisite chemical and physical phenomena were present, though hitherto unnoticed, will result in the production of diamonds. It would then be comparatively easy, with the aid of the note-book, to work back and find out exactly what was the necessary physical and chemical combination for the solution of this great mystery.

So far, experiments have remained hypnotised, as it were, by the celebrated experiments of Moissan. Yet nobody knows precisely the details of his method, and certainly it is by no means clear that other and more reliable ways are not open. Moissan himself was doubtful as to his ground, for he was restive under the suggestion that his experiments should be repeated under control. It is significant that M. le Chatelier found that the carbon resulting from the decomposition of iron at temperatures varying between 700 and 1,100° C., and a pressure of round about 15,000 atmospheres, was always in the form of graphite, not of the crystalline diamond. There was something missing. As for Lemoine, with his rudimentary apparatus and his haphazard methods, his claims were purely fantastic. Nevertheless, this does not mean that Moissan was wrong; only that he had not seized the whole of the phenomena of his successful experiment.

But, as we have said, search can, and is being, made in other directions. For instance, recently the French Academy of Sciences proceeded to open sealed packets deposited by M. Guynot de Boismenu in April, 1908, and January, 1909. M. de Boismenu has a wide experience of the electric furnace, and in his sealed packets he described a method of manufacturing diamonds which differed completely from what Moissan had made known. Unfortunately, the Academy was unable to examine the process in its entirety, because patents taken out in 1907 were involved, and so far the method in its entirety remains a secret. But it is known that M. de Boismenu did not use very high pressures, which Moissan considered essential in order to approach as far as possible natural conditions. However, it is actually postulated that a new and reliable way of producing diamonds is before the Academy.

Many other students have been experimenting, and some of these have found that certain materials have an unmistakable tendency to favour the crystallisation of carbon. It is possible that if one of these had been used by le Chatelier, his graphite would have been transformed into the hardest form of pure carbon, the diamond. At all events, these observations mark a decided step forward and point out that though it is not definitely proved that the electric furnace will turn out large diamonds, there is much likelihood that M. de Boismenu may ultimately succeed in this difficult operation. It is abundantly clear, however, that whatever method is adopted, he who is destined to discover the key of the mystery must have an extensive practical knowledge of the electric furnace, and, moreover, must have studied deeply the extremely complex and little understood phenomena of electrochemical reactions. By co-ordinating his observations he may then, by patient and judicious deductions, arrive at the exact formula, and the indispensable physico-chemico conditions by which pure carbon can be crystallised. Unless, indeed, one fine day the mystery is revealed by chance—very possibly that is what may happen.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "THE EDITOR, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

INSULATED WIRE FOR CANADA.

Sir,—I am in receipt of a copy of the issue of October 15 and am interested to read your note on page 1, headed "Insulated Wire for Canada." I think it decidedly opportune that British wire manufacturers should make an effort to place their products on the Canadian market. As you are aware, we use the B & S gauge altogether in this country, and British wire should be so described. Owing to the distance from the factory to the consumer, it is almost absolutely necessary that British manufcturers should have Canadian representatives, not only in the East, but in the Centre West, and in British Columbia. I would be very pleased to see a move made in this direction, and believe that considerable business might ensue if the goods are properly placed before the consumers.

I may say that the above remarks not only apply to wire but to various other products of British manufacture. This department inspects all installations before current is allowed to be used on the same, and therefore has to criticise various materials entering into the installation. In the matter of English tumbler switches, out of a batch of six or seven different makes that were submitted by local dealers to this department for examination, only one would at all meet our requirements, the features criticised being the absence of an insulating lining in the metal cover; the smallness and insecurity of the binding posts and screws; and the absence of any mark as to ampere capacity and voltage. At the present time we work altogether on the National Code rules of the United States and Canada, and articles such as switches and so forth would have to comply with these requirements.

Yours, etc.,

Winnipeg, Manitoba.

F. A. CAMBRIDGE.
City Electrician.

DEVELOPMENT OF RADIOTELEGRAPHY.*

By PROF. H. STROUD, M.A., D.Sc., M.I.E.E.

As we have recently established a Wireless Telegraphy Station in connection with the Physical Department of Armstrong College, it seems appropriate that I should devote my address to the subject of Radiotelegraphy, with an account of the College station. This year the scientific basis of modern radiotelegraphy comes of age, Hertz having announced his discovery of electric waves in 1888. It was, however, not till about 1897 that Marconi brought into prominence, by his large scale experiments, the method of signalling by means of Hertzian waves. At that time the Branly coherer (1890) formed the chief method for detecting the electric waves, and the system of wireless telegraphy of 1897 owed much to the pioneer work of Sir Oliver Lodge as well as to the practical extensions with which Marconi's name is intimately associated.

In March, 1899, Marconi first made communication between England and France across the English Channel. At the beginning of this century the greatest distance of communication was about 200 miles, which has been increased within recent years to 2,500 and more miles in the transmission of signals across the Atlantic. Great progress during the last few years has been made in the production of persistent or undamped waves, in connection with which the Poulsen arc method is most prominent. These undamped waves permit great precision in tuning. They can also have their intensity altered by means of the voice acting on a suitable microphone, and thus, using a receiver which is quantitative in action depending on the amplitude of the waves, it is possible to transmit speech, and the foundation has been laid for the development of radiotelephony. Further, the spark sender has been much improved, due to the introduction of the "shock excitation" system based on Wien's "quenched spark," 1906. This

* Chairman's address to the Institution of Electrical Engineers, Newcastle-on-Tyne Section, Nov. 22.

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system is employed by the Telefunken Co., and has given excellent results.

The radiotelegraphic station in the Physical Department of Armstrong College is licensed by the Postmaster-General as one for experimental purposes. Mr. Morris-Airey has been associated with me in connection with the station, and I have much pleasure in acknowledging the enthusiasm he has exhibited in the design and equipment of the station. We have benefited by the valuable technical advice kindly given by Mr. Sörensen, engineer and manager of the Cullercoats radiotelegraphic station.

The towers of the College afforded a very simple method for the erection of the antenna. In its construction about 1,500 ft, of wire cable are used; the cable is seven-stranded, and is made up of No. 20 S.W.G. bare silicium bronze wire. A double cable of this wire, about 170 ft. long between the insulators, is stretched between the Sir Lowthian Bell tower (130 ft. high) and the Jubilee Exhibition tower (80 ft. high). The double cable is insulated at each end by three porcelain insulators of special construction so as to prevent the ends of the wire falling in case of the breakage of the insulators. Two sets of cables of the same wire are attached to the 170 ft. of insulated double cable, and lead to the room where the signals are sent and received—one set consists of five cables suitably spaced towards the higher tower end, the other set consists of three cables suitably spaced towards the lower tower end. The King's Hall necessitated this division into two sets, but it is arranged, by separately insulating the two sets, that the antenna can be used as a "loop" antenna, or all the eight cables can be joined at their lower ends, thus forming a "fan" antenna, but of unsymmetrical type. The connections between the insulated antenna and the experimental room are made through two leading-in tubes of porcelain above one window; each porcelain tube, which is filled with paraffin, has a brass tube, furnished with terminals at the ends, along its axis. The lower ends of the two sets of the antenna cables are joined to the outer terminals on these brass tubes, the inner terminals being normally joined together and connected to the switch in the centre of the wall of the room. The antenna is thus in the normal connection a "fan" antenna. The centre switch enables the antenna to be joined to (1) the spark sender; (2) the Poulsen arc sender; (3) the earth; (4) the receiving side. The earthing wire, used for sending and receiving, is a thick cable proceeding through the floor out to an extended lead roof over a corridor.

The spark sender consists of an 18 in. Apps' induction coil, which can be excited from the city alternating supply (100 volts) through a suitable resistance, or, using a mercury or other break, by means of storage cells up to 100 volts. The sending circuit includes a capacity of large Leyden jars arranged in parallel and series. This condenser discharges through an inductance consisting of a few turns of a helix of stout copper tubing and various types of spark gap. The capacity and inductance are adjusted for a wave length of 600 metres. At present the coupling with the antenna circuit is direct, as it is usually in the Braun sender. Such a number of turns of the helix are included in the antenna circuit as to produce the correct wave length. Weak coupling is provided by making only one or two turns of the helix common to the closed oscillation circuit and the antenna circuit.

The Poulsen arc generator is of an experimental type, having a separately excited magnetic field which can be varied over a wide range. The arc is struck between the usual copper and carbon electrodes inside a closed chamber with marble sides, with means for admitting hydrogen, coal gas, etc. The suitable atmosphere can also be provided by means of a spirit dropper which allows alcohol to drop on to the copper electrode, or into the arc near the copper. The arc is fed from the city direct current 240 or 480 volt mains through regulating resistances, air cored choking coils being introduced to prevent the oscillations passing to the supply mains. Under normal working conditions one terminal of the arc is connected to earth through a large capacity (block condenser), the other terminal being connected through a similar condenser to an inductance and capacity which are connected to the antenna. The capacity, which is in parallel with the inductance, is an oil condenser and both it and the inductance can be changed to give various wave lengths up to 1,500 metres. The sending key is arranged to short circuit either an extra capacity or an extra inductance in the antenna circuit, so as to produce the variations in wave length by means of which signalling is effected on the Poulsen system.

For the receiving circuit, a primary coil, wound with No. 14 wire over an ebonite cylinder (12 in. diameter), is arranged with its axis horizontal. Spring contacts connect the turns of the coil in use to the antenna and to earth, a variable condenser being arranged in parallel with the coil. By means of a double-pole-change-over switch, the variable condenser can in a moment be changed from the above connection and put in series with the coil between the coil and earth. In this way the wave length can be adjusted between wide limits from the lowest wave length used in wireless telegraphy of about 300 metres up to the highest used by Marconi of nearly 4,000 metres. Inductively coupled with this coil is another coil, sliding within it, also wound on an ebonite cylinder but of slightly smaller diameter. To this secondary, which can be closely or loosely coupled to the primary by sliding it in or out along guides, are connected the various detectors, electrolytic, thermo-electric, etc. Near one end of the primary coil is arranged another secondary wound on an ebonite cylinder (13 in. diameter), with a finely stranded conductor consisting of 21 strands of No. 35 silk covered wire. This secondary is intended for use as the receiving circuit for the undamped Poulsen waves. Variable condensers are joined to the turns of this secodnary coil, and adjustment of the wave length is made by means of contacts on the secondary and the variable capacity. By means of a Poulsen "tikker" the energy, accumulated by resonance, intermittently charges a condenser across which is the receiving telephone. The coupling between the tuned primary and secondary of the Poulsen receiver is varied by the rotation about a vertical axis of the secondary before one end of the primary coil, whose axis is horizontal.

The development of the Armstrong College experimental station will, we trust, afford facilities for studying radio-telegraphy, and for making investigations in connection with the subject. As previously mentioned, recent progress has been largely in the production of persistent or undamped waves. The advantages claimed for the Poulsen arc undamped wave system are (1) that, owing to the persistent effect of undamped waves, the receiving circuit can be very loosely coupled to the antenna circuit, and thus rendered very insensitive to atmospheric electricity, or to undamped waves of wave length differing by even a small percentage from those for which the receiver is adjusted. Again (2) the potentials imposed on the sending antenna are only a few thousand volts, and only a few hundred volts are used in the sending system. Following upon Poulsen's arc method and Fessenden's high frequency alternator for radio-telegraphy and telephony, we have Marconi's high speed discharger. The arc is only able to produce very high frequency oscillations when means are supplied for quickly getting rid of the heat liberated in it. Poulsen effects this by conduction, using a water cooled copper electrode as anode. Marconi effects this by a convection method.

The new Telefunken "shock excitation" systemsbased on Wien's "quenched spark" 1906, has proved a great improvement on the ordinary spark method. In the ordinary spark method for the production of electric waves, reaction takes place between the primary spark circuit, as long as the spark lasts, and the secondary antenna circuit, this reaction resulting in the production of waves of two wave lengths. In the new Telefunken system, advantage is taken of the very large damping of a series of very short sparks. The primary oscillations are "quenched" by this damping after but one or two swings and the secondary circuit continues to oscillate in a single period, giving rise to an electric wave of definite wave length. An alternator having a frequency of the order of 1,000 per second produces, by means of a transformer, a very high number of discharges per second. One of the principal advantages of this system is the musical tone produced in the telephone at the receiving end, this is distinctive of the station transmitting, and very different from the noise of atmospheric disturbances.

In the Lepel system one very short cooled spark between two flat metal plates, 3 in. in diameter, is used. These plates are separated by paper except at the centre, and the supply voltage is 400–500 volts. The receiver in this system contains two tuned circuits, the aerial and the intermediate,

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and an aperiodic circuit in which is the detector of the thermoelectric type.

The problem of directive wireless telegraphy has made considerable advance towards solution by the experiments of Bellini and Tosi, who have constructed a complex antenna, by means of which the waves are sent almost entirely in one direction. Similarly at the receiving antenna they can locate the sending direction. In their first arrangement two triangular antennæ, open at the top, are supported from one mast. The planes of these antennæ are perpendicular. When oscillations are set up inductively in coils included in the bases of the triangles by means of a single coil that can be turned in different directions, the radiation is greatest in the plane of the moving coil. Considering each antenna separately, the radiation is greatest in the plane of that antenna, but with both antennæ the radiation is greatest in the plane of the coil inductively coupled with the antenna coils. The arrangement is called by Bellini and Tosi a radiogoniometer.

In their final arrangement the radiation is confined almost entirely to the one side of the transmitting direction by employing an ordinary vertical wire antenna in conjunction with the above. The curve of radiation may then be made of the form of a cardioid with the antenna at the cusp, instead of the figure of 8 curve given by the first arrangement. Experiments with this system were made with satisfactory results last year between Dieppe and Havre, and Dieppe and Barfleur. Wireless telegraphy has special fields of its own, viz., communication between ships, and between ships and shore, and communication between places between which it is difficult to lay cables, as well as the fields already served by means of telegraphic wires. The transmission of news to ships at sea renders it possible to publish daily on the various liners several editions of a newspaper, and it is important to note that the same message can be transmitted simultaneously to any number of stations that are provided with suitable receivers, and are within the range of the sending station. Moreover, radiotelegraphic communications are independent of the many causes that interrupt wire telegraphy, such as snowstorms, hurricanes, etc., on land, and cable accidents at sea.

At the present time wireless telegraphy forms an indispensable adjunct for warships, as well as for the great liners crossing the ocean, and soon, no doubt, no ship will proceed to sea without this invaluable method of communication. We may also note that, by the receipt of weather reports from ships at sea at definite times, it will be possible for the meteorological authorities in England to obtain the advantages that have previously only been possible to countries of vast extent, such as America, and thus to be able the more exactly to predict the weather. It has also been proposed to send signals at pre-advertised times from the Eiffel Tower, say at midnight, when there is least liability to interference, and thus ships in the Atlantic could receive the correct time necessary for determining the longitude. Before concluding my address I desire, if I may be allowed to do so, to offer a high tribute to the numerous valuable expositions of the subject contributed by Prof. J. A. Fleming, F.R.S.

THE MAGNETIC TESTING OF IRON.*

By PROFESSOR W. BROWN, B.Sc.

I make no apology for taking "Iron" as my text, because it is of the greatest interest to all electrical engineers and the magnetic testing of iron has long passed the experimental and laboratory stage, and is an operation of the utmost practical importance in the building of dynamos, transformers, etc.

Of the various methods for testing the magnetic properties of iron which have been mentioned, the *Ballistic method*, where the specimen is in the form of a closed ring, is, no doubt, the most accurate when we wish to investigate the magnetic properties of iron from a strictly scientific point of view, more than from the point of view as to its commercial application.

The experiment is long and tedious on account of both the magnetising coil and ballistic coil having to be wound on each specimen, and even when the observations have all been made, a good deal of time is consumed in performing the calculations, not to speak of the time and care required in standardising the ballistic galvanometer.

The *Magnetometer method* is more straightforward, and is as accurate as the ballistic method if the specimen of iron under test is at least 400 diameters long. In this case, of course, the one solenoid or magnetising coil serves for any number of specimens; it is, however, like the ballistic method, more a laboratory than a workshop test; all the same, it is, in my opinion, the most convenient method when we want accurate results in a comparatively short time.

In *Hopkinson's divided-bar method* the time taken to prepare the specimens is a consideration, and more important still is the difficulty of getting good iron to iron contact when the parts of the test bar come together. It was, however, a distinct advance on the previous laboratory methods in use.

In *Ewing's Hysteresis tester*—though some time is required to prepare the samples—we have a handy workshop instrument, and though it determines the value of the magnetic induction for only a few points on the curve given by the sample, it is sufficient to indicate if the specimen is near or within the limits specified by the manufacturer. This is itself an important consideration as it may often save the time which would be consumed in a longer test.

Ewing's Bridge has the objection of many instruments, and that is the time taken to turn up and prepare the specimens to be tested; the effects of the air-gaps, however, are fairly well got over. It is, as we have seen, a modified form of the ring method, where a magnetic balance is obtained against a standard rod, instead of getting the absolute value. As a workshop or even a laboratory instrument it is valuable for getting the first up-going or permeability part of the curve, and with the instrument the calculation is reduced to a minimum.

Thompson's Permeameter has the objection of all traction methods, namely, the presence more or less of air-gaps in the magnetic circuit, as well as the old difficulty of getting good iron to iron contact. As you know, air-gaps even of the smallest have a great influence on the magnetic flux. The instrument on the whole has its merits as a rough workshop tool.

Of the magnetic balance type of magnetic tester, *Du Bois form* makes use of an air-gap and measures the attraction or pull of the magnetised specimen across it; whereas in *Ewing's balance* the air-gap is parctically got rid of and the iron to iron contact reduced to a mere line. One great advantage of these balances is that you can get your result by either multiplying by a simple number or by reading off direct, the constants having been previously obtained by means of a standard iron bar.

In the *Permeameter of Lamb and Walker*, an air-gap is actually made the standard of reference, that is, the magnetic reluctance of something unknown (the iron) is compared with the reluctance of the air-gap which is quite definite and is *unity*. In this instrument I think we have a very distinct advance.

As for *Drysdale's Permeameter*, I think that the testing of a small part of a bulky material is very doubtful; the assumption is made that the material is homeogenouse throughout, but the result of a test made at one part might not agree with that obtained at another part. Again iron is not used in the bulk commercially; at any rate we don't want to know the "bulk losses," but the losses when the material is in the form of strips or plates. Then the small pin—the part really tested—may be changed physically in the process of drilling, and there must be small air-gaps between the pin and conical plug, and between the plug and the mass of the material, all of which one would think would affect the results. Drysdale, however, says that the results got with his instrument are within 2 or 3% of those obtained with the same material by the ring ballistic method; so that on the whole we may say that the instrument is suitable for workshop tests.

The methods of *Professors Fleming and Beattie* for testing the hysteresis loss in iron by means of alternating currents, are of extreme interest, and are of great use when once the apparatus has been set up and calibrated.

* Abstract of Chairman's Inaugural Address, Institute of Electrical Engineers Dublin Local Section, Nov. 11, the retiring Chairman, Mr. R. F. Pilditch, in the chair.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

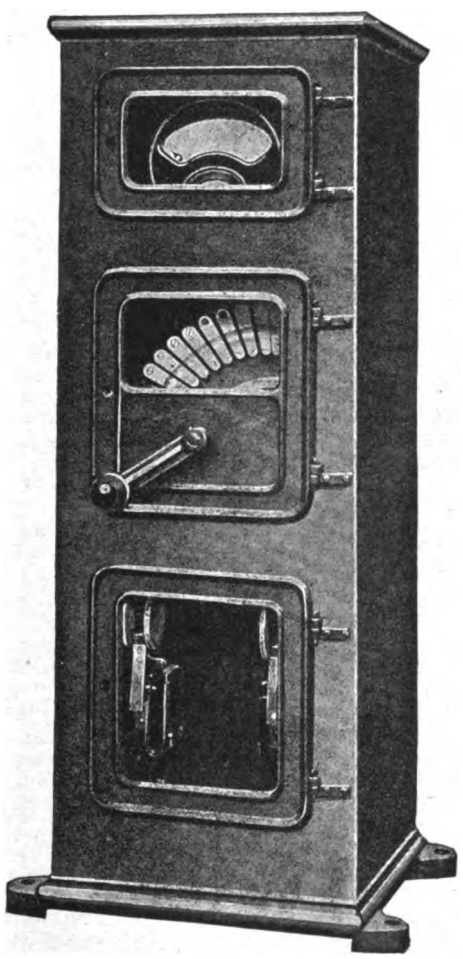
PILLAR TYPE MOTOR PANELS.

The Adams Manufacturing Co., Ltd., have recently placed on the market a line of standard panels of the Pillar pattern, which represents the latest developments of this type of apparatus. These panels are not experimental, but represent the result of the experience of a large staff of specialists in this work. The Regulations of the Home Office and all other public and many private authorities are completely satisfied by them. In their design, while due regard has been paid to low cost of manufacture and consequent reasonable selling price, quality the best has been the determining factor in every decision.

Particular attention has been paid to providing easily renewable parts where wear and tear or sparking could occur.

Each piece of the design is robust; nothing is flimsy; there are no soldered joints or floating wires; and insulation is always by porcelain, air or mica.

We illustrate one of the latest types of these panels. This consists of two of the company's magnetic circuit breakers, one of their robust type starters, and an ammeter.



PILLAR TYPE MOTOR PANELS.

In this panel the circuit breakers are designed to open the motor circuit on both poles in case of an overload, and are interlocked with the starter, so that they cannot close except when all starting resistance is in circuit. Being operated magnetically, no handle is required for the circuit breaker. The first movement of the starter handle in the starting direction causes the circuit breaker to close, but it will not remain closed if an overload exists, even though the operator should continue to move the handle forward. By the employment of their patent "arc-preventing interlock," all circuit breaking, whether resulting from an overload or any other cause, is performed by the circuit breaker, and cannot take place on the contacts of the starter.

If the starter handle be moved backward, the circuit breaker immediately opens circuit; consequently, sparking cannot take place on the starter contacts, because they are then dead. Circuit is broken in a fire-proof chamber, the walls of which are formed by the pole pieces of the blow-out magnet; consequently, arcs are instantly quenched. The pole pieces of the blow-out magnet can be turned upward so as to allow of inspection and renewal of the carbon contacts.

The company claim the panel to be absolutely "fool-proof," and, we understand, they have recently secured large orders for this type of apparatus, particularly for wood-working machinery, mines and shipyards.

SIMPLEX HEATING AND COOKING APPARATUS.

The peculiar features of heating and cooking appliances manufactured under Prometheus patents are the thin resistance strips or "Elements," as they are usually called, of special construction presenting an exceptionally large heating surface per watt energy dissipated, and consequently they are run at comparatively low temperature. Unlike wire coil systems they are entirely free from oxidisation effects, and the fact that the destructive results attendant upon the alternating heating up and cooling down, ensures long life. Further, self induction does not enter into consideration. The actual element itself is unusually light, thereby reducing the total weight of the appliance considerably, particularly in regard to convectors. The increase in weight of Simplex apparatus is very little over that of the equivalent made for heating upon a gas ring or coal fire. The construction provides that the elements are kept in close contact with the surfaces which it is desired to heat, in many cases by means of substantial press plates, and there is no embedded enamel.

There are several types of elements designed to be suitable for various pieces of apparatus for which they are employed. The flat open type of elements which are used for food warmers, hot cupboards, etc., are connected in parallel,so that a mishap to one will not affect the working of the whole. For water heater in some types of bettles the ring form of element is employed, in which case the element is assembled round the hot well of the vessel. A small flat element is used on saucepans and the majority of kettles, whilst for flat irons a flat element provided with spring "Z"shaped terminal is employed. In all cases metal press plates are carefully constructed, having machined surfaces, so that every portion of the strip may efficiently transmit the heat generated. Temperature regulation is fitted to all appliances of large capacity or of a more expensive nature. This is arrived at by means of three terminals or by a special regulating plug; the latter does away with the necessity for triple flexible connectors to the three terminals, made by means of three sockets, two black and one red, the former being connected to one pole and the red socket to the other pole. The self indicating plug shows at a glance the power being absorbed, the four different positions buts both circuits in parallel, both in series or one circuit on only and off position.

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We have received from the Simplex Co. the new seasons' list of electric cooking appliances. The main lines are, of course, kettles and irons. The former range in price from an article in tin or to a heavily silver-plated kettle with ebony fittings, complete on a stand. A number of this pattern were supplied a short time ago for use of H.M. the King.

The most popular types are a pint-and-a-half copper kettle of kitchen design, loaded to 400 watts to boil in 12 minutes, and a rather more ornamental brass kettle with a cane handle, more suitable for afternoon tea use.

A further useful utensil supplied at a low price is a small copper shaving pot. This has a capacity of half-a-pint, just sufficient for the purpose, and boils in the short space of three minutes.

A glance through the Simplex Co.'s new catalogue shows a general tendency towards cheaper utensils, together with design, leaning towards the ordinary kitchen articles with which everyone is familiar. For example, we have an exceedingly useful range of saucepans of the cast iron variety, with a thin lid, ranging from a capacity of two pints and a loading of 500 watts, to 12 pints, loaded to 1,400 watts. Potato steamers, double saucepan porringers, frying pans, etc., listed at reasonable prices all tend to indicate the domesticating of electrically heated appliances.

Irons, of course, are an important feature. A feature in connection with irons is the automatic stand, the action of placing the iron on the stand completes the circuit, but when the iron is actually in use it is not in circuit. This has been found an excellent arrangement for short intermittent work.

Then there are hot cupboards for linen drying in the case of large wooden constructions, or for plate or food warming in the case of the smaller iron variety. The larger type of apparatus, particularly adapted to restaurant use is given considerable attention. Firstly, there are large capacity water urns, commencing at one gallon capacity up to four, together with combined tea, water, and coffee urns, and also the regulation form of *cafe au lait*, adapted to electricity and fitted with regulation.

One of the most important uses to which electrically operated apparatus can be put is for medicinal and dental purposes. A wide range of prices are already available, in addition to the regulation form of sterilizers, there are medical tanks for maintaining constant temperatures, also copper water bottles and ovens suitable for medical and laboratory purposes.

A novel innovation is the production of universal voltage apparatus. At first sight there does not appear to be a very great demand for this class of appliance, except as regards the convenience of the manufacturer, but when we remember the habitual traveller, particularly the invalid, we recognise the advantage accruing if, during the itinerary amongst hotels a bed warmer is always available. Universal voltage apparatus comprises irons (suitably packed in a leather covered box with hot pad, etc.), kettles and bed-warmers. The arrangement of the double elements and their terminals is simple.

SOUTH LONDON ELECTRIC TRAINS.

The London, Brighton and South Coast Railway Co. propose to commence the new electric service over the South London line between Victoria and London Bridge, *via* Peckham Rye, on December 1. The new line is just 9 miles long. At Victoria Station seven lines are equipped with overhead construction, giving access to five platforms, and there will be the same arrangement at London Bridge. The full journey will occupy 25 min., and it is intended to run a 10-min. service.

ELECTRICITY FOR DRIVING MILLS.

The New Goch Mining Co. announces that that portion of the plant which had previously been driven by power generated by its own electric plant was during the past quarter changed over to the supply mains of the Victoria Falls Power Co. Arrangements are now being made for driving the mill electrically by purchased power.

LONG DISTANCE TELEPHONE TRANSMITTER.

We note that Mr. M. Moloney, of the staff of the Auckland (New Zealand) Telegraph Office, and the inventor of the long-distance telephone transmitter known as the Tandem Looseback, is now on his way to England to place his invention before telephone experts. The transmitter is a device constructed on the principle of the human ear, and it is claimed for it that by means of it long-distance telephoning is greatly facilitated, and for ordinary use conversations can be carried on in whispers by persons using the telephone in crowded rooms where others are talking. Mr. Moloney, says a Colonial contemporary, is also taking to Europe the fire alarm indicator known as the Moloney-Ross fire alarm. Mr. John Ross, of the Christchurch Telegraph Office, who is co-patentee with Mr. Moloney of the telephone transmitter, intends leaving for the United States shortly, in order to place the invention before representatives of the telephone companies in that country. It is stated that the transmitter has been recognised by the New Zealand Government as a valuable invention, and it has been adopted by the Government, while the Commonwealth Government has become interested in it.

PHOTOGRAPHS BY WIRE.

An interesting method for the transmission of photographs by telegraph and telephone, using the ordinary wires, has been invented by Professor Antonio Montagña, reports a Rome correspondent. The inventor has discovered a system whereby he can decompose the pictures into elementary and graphic signs, which, when separated, can be designated by letters of the alphabet. The letters are transmitted in the usual way, and the operator who receives them is enabled to reconstruct the photograph by substituting the signs corresponding to the letters. The invention can be used by telegraph, telephone, and the wireless system, and photographs can be transmitted any distance.

PERSONAL.

At the meeting of the Royal Meteorological Society, the President announced that the Council had awarded the Symons Gold Medal to Dr. William Napier Shaw, F.R.S., in recognition of the valuable work which he has done in connection with meteorological science. The medal will be presented at the annual general meeting of the Society on January 20, 1910.

At the Institute of Marine Engineers, the Denny Gold Medal was presented to Mr. Wm. P. Durtnall (Member) for his paper on "The Generation and Electrical Transmission of Power for Main Marine Propulsion and Speed Regulation," read in July, 1908. In making the presentation, Mr. J. T. Milton (Chairman of Council) said the Council of the Institute considered the paper to be the best submitted during the session, and well worthy of the award. Mr. Durtnall, in acknowledging the presentation, said that the subject was being taken up in a practical way. A cargo boat would be fitted with this system of propulsion in about seven months' time, and he would be pleased to present to the Institute the results of the trials of this vessel as soon as they could be ascertained.

The Royal Society have granted the Hughes Medal to Dr. R. T. Glazebrook, F.R.S., for his researches on Electrical Standards, and the Davy Medal to Sir James Dewar, F.R.S., for his researches on Low Temperatures.

Mr. Charles Leonard Agnew, of Manchester, has been elected chairman of the board of directors of Galloways, Ltd., engineers and boiler makers, Manchester, in the place of Mr. Edward N. Galloway, resigned. Mr. Galloway will retain his seat on the board. The firm are at present engaged in the electrification of their works.

Congratulations to Councillor Howarth, Chairman of the Manchester Electricity Committee, on the attainment of his 70th birthday. He has filled the position of chairman of the Electricity Committee for the past seven years. This period has witnessed many important developments in the electricity undertaking of Manchester, which now ranks as one of the best equipped and best managed in the country.

Mr. G. E. Mason, of the Lancashire Dynamo & Motor Co., Trafford Park, Manchester, England, has opened an office in the Peterkin Building, Bay Street, Toronto.

Mr. E. P. Featherstonhaugh, Professor of Electrical Engineering in the University of Manitoba, was called in by the City of Winnipeg to give expert evidence with reference to the production of electrical energy, used to operate the cars of the Winnipeg Electric Railway.

Messrs. Moore & Scollan of King-street West, Toronto, have been called in by the municipality of Trenton, to advise in connection with a by-law to grant a franchise to the Trenton Electric and Water Power Co.

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ELECTRIC PROJECTS FOR 1910.

The *London Gazette* contains a long list of Corporations, Companies, and individuals who have given notice to apply either for Provisional Orders from the Board of Trade, or for leave to introduce Bills during the next Parliamentary Session, relating to electric lighting or traction. Below will be found a comprehensive abstract of these proposals.

Reading and District Electric Supply.

Application by the Reading Electric Supply Co., Ltd., for an Act to extend the area of supply for electrical energy so as to include the parish and urban district of Caversham and the parish of Mapledurham, Oxford, and the parishes of Tilehurst and Theale, Berks; to empower the Company to supply electrical energy in bulk or otherwise to any local authority, company, body or person authorised by Act of Parliament or Provisional Order or any Licence or Order of the Board of Trade to supply or generate electrical energy within the districts of the Poor Law Unions of Wokingham, Bradfield and Wallingford, in the counties of Berks and Oxford, and so much of the district of the Poor Law Union of Henley as is situated within the County of Oxford; to empower the Company to continue, maintain and use their station or stations for generating electrical energy, and to alter, extend, rebuild and renew the same together with any existing or additional buildings, machinery, works, matters or things for the purposes of their undertaking; to empower the Company within its area of supply as extended by the intended Act and within the bulk supply area and also within any area or district in which it may be necessary or expedient so to do for the purpose of connecting any part of the area of supply with any other part thereof, to open, break up, alter the position of, and remove and interfere with the public and private streets, roads, railways, tramways, canals, telegraphic, telephonic, pneumatic, electric lighting, and other tubes, pipes, lines, wires, and apparatus. The Reading Corporation Tramways: The names of the streets in which it is proposed that electric lines shall be laid down within a period to be specified in the intended Act are as follows:—In the parish of Caversham—Bridge-street, Church-street, Gosbrook-street from School-lane to Wolsey-road, Prospect-street, Peppard-road from Prospect-street to Derby-road, Derby-road, Church-road, St. Peter's-hill, Woodcote-road from St. Peter's-hill to Highmoor-road, St. Anne's-road from Church-road to Clifton Park-road, Clifton Park-road, Albert-road from Clifton Park-road to Highmoor-road, The Mount from Clifton Park-road to Kidmore-road, and Kidmore-road from Clifton Park-road to Oakley-road. To provide for the differentiation of the price or prices to be charged for electrical energy supplied by the Company in different parts of the area of supply and of the bulk supply area respectively; to enable the Company to give a supply of electrical energy to persons and premises outside the area of supply; to empower the Company to manufacture, purchase, provide, supply, sell, let on hire, fix, set up, alter and repair and remove engines, machines, motors, accumulators, cables, conductors, service wires, tubes, pipes, insulators, lamps, meters, fittings, apparatus and appliances required for or used for or in connection with the supply, production, transmission, storage, transformation, distribution, measuring or regulating of electrical energy, and to charge for work done by them in or in relation to the matters aforesaid or any of them, and to make and enter into agreements with reference to such matters and the charges to be made therefor and other matters in connection with or incidental thereto; to authorise the Company to acquire, take and use patent rights, leaves, licences and authorities under letters patents, for the working, use, exercise, and putting into practice of any invention relative to the production, utilisation or distribution of electrical energy, and to sell, work, use, exercise and put in practice any such invention or patent rights, leaves, licences or authorities; to enable the Company to allow discounts or rebates on payment of charges for supplies of electrical energy or in respect of the provision of meters, fittings, appliances and apparatus used for or in connection with such supplies or in relation thereto; to empower the Company and the local authority of any district within which the undertaking of the Company, or any part thereof, may be situate to enter into and carry into effect contracts or agreements with reference to the purchase by such local authority of the whole or any part of the undertaking of the Company, and to prescribe and define the periods at which and the terms and conditions on and subject to which any such contracts or agreements may be entered into and carried into effect.

Runcorn Urban and Runcorn Rural Electric Lighting.

Application to the Board of Trade by George Henry Cox, of Colonial House, Water-street, Liverpool, salt manufacturer, and Herman John Falk, of the same place, salt manufacturer, under the provisions of the Electric Lighting Acts, 1882 and 1888, for a Provisional Order for all or some of the following purposes (that is to say):—To authorise the Undertakers to produce electricity and to purchase or obtain the same from any other company, body or person, and to supply electricity for all or some of the public and private purposes as defined by the said Acts within the urban district of Runcorn and the rural district of Runcorn, both in the county of Cheshire, and for the purposes of the intended Order to enter upon, open and break up, cross over and interfere with all streets, roads and places, ways, foot-paths, towing paths, railways, tramways, canals, rivers, bridges, culverts, sewers, gas and water mains and pipes, and telegraph, telephone, electric, hydraulic, pneumatic and other pipes, wires, mains, works and apparatus of any description within the area of supply, and to lay down, place, set up, maintain or renew either above or underground, and remove pipes, tubes, wires, posts, apparatus and other works or things required for enabling the Undertakers to produce, obtain, store, convey, transmit, transform, supply or distribute electricity for the purposes of the Order, and to confer all such other powers upon the Undertakers as may be necessary for effecting the objects of the undertaking; to authorise the Undertakers to erect, provide, maintain, use and work all necessary stations, buildings, machinery, apparatus, works and appliances for the generating, obtaining, storing, transmission, transformation and distribution of electricity; to authorise the Undertakers to hire, sell and let meters, motors, lamps, fittings and apparatus.

Runcorn and Weston Electric Lighting.

The Castner Kellner Alkali Co., Ltd., whose works are at Weston Point, Runcorn, intend to apply to the Board of Trade for a Provisional Order under the Electric Lighting Acts, 1882 and 1888, to authorise the company to generate, store and supply electric energy for lighting, heating, power and all other purposes public and private as defined by the Electric Lighting Acts within the urban district of Runcorn and the township and parish of Weston, within the rural district of Runcorn, in the county of Chester. The names of the streets in which it is proposed that electric lines shall be laid down within a period to be specified by the Order are as follows:—Within the township and parish of Weston: South-road, Weston Point and Sandy-lane. Within the urban district of Runcorn: Weston-road (being the main road from Runcorn to Weston), from Sandy-lane to Highlands-road, Highlands road, Greenway-road, Sandy-lane, High-street from Waterloo-road, to the junction of High-street with Church-street, Church-street and Waterloo-road.

Bath Electric Lighting Extension.

The Mayor, Aldermen and Citizens of the city of Bath, being the undertakers under the Bath Electric Lighting Order, 1896, intend to apply to the Board of Trade for a Provisional Order to alter, extend and amend the Bath Electric Lighting Order, 1896, so as to extend the area of supply therein named, and to authorise the Corporation to generate, store, supply, distribute and sell electrical energy for all public and private purposes as defined by the said Acts within such portion of the rural district of Bath as lies within the distance of three miles from the Guildhall in the city of Bath. To incorporate with the Order and generally to extend and make applicable to the proposed extended area of supply, such of the provisions contained in the schedule to the Electric Lighting (Clauses) Act, 1899, as it may be deemed necessary to apply to the under-

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taking to be authorised by the Order, subject to such variations and exceptions as may be contained therein, and if deemed desirable to extend those provisions to the existing area of supply of the Corporation, and to repeal so much of the Order of 1896 as will be thereby rendered unnecessary. To confer upon the Corporation all or some of the powers of the Electric Lighting Acts, 1882 and 1888, and enactments incorporated therewith, and to alter, vary or extinguish all rights and privileges which would or might interfere with any of the objects of the Order, and to confer all other rights and privileges necessary for carrying such objects into effect.

DERBY CORPORATION ELECTRIC LIGHTING (EXTENSION).

The Mayor, Aldermen and Burgesses of the borough of Derby intend to apply to the Board of Trade for a Provisional Order to extend the area of supply under the Derby Corporation Electric Lighting Order, 1890, as amended by the Derby Corporation Act, 1901, so as to include therein the urban district of Alvaston and Boulton and the parishes of Breadsall, Chaddesden, Normanton, Littleover and Sinfin Moor, in the rural district of Shardlow, and the parish of Darley Abbey and the township of Markeaton, both in the rural district of Belper, all in the county of Derby; and to authorise the Corporation to generate, supply, distribute and sell electrical energy for public and private purposes as defined by the said Acts within the exetnded area of supply. To incorporate with the Order and generally to extend and make applicable to the extended area of supply all or some of the provisions contained in the Schedule to the Electric Lighting (Clauses) Act, 1899, and to apply such provisions to the undertaking to be authorised by the Order, subject to such variations and exceptions as may be contained therein; to confer upon the Corporation all or some of the powers of the Electric Lighting Acts, 1882 and 1888, and enactments incoroprated therewith, and to alter, vary or extinguish all rights and privileges which would or might interfere with any of the objects of the Order, and to confer all other rights and privileges necessary for carrying such objects into effect. To alter, extend and amend or to repeal some or all of the provisions of the Derby Coropration Electric Lighting Order, 1890, and the Derby Corporation Act, 1901.

FARNHAM GAS AND ELECTRICITY.

Application by the Farnham Gas Co., Ltd., to dissolve the Limited Company and to incorporate into a Company the members of the Limited Company and all other persons and corporations who shall hereafter become proprietors in the undertaking of the Company for the purpose of supplying gas and electricity to and within the respective limits hereafter mentioned and generally for carrying on the business usually carried on by gas and electricity companies and for other the objects and purposes of the intended Act; to vest in the Company all the undertaking, works, lands, buildings, property, stock, plant, interests, rights, etc., and the benefit of all contracts, licences, agreements and rights of action now belonging to, vested in or enjoyed by the Limited Company or any person on their behalf: To declare void and cancel the memorandum and articles of association and regulations of the Limited Company and to make all necessary provisions consequent thereon: To declare, define and regulate the capital and borrowing powers of the Company: To empower the Company to form and to make special provisions with respect to reserve and special purposes funds, and to provide for the application of the funds so formed and for the investment of the moneys forming such funds and of the interest to arise therefrom, and if thought fit to make provision for the fixing of dividends in accordance with the price charged for gas and for the payment of the dividends on the capital of the Company being made yearly or half yearly: To authorise the Company to produce, generate, store, distribute, sell and supply electricity for all public and private purposes as defined by the Electric Lighting Acts, 1882 and 1888, and generally carry on the business of an electrical supply company within the parish and urban district of Farnham and the parish of Farnham Rural, in the rural district of Farnham both in the county of Surrey (hereinafter referred to as the "area of supply"). To empower the Company on the lands hereinafter described or on any part thereof to erect, maintain, work and use a station or stations for producing or generating, transforming, storing and distributing electricity or electrical energy and resulting residual products (including the manufacture of gas for the generating of electricity) with all suitable or necessary dynamos, batteries, accumulators, engines, plant, machinery, works and conveniences connected therwith; to empower the Company on the one hand and any local authority, company, body or person authorised by Act of Parliament or Provisional Order to supply electricity within any area contiguous to the area of supply on the other hand to enter into and carry into effect agreements with respect to the supply of electricity, plant, fittings or materials by or to the Company, to or by any such local authority, company, body or person and with respect to all or any of the objects of the intended Act; to repeal, vary, alter and amend the provisions of the Farnham Electric Lighting Order, 1905, confirmed by the Electric Lighting Orders Confirmation (No. 6) Act, 1905, and to provide that all the powers, rights, authorities and privileges of or belonging to the Farnham and District Electric Supply Co., Ltd., within the area of supply shall cease and determine; to empower the Company to manufacture, purchase, sell and let on hire or otherwise deal in, fix and repair or remove meters, pipes, fittings, engines, machines, stoves, ranges, accumulators, dynamos, cables, conductors, insulators, lamps, burners, electric lines, motors, apparatus, appliances, articles and things incidental to the supply, use or consumption of gas or electricity, and to exclude the same from liability to distress or to be taken in execution, and to provide that apparatus let on hire shall remain the property of the Company notwithstanding that it may be affixed to the soil; to confer on the Company powers for and in relation to the laying down and maintaining mains, cables, wires, pipes and apparatus in connection with the supply of gas and electricity in, along, across and under streets, roads, footways and places not dedicated to public use; to repeal, alter, vary or amend or re-enact all or any of the provisions of the Farnham Gas Order, 1899, and the Farnham Gas Order, 1906, and of the respective Acts confirming such Orders and any other Act or Order relating to or affecting the Limited Company or their undertaking.

ORMSKIRK ELECTRIC LIGHTING.

Application to the Board of Trade by the Urban District Council of Ormskirk, in the county of Lancaster, for a Provisional Order to amend section 5 of the Ormskirk Electric Lighting Order, 1900, confirmed by the Electric Lighting Orders Confirmation (No. 1) Act, 1900, by extending the period in that section mentioned within which the Council are required to lay down sufficient and suitable distributing mains within the streets and parts of streets named in the third schedule to the said Order; to authorise the Council to transfer, assign, lease or otherwise convey all or some of the provisions, powers, rights and privileges conferred upon them by the Order of 1900 to a company to be registered under the Companies Acts, for the purpose of taking such transfer, assignment or lease and to be called the Ormskirk Electric Supply Co., Ltd., or in case of default to such Company as may be approved by the Board of Trade for such consideration and subject to such terms and conditions and either absolutely or for such other period as may be prescribed by the Order or be authorised by the Board of Trade; to divest the Council of any legal powers, rights or obligations conferred or imposed upon them by the Order and to relieve the Council from liability in respect of any acts or defaults of the Company in respect thereto, and if thought fit to alter or amend the provisions of the Order of 1900 and to authorise the Council to enter into and carry into effect agreements with the Company for that purpose, or to confirm any agreement which may have been entered into or which may be entered into before the issue of the Order by the Board of Trade or the confirmation thereof by Parliament.

WIDNES ELECTRIC LIGHTING.

Application to the Board of Trade by George Henry Cox, of Colonial House, Water-street, Liverpool, salt manufacturer, and Herman John Falk, of the same place, salt manufacturer: To authorise the Undertakers to produce electricity and to purchase or obtain the same from any

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other company, body or person, and to supply electricity for all or some of the public and private purposes as defined by the said Acts within the borough of Widnes, and for the purposes of the intended Order to enter upon, open and break up, cross over and interfere with all streets, roads, railways, tramways, canals, rivers, bridges, and telegraph, telephone, electric, hydraulic, pneumatic and other pipes, wires, mains, works and apparatus of any description within the area of supply, and to lay down, place, set up, maintain or renew either above or underground and remove pipes, tubes, wires, posts, apparatus and other works or things required for enabling the Undertakers to produce, obtain, store, convey, transmit, transform, supply or distribute electricity for the purposes of the Order; to authorise the Undertakers to erect, provide, maintain, use and work all necessary stations, buildings, machinery, apparatus, works and appliances for the generation, obtaining, storing, transmission, transformation and distribution of electricity; to authorise the Undertakers to hire, sell and let meters, motors, lamps, fittings and apparatus; to authorise the Undertakers to transfer the undertaking or any part thereof authorised by the Order; to incorporate with the Order and to make applicable to the undertaking and works and to the Undertakers, with or without modifications and exceptions, all or some of the provisions of the Electric Lighting Acts, 1882 and 1888, and the Electric Lighting (Clauses) Act, 1899, and of the Electric Lighting Act, 1909, so far as applicable, and of the Acts and portions of Acts incorporated with those Acts, and to confer upon the Company and any local or road authority all or some of the powers within the area of supply which by the said Acts or any Act amending the same are or may be conferred upon the Undertakers, and the Order will or may contain such regulations and conditions as to the supply of electricity and other matters as the said Acts authorise or the Board of Trade may prescribe and will alter, vary or extinguish all rights and privileges which would or might interfere with any of its objects, and confer all other rights and privileges necessary for carrying such objects into effect.

Church Electric Lighting.

The Urban District Council of the Urban District of Church, in the county of Lancaster: To authorise the Council to generate and supply electricity for all public and private purposes as defined by the Electric Lighting Acts within the whole of the urban district of Church, in the county of Lancaster aforesaid; to incorporate with the Order such of the provisions contained in the schedule to the Electric Lighting (Clauses) Act, 1899, and in any Act amending or extending the same as are applicable to cases in which the undertakers are the local authority, and to apply such provisions to the undertaking to be authorised by the Order subject to such variations and exceptions as may be contained therein; to authorise the Council to break up, cross or interfere with the following tramways, viz.: The Tramways of the Blackburn Corporation and of the Accrington Corporation: To authorise the Council to manufacture, purchase, hire, sell and let all necessary lamps, accumulators, meters, fittings, plant, engines, dynamos, machinery and other matters or things required for the purposes of the Order, and to acquire work and use patent rights for the producing, storing, controlling, distributing and measuring or otherwise relating to the supply of electricity; to confer upon the Council all or some of the powers of the Electric Lighting Acts, 1882 and 1888, and the enactments incorporated therewith, and to alter, vary or extinguish all rights and privileges which would or might interfere with any of the objects of the Order, and to confer all other rights and privileges necessary for carrying such objects into effect; to authorise the Council to enter into contracts with corporations, companies or persons for the execution and maintenance of works and the supply of electricity and to relieve the Council from the consequences of any acts or defaults of any such contractors, and to empower the Council to sell or transfer to the Mayor, Aldermen and Burgesses of the borough of Accrington or to such other corporation, company or person as may be thought desirable all or some of the rights, powers, privileges and obligations intended to be conferred or imposed by the Order for such period and upon such terms and conditions as may be agreed upon.

Southampton Corporation.

Application by the Mayor and Corporation for an Act to make, form, lay down, work, use and maintain all or some of the tramways in the parishes of All Saints, Portswood, Saint Mary and Shirley, all in the county borough of Southampton and the county of the town of Southampton, and to remove so much of the existing tramways as will be superseded by the proposed tramways.

Stratford-upon-Avon and Midland Junction Railway.

Application by or on behalf of The Stratford-upon-Avon and Midland Junction Railway Co. and the Northampton and Banbury Junction Railway Co. or by one of those companies for an Act for the transfer by the Northampton Co., and for the acquisition and vesting in the company of the Undertaking, lands and property, including all railways, works, lands, stations, sidings, buildings, telegraphic and telephonic apparatus, plant, rolling stock, machinery, etc., obligations of what nature or kind soever, and whether with reference to the separate Undertaking of the Northampton Co. To provide for the winding up of the affairs of the Northampton Co. and its ultimate dissolution. To authorise the company to provide, work and use in connection with or in extension of their railway system, or otherwise, in any district to which their railways afford access, omnibuses, coaches, cars, wagons and other road vehicles to be drawn or moved by animal power, electricity or any other mechanical power.

Clevedon Electric Lighting.

The Urban District Council of Clevedon, Somerset, intend to apply to the Board of Trade on or before December 21 next, for a Provisional Order to authorise the Council to generate and supply electricity for all public and private purposes as defined by the Electric Lighting Acts, within the whole of the urban district of Clevedon, and so much of the parish of Walton-in-Gordano, in the rural district of Long Ashton, as lies to the south of an imaginary line drawn along the northern boundary of Holly-lane from its junction with the main road from Clevedon to Portishead to the point where such lane intersects the centre of Walton Park-road opposite Castle Lodge, and thence in a due north-westerly direction to the sea. To empower the Council within a limited period after the commencement of the Order and with the consent of the Board of Trade, to transfer the undertaking authorised by the Order to any company or corporation.

Brumby and Frodingham Electric Lighting.

Application by the Urban Council for a Provisional Order to authorise the Council to generate and supply electricity for all public and private purposes as defined by the Electric Lighting Acts within the whole of the urban district of Brumby and Frodingham.

Sheffield Electric Lighting.

The Corporation intend to apply for a Provisional Order to extend the area of supply under the Sheffield Electric Lighting Order, 1892 (as amended by the Sheffield Corporation Act, 1900), so as to include therein the parish of Tinsley, in the rural district of Rotherham, in the West Riding of the county of York (the said area of supply so extended being hereinafter referred to as "the extended area of supply"), and to authorise the Corporation to generate, store, supply, distribute and sell electrical energy for public and private purposes as defined by the said Acts within the extended area of supply.

Baker-street and Waterloo Railway.

Application by the Baker-street and Waterloo Railway Co. for an Act to empower the Company to make and maintain the subway hereinafter described, with all necessary and proper passages, stairways, escalators, approaches, platforms and other works and conveniences (that is to say):—A subway to be situate in the parish of St. James, in the city and metropolitan borough of Westminster, and in the parish and metropolitan borough of St. Marylebone, in and under Oxford-street, Oxford Circus and Regent-street and Argyll-street or some of them, commencing at or near their Oxford Circus station buildings and terminating at or near the southern end of the Oxford Circus station tunnels of the Company, at a point beneath Regent-street,

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1·75 chains, or thereabouts, measured in a southerly direction from the junction of Great Castle-street with Regent-street; to empower the Company to acquire property, by compulsion or agreement and to hold and use for the purpose of constructing a new station at or near Oxford Circus; to empower the Company on the one hand and the Central London Railway Co. on the other hand to enter into and carry into effect agreements with respect to the construction, equipment, maintenance, renewal, and user of the present or any future stations of the Company and the Central London Railway Co. respectively at or near Oxford Circus.

CHARING CROSS, EUSTON AND HAMPSTEAD RAILWAY.

Application to Parliament by the Charing Cross, Euston and Hampstead Railway Co. for an Act to empower the Company to make and maintain the railways and works hereinafter described or some part or parts thereof, with all necessary and proper stations, platforms, approaches, stairs, passages, inclines, subways, tunnels, sidings, shafts, lifts, stagings, buildings, machinery, appliances, apparatus, works and conveniences (that is to say):—A Railway (No. 1), 3 furlongs 8 chains, or thereabouts, in length, to be situate wholly in the parish of St. Martin-in-the-Fields, in the city and metropolitan borough of Westminster, commencing by an end-on junction with the eastern line of the existing railway of the Company at its termination at a point beneath the forecourt of the Charing Cross station of the South-Eastern and Chatham Railway and terminating by an end-on junction with the western line of the existing railway of the Company at its termination beneath the said forecourt; a Railway (No. 2), 5·5 chains, or thereabouts, in length, to be situate wholly in the said parish of St. Martin-in-the-Fields, commencing by a junction with Railway (No. 1) beneath the Victoria Embankment, at a point beneath the kerb of the western pavement of Victoria Embankment, distant 1·75 chains, or thereabouts, measured in a north-easterly direction along such kerb from the Victoria Embankment entrance of the Metropolitan District Railway Co.'s Charing Cross station, and terminating beneath Victoria Embankment Gardens, at a point 3 chains, or thereabouts, north-east of Villiers-street and ·5 chain, or thereabouts, south-east of York-terrace; a Railway (No. 3), 5·25 chains, or thereabouts, in length, to be situate wholly in the said parish of St. Martin-in-the-Fields, commencing by a junction with Railway No. 1 at a point beneath the kerb of the eastern pavement of Victoria Embankment, distant 2·25 chains, or thereabouts, measured in a southerly direction along such kerb from the southern face of the South-Eastern and Chatham Railway Co.'s Charing Cross Bridge, and terminating at a point beneath the River Thames, distant 5·25 chains, or thereabouts, measured in a south-easterly direction from the point of commencement of such railway, and 3·25 chains, or thereabouts, measured in a southerly direction from the southern face of the said bridge; to incorporate with and extend and make applicable, with or without modification or alteration, to the intended railways and works all or some of the provisions of the Charing Cross, Euston and Hampstead Railway Acts, 1893 to 1905, with reference to the mode of construction of the intended works, the working of the railways by electrical power, etc.

THE LONDON ELECTRIC RAILWAY AMALGAMATION.

(See page 752).

CHESHAM ELECTRIC LIGHTING (EXTENSION).

The Chesham Electric Light and Power Co., Ltd., Chesham, Buckingham, intend to apply for a Provisional Order to extend the area of the company for the supply of electricity, so as to include the borough of Hemel Hempstead and the parishes of Bovingdon and King's Langley, in the rural district of Hemel Hempstead.

BRADFORD CORPORATION.

The Corporation intend to apply to bring in a Bill to enable the Corporation to construct, lay down, and maintain wholly in the West Riding of the county of York tramways.

SMETHWICK ELECTRIC LIGHTING.

The Birmingham and Midland Tramways, Ltd., intend to apply for a Provisional Order to repeal, alter or amend all or some of the provisions of the Smethwick Electric Lighting Order, 1898 (hereinafter referred to as "the Order of 1898"); to transfer or empower the Birmingham Co. to transfer to the Shropshire, Worcestershire & Staffordshire Electric Power Co. (hereinafter referred to as "the Shropshire Company") the undertaking authorised by the Order of 1898 or any part thereof, with all or any of the rights, powers, duties, liabilities, property and assets belonging or attaching to the Birmingham Company as undertakers for the purposes of the Order of 1898, subject to such variations and exceptions as may be contained in the Order or approved by the Board of Trade.

HASTINGS CORPORATION (VARIOUS POWERS).

Application by the Corporation of Hastings for an Act for the compulsory purchase of site of existing electricity Generating Station of Corporation; further powers in regard to the supply of electricity, electric fittings and charges therefor and by-laws for safety of consumers of electricity, etc.

NORTH AND SOUTH SHIELDS ELECTRIC RAILWAY.

Application by the North and South Shields Electric Railway Co. for an Act to revive the powers granted and to extend the time limited by the North and South Shields Electric Railway Act, 1902, as revived and extended by the North and South Shields Electric Railway Act, 1906, for the compulsory purchase of lands and to further extend the time now limited by the said Act of 1906 for the construction and completion of the railway and works by the said Act of 1902 authorised.

DEVONPORT AND DISTRICT TRAMWAYS.

Application by the Devonport and District Tramway Co. for, among other things, the rescission or variation of awards of Major Cardew dated June 6, 1902, and October 1, 1906, and agreement dated July 24, 1902, between the Company and the Corporation with reference to supply of electrical energy; amendment or repeal of Provisions of Tramways Act, 1870, and the Act of 1898 with respect to the acquisition by the Local Authority of the Tramways and undertaking of the Company; increasing borrowing powers; appointment of managing or sole director; amendment or repeal of Acts.

(To be continued).

SOUTHPORT ELECTRICITY WORKS FATALITY.

At Southport, Mr. S. Brighouse opened an inquest on the body of William Sanders, who died from burns received in an accident at the Electricity Works.

Mr. J. E. Jarratt (Town Clerk) appeared on behalf of the Corporation, and Mr. A. S. Black (Electrical Engineer) was also present.

It appeared that Sanders was an engine driver of No. 5 engine at the Electricity Works of the Corporation. About 8 o'clock on the evening of the 12th inst. deceased and a man named Hesketh were engaged in shutting down the engine when a loud explosion occurred. Sanders was found by some workmen enveloped in flames. Hesketh was also badly burned, and the pair were conveyed to the infirmary. Sanders grew worse, and succumbed to injuries early the following morning.

It was necessary to have Hesketh's presence, the coroner said, and the doctor at the infirmary stated it would be some six weeks before he could leave. In addition to that, some important letters would have to be put before them, namely, some letters from deceased to his wife with regard to what had been taking place at the works.

Ellen Sanders said she was the wife of deceased, who was 39 years of age. Before he went to his work on the Friday he told her that he was going to drive No. 5 engine, which had recently been prepared. She asked him if it had had a new cylinder put in, and he replied he didn't know. They had probably put some bands around it. About a week ago he told her that he had discovered some knocking in this engine. Asbestos had been put under it instead of copper. He also said he had told one of the officials that the engine was out of repair. At the infirmary he informed her that the engine was running hot, and he had to stop it. He also said that they had used some oil which they had no right to use, and in his opinion the accident was due to the oil.

Mr. Jarratt, on behalf of the Corporation, expressed profound sorrow at the accident and the sympathy of the Electricity Committee and the Electrical Engineer with the widow and family of the unfortunate man. Some statements, he said, had been made by the widow which he could not accept, and upon which he would have to submit evidence at a later date. The committee would give every consideration to the widow and family of deceased, and also to the family of the other poor man, Hesketh, who, he was glad to say, was doing well.

The jury also expressed their sympathy with deceased's relatives.

The inquiry was adjourned to January 5.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

"If thou hast knowledge, let others light their candle at it."

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should be *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

QUESTIONS.

Question No. 1210.—What are the advantages of electric motors over steam engines for driving rolling mills? Please give some idea of the power required for rolling stated sections and of the extent to which electric motors have replaced steam engines in this service. Is the *replacement* justifiable, or are electric motors only commercially practicable in *new installations*?—C. T.

Question No. 1211.—How far is it possible to use a given cable for telephone *and* telegraphic purposes? To what extent does one use interfere with the other, and what precautions must be taken when arranging for such double working? How does distance affect each form of communication?—"ENQUIRER."

Question No. 1206.—In order to place a temporary light in one of the haulage houses of a coal pit, the mains supplying the motor were used. The motor is a 3-phase induction motor, working at 520 volts and 50 cycles, and it is about 500 yards from the distributing station. Here the mains to the motor were temporarily disconnected from the power supply and two of them were connected to the lighting supply, which is at a pressure of 260 volts, but no light could be obtained in the haulage house. There was found to be a pressure of 150 volts between each of these two wires, and earth, but no voltage between the pair. I should be glad if some reader would explain.

Answer to Question 1206 (*awarded* 10*s*.).—This question is essentially practical, and presenting, as it does, a working difficulty, is harder to answer than if all the details of the case were known.

In the present instance more information might have been given as to the lighting supply, and its relation, if any, to the power circuits.

It is noticed that the voltage of the lighting circuits, 260, is half that of the power, which seems to indicate the relation as one of the following:—

(*a*) One phase of the three-phase power generator is used for lighting, the latter being arranged on a 3-wire system with insulated middle wire, thus giving 260 volts between middle and outer lines.

(*b*) The windings of the generator consist of two separate and similar sets, and their connections brought to separate terminals (*i.e.*, A,A^1,B,B^1,C,C^1, have separate terminals). For the power supply the windings are connected in series, *i.e.*, taken from A,B,C, while the lighting is taken from A^1,B^1,C^1, giving half the power voltage.

Next, why 150 volts from each line to earth?

$$150 \times \sqrt{3} = 260$$

This seems to indicate that the alternative arrangement (*b*) above, is correct, and also that the generator has an earthed neutral (*i.e.*, the common point 0 is earthed by a connection to some part of the generator).

When the lighting mains are connected to A^1 and B^1, say, then when either is earthed there is a voltage due to the difference of potential between O and A^1, or O and B^1.

Since in 3-phase working the voltage across lines is $\sqrt{3}$ times the voltage per phase; voltage A^1 to B^1 = $\sqrt{3}$ × voltage O^1 to A^1.

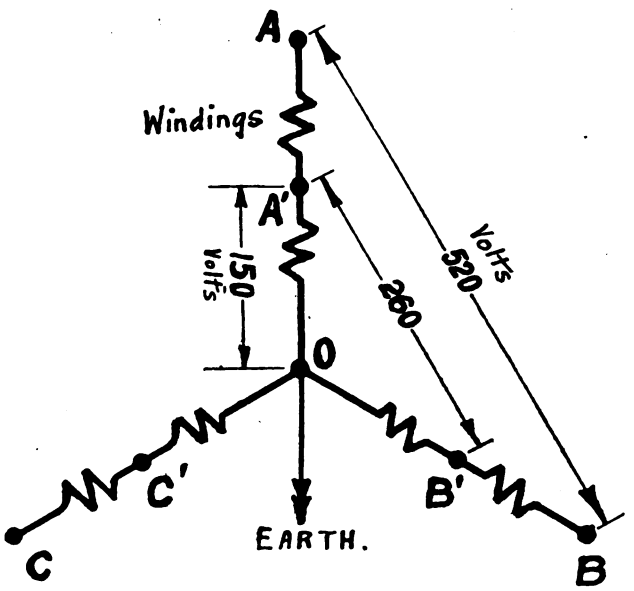
It is therefore very probable that the relation (*b*) above exists between the power and lighting circuits; although it may be that the lighting is supplied from a separate 3-phase generator with earthed neutral giving 260 volts between lines. In this case also, the 150 volts to earth would still be obtained as in the question.

Now comes the difficulty: why no voltage between lines?

One can only suggest some possible causes:—

(1) Only two of the motor leads at the distributing station might have been disconnected leaving the third to interfere with the lighting circuit if power and lighting is interconnected as mentioned above.

(2) Some misunderstanding may have caused a connection through to the motor to have been left; for instance,



the motor leads may be left connected on motor terminals and the lighting circuit at the haulage house taken from the same terminals, in which case complications would ensue.

(3) The two lighting leads may have been connected, unknowingly, to the *same bus bar* (but perhaps at different points). In this case no voltage would be obtained between lines but the voltages to earth would both exist.

The last suggestion *may* seem of an impossible nature, but strikes the writer as the most probable, since the existence of *no* voltage under the conditions of the question is hard to understand otherwise.

Examine the circuits, correct where necessary according to the above, and it is more than probable that the lights in the haulage house will shine "constant as the northern star," and smile at the fault that has been made.—"K."

LEICESTER MODEL ELECTRIC HOME.

At the invitation of Councillor Jennings, Chairman of the Gas and Electric Lighting Committee, Leicester Corporation (Mr. A. Colson, M.I.E.E., Electrical Engineer and Manager), a private inspection took place yesterday afternoon at the suite of rooms arranged at the offices, Millstone-lane, to demonstrate the application of electricity to general household requirements. The rooms are fitted with electric pendants, brackets, standards, etc., for lighting; radiators and convectors for warming; fans for ventilating, and with small apparatus for a variety of purposes, all connected in positions in which they might be used in a private establishment. In the kitchen are electric cookers, grillers, water-heaters, kettles, stew-pans, smoothing irons, etc. The water in the bath-room is heated by an electric water heater. At the showroom, a general assortment of electrical fittings and apparatus may be seen for lighting, heating, cooking and power purposes. Residents are invited to inspect the suite of rooms and from time to time a lady lecturer will give demonstrations in cooking, ironing, etc., by electricity.

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ELECTRICAL PROGRESS AT HOME & ABROAD

FROM OUR SPECIAL CORRESPONDENTS.

TYNESIDE NOTES.

NEWCASTLE.

Two very interesting pieces of work are being carried out by the municipal electricity supply undertakings in this area. The first is in the borough of South Shields, where a considerable amount of power supply is being given to the various dry docks, engineering works and other concerns in the municipality. Owing to the importance of this load, it has been decided to eliminate as far as possible any chance of a breakdown on the power supply system, and a duplication of the power feeder from the Corporation power station to the various works is in progress. A ring main consisting of 0·75 sq. in. single, paper insulated, lead covered B.I. cable is now being laid, and will shortly be put into commission. The other instance occurs at Sunderland, where the Corporation are renewing the whole of the low tension lighting distribution network in the centre of the town with armoured paper covered cable. The work is being carried out by the British Insulated & Helsby Cable Co., Ltd.

West Stanley Colliery.

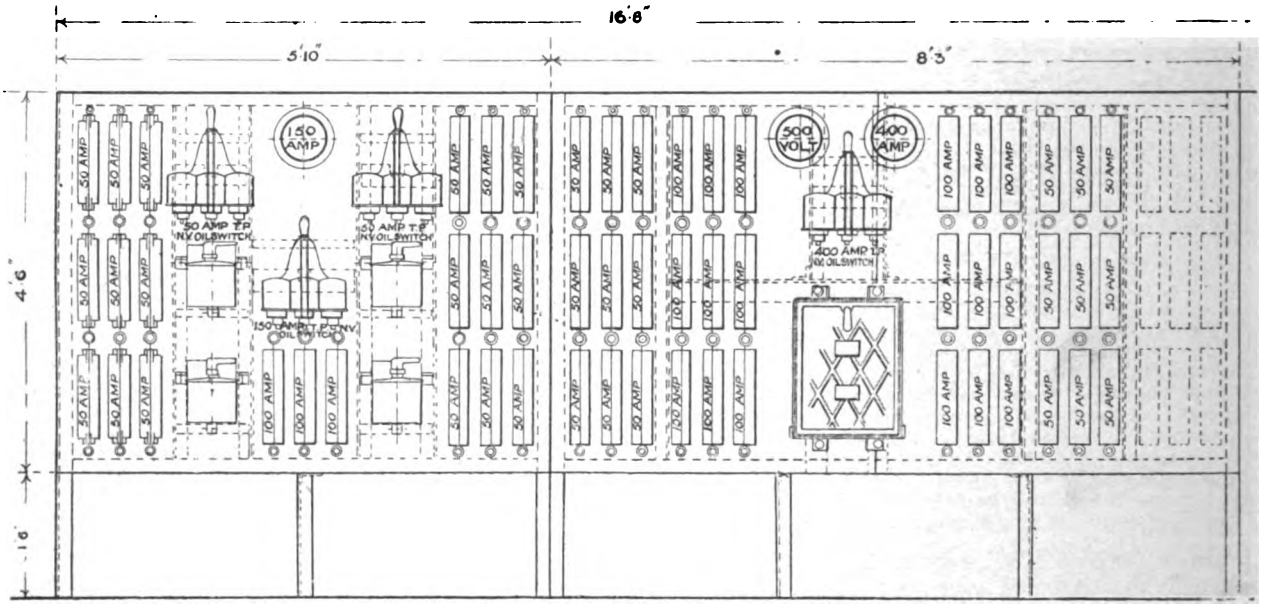
In view of the recent scare among mineowners and workers as regards the safety of electricity in collieries, and the very strong resolution of the Durham Miners' Union upon the subject, it is gratifying to be able to report that the West Stanley Colliery, which was the scene of the lamentable disaster last year, is again to be opened out and is to be operated upon an electrical basis. The power is to be supplied by means of a high tension 3-phase line construction, partially overhead and partially underground, from the Consett station of Cleveland & Durham Electrical Power, Ltd., by means of which 3-phase 50 period current will be delivered to a sub-station erected at the colliery. This information should prove re-assuring to mining engineers in all parts of the country.

An Interesting Switchboard.

A very interesting switchboard has recently been supplied by Messrs. A. Reyrolle & Co., Ltd., of Hebburn-on-Tyne, to the Priestman Colliery Co., and is to be erected at their Otto Vale Colliery. The board is to be used for 3-phase distribution at 440 volts, 40 cycles, and will be placed in a position where it may possibly be subjected to a considerable amount of heavy usage. The design is, therefore, fully iron clad, no slate or other material of a breakable nature being exposed. All the fittings on the board are mounted on planished steel sheeting, which is in turn mounted on angle iron uprights. The switches are of the oil break type, and the main circuits are provided with fuses and no-voltage automatic releases. The subcircuit fuses are of the switch type, these having fuse contacts attached to the middle of the box, so that the fuse can be rewired without any fear of shock to an operator through touching live metal. These fuses are also to be used on circuits of small capacity as isolating switches, no other switches being necessary. The board is in two sections, one being for power and the other for lighting. In connection with the latter section, a very interesting point occurs in the fact that owing to a large number of arc lamps being included in the equipment protection is provided against failure of supply, in addition to the fuses which are placed on the 3-phases. It will be seen that if the supply should fail for a short time, if the arc circuit were left on and be started up suddenly on the mains, there would be practically a dead short circuit on the system for a moment or so which would possibly involve serious trouble. In order to guard against this, if the supply fails, a switch drops out and renders it practically impossible for the arc lamps to be started up all at once. All the connections are carried out in insulated cables through insulators on planished steel. This board meets all the latest Home Office regulations, having fuse protection on the subcircuits. The sub-circuit oil switches are non-automatic and are fully protected in tight cast iron covers against breakdowns, dust and moisture, and the connections are taken through insulation blocks.

Test on Overhead Work.

It will be generally known that the supply of power in bulk through the North-Eastern area is carried on to a greater extent than is, perhaps, found anywhere else in the United Kingdom by means of overhead pole line construction, and one of the arguments which has been advanced against this form of distribution, namely, that it was liable to interruption by weather conditions, has been refuted within the last few days. Recently a very heavy gale, one of the heaviest recorded within recent years, visited Northumberland and Durham, but as the result of enquiries made it has been ascertained that not a single electric distribution pole line was brought down by the storm, a fact which speaks volumes for the way in which the work is done. Extensions to pole line systems are still going on very rapidly, one of the latest being a high tension pole line between Birtley and Harraton. In this connection the British Insulated & Helsby Cables, Ltd., are suspending the pilot and telephone cables by means of their special cable suspenders, and they have recently brought out two or three special types of suspenders which are worthy of attention. The most recent is a zinc suspender with a patent fastener, which has an advantage over other forms, that it cannot be rapidly cut or damaged by anything falling on to it, and in this connection it is finding considerable use in collieries.



REYROLLE MINE SWITCHBOARD.

MIDLAND NOTES.

BIRMINGHAM.

Electrical engineering in the days of the late Mr. Radcliffe's association with Birmingham was, of course, a very different thing from what it is now. Even the electric light undertaking, which was founded about the time of Mr. Radcliffe's removal from Birmingham, is in itself a remarkable illustration of the change which has been going on. Although the company, whose business was subsequently taken over by the Birmingham City Council, included the supply of power among its declared objects, there was a disposition at the time to look upon lighting as altogether the main source of revenue. It is only, in fact, since the works have been under the management of the Council that any serious attempt has been made to push the business in the direction of power supply. Some indication of the advantages of

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this policy were given by Mr. Chattock, the Engineer of the Department, in his recent speech at the local dinner of the Institution of Electrical Engineers. In 1891, when lighting was looked upon as the main source of revenue, the Department had 123 consumers, of whom all but one took the current solely for lighting, the only motor on the mains being one of 3 h.p.

Increasing Use of Electricity.

Four years ago, when the Summer Lane station was opened and the high tension scheme was brought into operation, business rapidly improved. In the year ending March, 1906, there were 2,700 consumers, of whom 758 used motors, the total horse-power for motive purposes being 3,200. It was then that the department started the motor hiring scheme, under which motors of from one-half to 50 h.p. could be rented by consumers. During the first year, that ending March, 1907, 112 motors, representing 900 h.p., were hired, and the total motor load grew to 6,000 h.p. In the following year, ending March, 1908, there were 272 motors on hire, representing a total of 1,700 h.p., the total motor horse-power from the mains being 9,500. In March this year, the motors on hire numbered 411, representing 2,500 h.p., making a total motor load of 14,500 h.p. As may be supposed, the majority of the motors on hire have been for businesses in which the power demand is light, such as jewellers and small brassfounders, and plating and polishing establishments, and small shops in which a variety of minor work is done. The majority of the privately owned motors are in large works. Thus, while the higher scheme has developed an increasing use of electricity for the smaller power works, the 3-phase supply scheme, which gives current at a cheaper rate to large manufacturers, has been developing the use of motors for heavier work.

Results of Trading.

At the present time, there is about 17,000 h.p. on the main. The general results of the department's trading are indicated by the following figures: In 1891, the total supply was 73,000 units. Taking the year to March, 1906, about 5¼ millions were sold; the year ending March, 1907, 10,800,000; year ending March, 1908, 20 millions, and in 1909, 24½ millions. The last three figures include the tramways supply, and the total for the twelve months up to March, 1909, may be approximately apportioned as 5,000,000 units for lighting, 7,000,000 for power, and 12,500,000 for tramways. During the past six months, the number of motors on the mains has been increased 2,200, representing 17,000 h.p., the total number of consumers, including those for lighting only, being about 4,000.

Miscellaneous Applications of Electric Power.

There has been a marked advance, also, during the last two or three years in the miscellaneous applications of electrical power in Birmingham, the supply of current for which is included in the above figures. A number of churches and other places of worship have adopted electrically-driven fans for ventilation, and the similar use of electricity in restaurants, offices, shops, and other commercial establishments, is growing in a rising ratio, while recent Home Office regulations have brought a large demand for electrical ventilating apparatus in foundries and other manufactories. The Central Free Library, which is now undergoing alteration, has also been provided with power for electrical exhaust fans, and at the branch libraries also, as opportunity arises, similar provision is being made. Thus, a long-standing complaint of frequenters of the libraries is in a way of being remedied. The Education Committee are also adopting this means of ventilating for the public schools.

Electricity for Heating.

The use of electricity for heating is not spreading so rapidly as might have been expected, but the demand is improving. Electrical cooking apparatus is not so much favoured in Birmingham as in London, where, among the many dwellers in flats, there is a preference shown to it over gas. Of the types of stove favoured in Birmingham, the radiation is much more popular than the convection. A stove combining the advantages of the two methods of heating was brought out some time ago by Messrs. O. C. Hawkes, Ltd., but has not met with the patronage that was expected, though the convection stoves, which have for some time been a speciality of this firm, are growing in popularity as the true principles of heating a room become better understood.

LANCASHIRE NOTES.

MANCHESTER.

Trade continues to be very bad in the district. As a result many local manufacturers are following the usual rule of cutting all prices and accepting orders at bare cost to keep their works open. Business in the mechanical line is not so poor. Those firms who have both mechanical and electrical departments are not feeling the depression so much as others. While the electrical machinery makers and manufacturers of arc lamps and accessories are suffering most, it is rather surprising to note that local switchgear firms are obtaining a fair amount of work. This is largely due to extensions of power service from stations—private or public—already existing. Much of this switchegar goes to mines and iron works. The agitation, already heard of from other parts of the country, against coal cutters, especially when electrically operated, has commenced in the Lancashire coalfields and promises to give the local section of the Mining Electrical Engineers work in defending the electrical interest. There is talk of the mines demanding a re-adjustment of rates in mines where coal cutters are employed.

Electricity in Mines.

Many of the mines, even those in which no coal cutters are used, have, at least, got electric light on the surface, and one comes across many interesting installations here, some quite old. I noticed one the other day at one of the Astley mines, where, driven off the old-fashioned winding engine, is a very old Mather and Platt "Manchester" type generator. The ammeter and voltmeter are quite curiosities. Along with a double-pole switch and fuses, they are mounted on a wooden board, and constitute the switchboard. The load is about 10 kw. at 100 volts, and current is only supplied to incandescent and arc lamps in the offices and on the surface. Despite its age, the installation gives no trouble whatever.

Private Electric Lighting Plant.

Another interesting lighting installation I recently saw, was that at McDougall's chemical works near Middleton. Here a very old compound wound Byng-Hawkins machine, with the series cut out, has been installed by a local contractor—who persuaded the firm to use electric light. It is driven from the works shafting and charges a small 100 volt battery of Chloride Co.'s cells, during the daytime, from which the works are lighted. As there is so much fine dust about, everything, including the machine and small switchboard, is boxed in. As far as power costs and attention show, the electric lighting costs nothing, and its convenience and simplicity has opened the way to the electric drive for the works. I mention this case as an example of many other similar cases, where local contractors could, with a little persuasion, induce manufacturers in all lines to instal at least electric light. As has already been found here, a small private electric lighting plant as above described, worked from the shafting "for nothing," leads the way to the conversion from mechanical to electric driving, as it brings the manufacturer into touch with electricity and its advantages, and breaks down any prejudices he may have had.

Electric Drive in Textile Factories.

The report of the Bradford Committee has caused indignation among local engineers, and much amusement to those textile manufacturers who have adopted the electric drive. Practically every cotton spinner who has done so, has kept very detailed records of the results of the change, but they naturally will not publish these tests, as they find the more even thread produced by the electric drive gives them a better market position than firms still using the old drive. In order to get actual data, which would convince Lancashire mill-owners of the truth of the statements made by electrical engineers on this matter, Mr. W. F. Rhodes, of Squirrel Works, Stockport, has made a series of experiments. He took tests for speed variation in a large cotton mill, before and after changing to electric driving, and the results show a clear proof of the steadier drive and increased output resulting from the change. In one case he connected the speed recorder direct to the tin roller shaft of a ring spinning frame and found that the speed variation with mechanical drive was 8% and only 2½% with the electric. Also in the latter case the mean speed was 3½% above that in the latter. The drive from motor to line shaft was by ropes, and from the shaft to frames, by belts. In the mechanical it was through spur and bevel gear with vertical shafts. Of course, if motors had been fitted to each frame, the variation would have been still less, probably only ¾%. As a result of the steadiness, breakages and the consequent stoppages for piecing up are almost nil with the new drive, which has fully increased the output 10%. Mr. Rhodes thinks that where, on account of their superior performances, steam turbines are employed, the electric drive is almost essential.

Utilisation of Exhaust Steam.

Mr. J. W. Bailey read a paper before the Manchester Association of Engineers on "The Exhaust Steam Turbine." To give some idea of the power now going waste, he mentioned that the monetary loss to the nation, since non-condensing engines began to be used, was approximately equal to the National Debt. While in the early days boiler pressures were so low that engines had of necessity to be run condensing, still, when higher boiler pressures began to be used the idea of working below the atmosphere line became more and more neglected, probably owing to the erroneous idea that initial pressure was of paramount importance. Recent researches have, however, made clearer the properties of steam and results have proved the economy of the exhaust turbine. By means of formulæ and diagrams, Mr. Bailey made clear that the combination of engine and turbine, dealing with the expansion through high and low pressures, respectively, was more economical than either engine or turbine alone. The exhaust turbine was the cheapest means of extending a power plant where the engine already existed in good condition, as it was cheap in first cost, and its addition reduces the coal cost per h.p. considerably. The chief

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difference between high pressure and exhaust turbines was that in the latter there were only about half as many blades, as the heat drop was only about half. Every type of pressure turbine may be adapted for exhaust steam. In working an exhaust as turbine successfully, a good vacuum is of first consideration, this greatly affects the pressure range, or the available heat range. The limit of the useful vacuum, however, is quickly reached and careful consideration is required to get the best results by choosing a condensing plant and vacuum to give maximum economy with the outlay. Mr. Bailey thought that in this country and abroad, there is a great field for the exhaust turbine, because there are so many engine sets, too good to scrap, but too small to be in themselves of much use. With the turbine added, the output might easily be doubled at small cost and high efficiency, particularly where the day and night loads are short and peaky

AMERICAN NOTES.

NEW YORK.

The Inventors' League, which has just come into being in this city, is an organization which has many features to commend it to all engaged in the electrical industry. Mr. Joseph J. O'Brien, the General Secretary, in introducing the League to public notice, observes that in a world organized by invention the inventors are now the most isolated and disorganized class. "Their grievances," he says, "are in large part the indirect result of their helplessness, due to their present isolation. For years individuals have contended for improvement in the laws and methods of the patent system, but with little or no result, and it is safe to assert that individuals may continue to contend as individuals for years to come and will achieve little of value. Organization is absolutely essential to a correct itemization of existing evils and needs; a correct definition of negative and positive causes; and the elaboration and successful promotion of an adequate programme of revision and reformation. To provide the basis for an organization of inventors which would be at once free and properly limited to the vital needs of the inventors as a class, the Inventors' League has been organized."

The Objects of the League.

The Constitution of the League sets forth that its objects are the intellectual and material advancement of inventors and the development of collective means for the protection of their rights; to secure a higher, more just and more practical realization of the constitutional foundation of the Patent System, of the United States, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries; to secure closer co-operation between inventors for their mutual protection, without loss of their independence; to secure adequate provision for the just and effective consideration of new inventions and the safe keeping of the priceless records of invention; to facilitate the development, advancement and utilization of inventions by the extension of existing opportunities and by the diffusion of facts among the inventors and the people, concerning the vital importance of the rights of inventors, and by the encouragement of awards and similar measures for new inventions; to discover and define opportunities for the application of inventions and to bring inventors into closer and freer relations with such opportunities; and to collect and preserve the history of inventive achievements and the literature of invention.

Rotary Condensers and Power Factor.

A remarkable circumstance in connection with electrical engineering, at any rate on this side of the Atlantic, is the scant attention which has been paid to the effect of the rotary condenser as a means of raising the power factor of systems carrying a heavy inductive load. One of the first central stations in the United States to realize the importance of the synchronous motor as a rotary condenser was the Cleveland Electric Illuminating Company, and an extremely interesting account of this corporation's experiment is contributed to the *Electrical World* by Mr. John Liston. Almost every central station has a group of induction motors working at light loads and consequently lowering the power factor of the whole system. Mr. Liston points out that the synchronous motor when used as a rotary condenser has the property of altering the phase relation between e.m.f. and current, the direction and extent of the displacement being dependent on the field excitation of the condenser. It can be run at unity power factor and minimum current input, or it can be over-excited and thereby deliver leading current which compensates for the inductive load on other parts of the system. The rotary condenser, therefore, can supply magnetizing current to the load on a system while the power component is supplied by the generators.

The Power-load Fluctuation.

The equipment of the Cleveland station, which serves a district of some 50 square miles, consists of two 9,000 kw. and one 1,500 kw. Curtis turbo-generator sets of General Electric manufacture, delivering energy at 11,000 volts, three-phase, 60 cycles. There are, in addition, some reciprocating engine-driven generators, delivering energy at 2,300 volts, three-phase, 60 cycles. Transformers step-up the e.m.f. to 11,000 volts for the sub-stations. There are also three 1,500 kw. motor-generator sets and direct current reciprocating engine sets and a storage battery. The sub-stations are six in number; the secondary lighting circuits are three-wire, single-phase, 115 volts to 230 volts, and motors up to 5 h.p. rating are operated from the lighting circuits, and the general inductive distribution is at three-phase, 2,300 volts, the e.m.f. being stepped-down to 460 volts and 230 volts at the customer's premises. The motors are nearly all three-phase, but some two-phase motors are run from three-phase transformers by means of a T-connection. Mr. Liston observes that the fact that more than 40% of the connected load consisted of induction motors had the effect of lowering the power factor of the whole system from between 85 and 90% at night to between 65 and 70% during the day.

Effect of the Rotary Condensers.

To bring the power factor as closely to unity as possible the Company upon the installation of two 2,300 volt rotary condensers of 750 kva. rating provided with directly connected exciters in one sub-station and another of similar rating in a second sub-station; while four 200 kva. General Electric rotary condensers with directly connected exciters were connected to the low tension side of the transformers on the customer's premises. A number of synchronous motors partially loaded were also installed, the kilowatt load delivered to the shaft varying from 50 to 75 % of the kva. rating of the motor. The general effect of the installation has been a marked improvement in efficiency, the power factor rising by more than 20%. Mr. Liston cites a graphic illustration of the value of the rotary condensers. A feeder circuit equipped with a 200 k.v.a. condenser was put out of action by a tree falling across the line. While repairs were being made a feeder from another sub-station which was carrying a heavy load at low power factor, was joined to take on, temporarily, the additional load. It was found that the ammeter readings with this combined load were actually lower than they had been with a single load on the circuit not provided with a condenser. The kilowatt readings showed an increase of about 75%, while the ampere readings dropped about 25%.

Gas-Electric Railway Motor Cars.

Two gas-electric motor cars each equipped with two standard commutating pole railway motors of 100 h.p. have been manufactured by the General Electric Company for the Southern Railway Company. The current is supplied from a 600 volt generator, which is direct coupled to an eight-cylinder gas engine in the forward compartment. A controller similar to that used on an ordinary trolley car is located near to the operator, and through this the current passes from the generator to the motors. The car bodies are of steel, about 55 ft. long, with seating capacity for 52 passengers.

New Meter Testing System.

A noteworthy exhibit at the recent meeting of the Illinois State Electric Association was the Central Electric Company's new "P-M" meter testing system. It consists of a pressed sheet-steel box containing the consumer's meter and a main line cut-out equipped with certain receptacles into which plugs from a test meter can be placed. The consumer's meter can be short-circuited by means of these plugs so as not to interrupt service while the test is going on. The meter can then be tested by the connection of an artificial load. The object of this arrangement is to save the large amount of time taken by meter tests in connecting up and getting ready to test consumer's meters. The enclosing box also protects the service and meter terminals from being tampered with.

New York's Mono-Railway.

The first sod has been cut of the new mono-rail line from Bartow, on the New York, New Haven & Hartford Railroad, to City Island, N.Y., to which reference has already been made in these notes. The line is being constructed by the Mono-road Construction Company, of which Mr. B. L. Burrows is president, and the project has the backing of the Interborough Rapid Transit Company. The Mono-road Company owns the rights, by purchase from the American Mono-rail Company, for that system of construction in the metropolitan district around New York. It is proposed to construct a small power house on City Island, where a water-front site has been secured, to furnish the energy for the operation of the line. The rails will be laid on concrete ties, and the pedestals of the steel pillars which support the upper trolley will also be made of concrete. Three cars will be constructed, built of steel and aluminium. They will weigh only 15 tons, and Mr. Burrows is confident that a speed of 100 miles an hour will easily be obtained.

Gasoline-Electric Street Car.

The Third Avenue Railroad Company is now operating with great success an experimental gasoline-electric car manufactured by the General Electric Company. The car is of the single-deck, double-ended type, and carries under the longitudinal wooden seating a supply of gasoline sufficient for 150 miles. It has a seating capacity for 28 passengers, and weighs 24,000 lb. The gas engine, which is mounted on a truck of 7½ ft. wheelbase, is of the

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four-cylinder, four-cycle type, directly connected to a generator and exciter, the energy developed being transmitted to two railway motors mounted on the axles. Controllers at each end connect the motors progressively in series and in parallel, and regulate the voltage supplied by the generator in proportion to the speed of the car. The gas engine has no mechanical connection with the driving axles, and runs at constant speed. Ignition is effected by a Bosch low tension magneto, the system being of the " make and break " magnet plug type.

The Titanium Arc.

A highly interesting paper on the Titanium arc was read by Mr. W. S. Weedon at the annual meeting here of the American Electrochemical Society. Mr. Weedon said that as a result of a series of experiments made some years ago to determine what material would give the maximum light efficiency when used as arc electrodes, none of the substances tried was equal to material containing the element titanium. Titanium carbides being the most convenient preparations of titanium available, were tried in various forms, and it was found that a mixture of TiC and Ti gave the best results, especially when iron was present only in negligible quantities, as this latter metal tended to cause unsteadiness of the arc. The best arc was obtained by using a cathode of titanium-carbide preparation, and an anode of copper, the latter being inactive and not wasting appreciably. The titanium arc being a flame arc, the efficiency increases with the current density and the arc length. Volt-ampere curves and volt-arc-length curves were shown by Mr. Weedon. The efficiency curves proved that titanium-carbide arcs are most satisfactorily operated on a constant-current circuit rather than on a low-voltage multiple circuit.

The Metal Filament Lamp.

One of the papers read at the recent meeting of the Illinois Electric Association dealt with the tungsten lamp. The author was Mr. J. G. Learned, of Chicago, who said it was feared by many central stations that on account of the high efficiency of this lamp, and therefore the possibility of furnishing the same amount of light with much less current, it would hurt the revenues of the companies quite materially. This fear has proven to be unfounded. The advantages of the lamp have been shown to apply mutually to the customer and the central station. By means of this lamp the central station has been enabled to secure a very large volume of new lighting business. The slight reduction in the revenue secured from some lighting customers, who have installed tungsten lamps to secure reduced bills, is more than made up by the large number of new customers who are attracted to central-station service on account of the great economy of this lamp. Tungsten lamps will continue to be improved, as they have been very materially since their introduction. Their cost will doubtless be decreased and their life or efficiency further increased.

$50,000,000 Telephone Company.

The Continental Telephone and Telegraph Company has been incorporated at Trenton, N.J., with an authorized capital stock of $50,000,000, divided equally into common and preferred stock, the latter bearing six per cent. noncumulative dividends. The objects specified in the charter are to unite and consolidate telephone, telegraph and cable lines. Authority also is given to consolidate or merge with any corporation engaged in a similar business, and the consolidated company may be any one of the merging companies or a new corporation to be formed by means of such consolidation. The incorporators are : William M. Clark, of Plainfield, N.J. ; Powell Crichton and William E. Conley, of New York.

GERMAN NOTES.

BERLIN.

A project for a line between Rixdorf-Berlin and Ge undbrunnen is being actively mooted. The distance is to be covered partly above and partly underground. The Spree is crossed by a tunnel under its bed. There are to be 11 stations, with an average distance between each and the next of one kilometre. The estimated capital required is 84 million marks, towards which the Town Council lends half at 4% interest. There is to be only one class of carriage, and ordinary and workmen's fares will be charged.

Rhine Power.

Brown, Boveri & Cie, A. G., of Mannheim, are planning a Government licensed plant at Huningen. They must not, however, take water for the turbines to such an extent as to interfere with the usual navigation of the river at any time. The older Kembser project, which contemplated taking, roughly, 500 cubic metres per second from the river, has, therefore, been abandoned, and Brown, Boveri have made arrangements whereby one-third of that quantity will suffice. This they have done by being less ambitious. It is estimated that 40,000 h.p. will ultimately be required, and the Kembser scheme provided for getting it all at once. The Brown, Boveri Co. propose to proceed by gradual stages.

Metal Electrodes for the Electric Arc.

Researches on this subject with reference to wireless telephony are in progress, but, although high frequencies are ensured, the alternation is very variable, for some reason as yet unknown. If the electrodes are carbon and copper, with 400 volts and about a quarter of an ampere, the frequency is from 1,300 to 43,000, but by discharging the same arc in the usual hydrocarbon atmosphere, a maximum of 250,000 alternations per second can be attained. Conductors near the arc seem to affect the frequency considerably.

A New Conductor.

The Chemische Fabrik Griesheim Elektron has patented a magnesium alloy under the name of Elektron, which is said to surpass aluminium in lightness and strength. The specific gravity of the new alloy varies from 17·5 to 2·0, and it has a silvery lustre. It resists exposure excellently, as the atmosphere covers it with a protective coat of oxide. The tensile strength averages 18 kg. per square millimetre, and the elastic limit extends to a stretching of about 5% of the original length. Compression, *e.g.*, by drawing into wire, increases its strength very perceptibly without greatly augmenting the specific gravity. In fact, the tensile strength can be brought up to 35 kg. per square millimetre, and the elastic limit to 18% without getting the specific gravity over two.

Damping Oscillations.

A Berlin electrician notes that oscillations in condenser circuits with a mercury lamp for the spark gap are damped on the average to the same extent as with an air gap, but that the shape of the resonance curve is very different. Higher temperatures and pressures in the mercury lamp diminish the intensity of the oscillations, and thus increase the damping and the resista ce. For wave lengths of 158 metres the ratio of the capacity C to the self-induction L of the circuit has much influence on the damping, which is a minimum when $\frac{C}{L}=0{\cdot}05$. With air spark gaps there is no such minimum. With increase of capacity the resistance of the mercury lamp rises rapidly at first, but more and more slowly with further increase, and tends to approach a constant value.

Atmospheric Electricity.

Researches by means of kites and small balloons into this subject have not been very successful. It is difficult to fly them properly when loaded with the necessary registering instruments, and their use in thundery weather is not unattended with risk, both to the instruments and to the operators. Professor Weichert, of Göttingen, proposes to use miniature aeroplanes, steered and brought back to earth by means of Hertzian waves.

New Power Station.

The Prussian Government is co-operating with those of Wurtemberg and Bavaria for erecting a power station at Fenthofen, where 35,000 h.p. are to be got from the river Iller at a cost of eight million marks. Additional works to utilise the current of the Argen are also contemplated.

New Teneriffe Cable.

The Deutsche Sud-Amerikanische Telegraphengesellschaft, of Cologne, has laid a cable from Emden to Teneriffe, which was put into action on August 26, 1909. It is to be the first item in a system of communication between South America and West Africa, avoiding the use of foreign cables at Vigo. Later, the new cable will be extended to Pernambuco, whether *via* Monrovia or not is as yet undetermined. It would cost more to include Monrovia, but at the same time an advantage would be gained by connecting the German West African colonies of Togo, etc., first with Monrovia. The laying of the cable from Borkum to Teneriffe was entrusted to the Seekabelwerke, of Nordenheim. It is 2,107 sea miles in length, and contains 340 lbs. of gutta percha and 600 of copper per sea mile. The cable from Emden to Borkum is, of course, a land cable. The Deutsche Sud-Amerikanische Telegraphengesellschaft was founded in August, 1908, with a capital of 11,800,000 marks, four millions in shares, the rest in debentures, and the completion of this great submarine cable is an eloquent testimony to its usefulness.

Company Notices.

The Elektrizitatswerk Siegerland, G.m.b.H., of Siegen, has declared a dividend of 5½% on the capital of three million marks.

The Berliner Elektrizitats Werke has made a net profit of 4,024,077 marks (3,346,803 in the previous year), and is paying a dividend of 4½% on its preference capital of 20 million marks and 11% on the ordinary capital of 31½ millions and 4% on the extraordinary share issue of 12½ millions in ordinary shares made in 1908. The prospects for the future are extremely favourable.

The Halle am Saale electric trams have been acquired by the town. 1,375,000 marks have been paid, and the debt owing by the line of 880,000 marks has been taken over by the municipality.

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BUSINESS NOTES AND NEWS.

LIGHTING AND GENERAL—Home.

COBHAM.—It is reported that the Woking Electric Light Co., intend to extend their mains to Cobham next year. The company already possess Parliamentary powers to supply Cobham, and for that purpose, to carry their mains through the portion of the Walton urban district which intervenes between the parishes of Byfleet and Cobham. They have laid their cables in Byfleet, and to get into Cobham an extension of about 2½ miles would be necessary.

DUNDEE.—Mr. H. Richardson, Electrical Engineer, asked the Corporation Electricity Committee for the appointment of a sub-committee to consider as to the lighting of common stairs with electricity automatically managed from the station. He stated that several tenements in the vicinity of Dudhope Power Station had been fitted up with the necessary appliances, and he had no hesitation in saying that there were no objections that could be raised to the system. He hoped to see great developments in the matter, and he wished a sub-committee to go into the whole question. This was unanimously agreed to.

GRIMSBY.—To the Corporation Lighting Committee the Borough Electrical Engineer, Mr. W. A. Vignoles, reported a breakdown on the No. 9 set, entailing damage estimated at £200. The failure of a stud through fatigue of metal was the cause to which the accident was attributed, and the committee confirmed the action of the engineer in immediately replacing the damaged parts. An application for current was received from certain residents at Scartho. The engineer said the cost of cable-laying would be £450, and the estimated revenue £50 per year. The committee decided to endeavour to obtain a guarantee from the proposed consumers, and then to decide whether to lay the cable.

HAVANT.—The Havant Gas Co., Ltd., propose to promote a Bill to dissolve the Company and incorporate a new Company for the supply of both gas and electricity.

KEIGHLEY.—The Town Council decided to apply to the Local Government Board for power to borrow £21,000 for extension of the electrical plant and mains. Mr. H. Whitehead explained that this recommendation was put forward in consequence of the increasing demand for electricity and the requirement of the Local Government Board Inspector that they should provide a duplicate plant in order to be prepared for accidents and emergencies. They had now sufficient applications for electricity to make the electrical undertaking, even after this expenditure, a paying concern, and he thought that when they got thoroughly going they would be able to hand over about £1,000 a year for the relief of the rates.

LEICESTER.—Mr. A. A. G. Malet, M.Inst.C.E., conducted a Local Government Board inquiry respecting the application of the Corporation for sanction to borrow £7,000 for the purposes of the supply of electrical energy. Councillor Flint said it was felt the Corporation must be in a position to supply cheap motor power not only for the existing industries of the town, but to attract other industries.

LONDON.—The Port of London Authority decided to provide entirely new electrically driven pumping plant for the purpose of raising the level of the water in the Royal Victoria and Albert Docks to the extent of 2 ft. 6 in., giving in the Victoria Dock a minimum depth of 28 ft., in the Albert Dock 29 ft. 6 in., and in the Albert Dock Basin 34 ft. 6 in.

LONDON.—The Metropolitan Electric Supply Co., the St. Pancras Borough Council, the South Metropolitan Electric Power Co., the Westminster Supply Corporation, the Bermondsey Borough Council, the Islington Borough Council, the St. Marylebone Borough Council, the Shoreditch Borough Council, and the Stepney Borough Council, propose to lay additional mains.

MARYLEBONE.—The Borough Council decided to apply to the London County Council for a loan of £24,000 to extend the electric light along 21 streets of the borough.

MIDDLESBROUGH.—The Corporation propose applying to Parliament for further powers with regard to electricity supply, including powers to supply meters, cookers and fittings.

NUNEATON.—At the Town Council meeting the Mayor stated that the electric department had lost on the half-year, but the whole profit for the year amounted to about £100. The new system had brought in a reduced revenue, and the Electric Committee were considering whether they ought to alter it or not.

PAISLEY.—The accounts of the Corporation electrical undertaking (Mr. C. F. Parkinson, M.I.E., M.I.Mech.E., Consulting Engineer and Manager) for the year ended May 15 last show that the total revenue was £20,343 12s. 3d., and the expenditure £12,073 11s. 7d. Interest and loan charges absorbed £8,764 17s. 10d., and the net result was a deficit of £690 5s. 10d. The sale of electricity during the year reached 2,562,046 units, of which 1,280,487 were used by the Tramway Co., 1,002,244 sent out to meet the general demand for power, light, and heat, and 279,315 to supply public lighting. The maximum demand on the generating station was 1,702 kw.

PRESTON.—The accounts of the electric tramway undertaking for the year ended March last show a surplus profit of £4,400. After defraying the cost of refuges and top covers for some of the tramcars, the surplus has been added to the reserve fund, which now amounts to £16,862. The capital expenditure totals £187, 269

READING.—The Reading Electric Supply Co., Ltd., have given notice of intention to apply for Parliamentary powers to extend their area of supply.

RADCLIFFE.—Lancashire Electric Power Co. has given notice of intention to apply for a provisional order to produce and sell electricity for all public and private purposes within the urban district of Radcliffe, where the District Council possesses monopoly powers. The company proposes to lay down lines and works in the main thoroughfare within two years after the commencement of the order.

ST. PANCRAS.—Applications to the Borough Council for supply of electricity have been received, which necessitate extensions of mains involving an outlay of £225.

WARRINGTON.—The electric tramway accounts for the year ended March last show a surplus of £2,370.

WATFORD.—The Urban District Council are negotiating with the County Council in reference to the supply of electricity for the proposed new tramways.

WEMBLEY.—To the Urban Council, Councillor Ainsworth reported that he, in company with the clerk and ex-Councillor Sadler, interviewed the North Metropolitan Electric Light Distribution Co. with reference to their decision not to proceed with the Wembley Electric Lighting Order. The deputation were informed that the reason was the want of funds and the difficulty of getting money. Questioned as to the company's eagerness to obtain the Order, they said they had great expectations of Wembley at that time. The question of purchasing or acquiring the rights under the Order was a matter for the arbitrator. When interrogated regarding the friendliness, or otherwise, of advising the Board of Trade behind the Council's back of their intention to give up the Order, the Company stated that the Council were pushing them, and they had no alternative. They also said that if anybody else could be got to take on the Order, they would not act as dog in the manger, but would be willing to pass on their rights for a reasonable consideration. The reason money could not be obtained was that in those districts where Orders had been worked no dividends had yet been paid, and at the present time an unforseen development in metallic film lamps had deprived the companies of half their current supply so that whatever chance there was before of making a profit was rendered still more remote. The Council then discussed the question in private.

WOOLWICH.—Owing to a breakdown at the borough electricity works, the greater part of Woolwich was plunged in darkness about half-past seven on Monday evening. All the street lamps were extinguished, and many business premises had to be closed. At the Hippodrome the performance had to be abandoned, and a meeting at the Town Hall had to be carried on in semi-darkness. The light was restored shortly before nine o'clock.

YORK.—A sub-committee of the Corporation Electricity Committee was appointed to consider arrangements with tradesmen and others for special displays of electric light both inside and outside shops during the "Shopping Week."

LIGHTING AND GENERAL—Overseas.

ARGENTINE REPUBLIC.—The Empresa Telefonica del Chubut have been granted a 30 years' concession for the establishment and working of a public telephone service between Rawson, Trelew, Puerto, Madryn and Gaiman. The service must be ready for public use within one year. The concessionary company engages to extend the telephone system to any rural centres comprised within the zone in question as soon as from 20 to 30 subscribers make application for it.

BRITISH COLUMBIA.—The Bull River Falls Power & Light Co. in the Fort Steele district have almost completed an immense flume, which will give at lowest water about 10,000 h.p. The company proposes to supply light and power to all the towns in the Pass country from Michel and eastward to Mayie. A connection from the falls town with Jaffray by electric railway is also contemplated. This may eventually be extended to Fort Steele and Cranbrook.

CANADA.—The rapids at Cornwall, on the St. Lawrence River, midway between Montreal and Toronto, have been examined by engineers on behalf of the Dominion Government, who report

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that it is quite feasible to dam the waters and secure 800,000 h.p by the undertaking. They estimate that it will cost $50,000,000 to carry out this scheme, but consider that the deflection of the rapids into a great power canal would be a remunerative enterprise. The objection has been raised that the navigation channel will thereby be diverted to the American side. This and other criticisms will be fully discussed when the whole scheme comes up for consideration before the Dominion Parliament shortly.

DENMARK.—A scheme is under consideration for the construction of an electric railway between the towns of Aarhus and Randers, which is estimated to cost £200,000, and of electric central stations for the purpose of supplying a good-sized district with electric current for power and light, which may entail an expenditure of rather more than £150,000. The loan, probably of £400,000, will be guaranteed in various ways.

NEW ZEALAND.—Mr. E. E. Stark, M.Am.I.E.E. (City Electrical Engineer), in his second annual report to the Dunedin City Corporation, respecting the Waipori hydro-electric plant, states that since September of last year the Department has taken applications for power of some 30 consumers, amounting to 672 h.p., with the proviso that the Corporation has the right to require the non-use of power during peak hour loads. This condition, together with the two-rate system of charging, has resulted in a large improvement in the load factor above that usually found in a mixed power and lighting plant. The second or "peak load" rate approximates four times the "non-peak load" rate, varying according to the hours of use. The load factor for the month of March, 1909, was 47·7 %, whereas the usual load factors in large light and power plants on the Continent range from 12% to 20%. The estimated cost of duplication at Waipori, Halfway Bush, and Converter Station for necessary water wheels, pipe line, electric generators, transformers, low tension transmission line and spare, amounts to £33,000. In February last tenders were received, and have since been accepted for the duplication of the present plant, embracing water wheels, governors, generators, exciter, Tyrell regulators, step-up transformers, step-down transformers, pipe line and three-core U.G. cables, amounting to £13,000. Work has been started on the excavation for the extension of the power house. With regard to the tramway, the insulation of the U.G. cable feeders between Manor-place and Maitland-street having broken down in many places, these feeders have now been removed from the Doulton ducts, where they were exposed to the undrained sewage of this section, and have been placed in "solid" with bitumen. At the Converter Station the new battery booster is a departure from the usual practice, in that its motor is an A.C. induction motor in place of a D.C. motor, the former deriving its current direct from the 3,000 volt A.C. lines, while the latter method would have involved the transforming of the alternating current to D.C. current, and a consequent loss of 20% on this portion of the plant. This departure has resulted in a decrease of the gross tram units of 90 per day, amounting to 2%. This change, however, involved an additional cost of £45 over and above the lower priced D.C. motor. The accounts for the year ended March 31 last show a net profit of £854 6s. 11d. The total revenue was £19,775 and the costs £9,412 0s. 7d. Interest charges, etc., absorbed £9,508 16s. The capital expenditure at the end of the year appears at £216,665 3s. 8d. The units sold totalled 4,850,685.

ONTARIO (Canada).—A vote of the ratepayers of Port Arthur resulted in favour of the acceptance of the agreement made with the Ontario Hydro-Electric Commission for the delivery of power. The total vote was smaller than expected, standing at 425 to 169. Tenders for the construction and equipment of a power station in connection with Hydro-Electric Power Commission, to cost approximately $60,000, are in the hands of the commission and will probably be considered at an early date.

QUEBEC.—The second reading was given by the Montreal City Council to a by-law authorising the corporation to establish a municipal lighting plant. The idea is that the city shall light the streets by utilising the power derived from burning garbage.

SPAIN.—Authority has been given Don Alfredo Moreno Ossorio, of Madrid, to utilise the water of the river Guadalimar, at Los Piezuelos (township of Ubeda), to the extent of 5,000 litres per second, for the purpose of generating electrical energy to be carried to La Carolina.

TRACTION—Home.

LONDON.—The London County Council's Highways Committee passed a proposal to enter into agreements with the West and East Ham Corporations and the Leyton Urban District Council to provide a through service of tramways to and from Aldgate *via* Bow. The routes comprised are:—(1) Aldgate to Ilford-broadway *via* Bow Bridge, Stratford-broadway, and Romford-road; (2) Aldgate to Epping Forest *via* Bow Bridge, Stratford-broadway, Leytonstone-road, the Green Man, Whipps Cross, and the Rising Sun. At Stratford-broadway the cars will branch off to either Leyton (Epping Forest) or Ilford. It is proposed that each authority shall take all fares on its own cars, pay its own working expenses for operating its own cars, supply electric energy in its own area to the other authorities and run cars—including workmen's cars—according to the length of track in its own area. An estimate of £6,400 was submitted for the extension south of the tramway in Farringdon-road, E.C. The Committee passed estimates amounting to £10,238 for the construction of roof covers for 90 double-deck electric tram-cars, the work to be carried out by direct labour. The Committee agreed that the assembling and fitting of car ploughs required for 200 new cars for the Council's tramways and for four electric car traversers at the central car repair depot and the Norwood car shed should be carried out by direct labour. The total traffic receipts of the City Council's tramways from April 1 to November 13, 1909, were £1,117,394 from lines worked by electric traction, and £89,163 from lines worked by horse traction, or a total of £1,206,557. The receipts for the corresponding period in 1908 under the same heads were £967,872, £186,383 and £1,154,255, respectively.

TRACTION—Overseas.

ARGENTINE REPUBLIC.—A decree has been issued authorising the Buenos Aires Great Western Railway Co. to extend its lines from the neighbourhood of Sadi Carnot-street to the lines of the port of the capital, passing under part of the city by means of a tunnel. Traffic on the new line is to be worked by electric traction, and the service of electric trains is to run also between Sadi Carnot and Moreno Station, the Company being empowered to construct two additional lines between Caballito and Moreno. The Company are obliged to set up fire-extinguishing apparatus in the tunnel. Messrs. Otto Franke & Co., concessionaires, for the electric railway between La Plata and Avellaneda, have been granted a concession for the construction and working of an electric railway from the side of the Riachuelo to Retiro station, joining there with the existing lines; a branch line is to be constructed from Entre Rios-street, by way of Brasil-street, to Constitución-square, and connections are to be made with the lines of the ports of Buenos Aires and La Plata. The main line is to cross the Riachuelo by a draw-bridge, and to continue at the same height along a viaduct to the top of Uspallata-street, where it is to enter a tunnel. Plans must be submitted for approval within 18 months from the date of promulgation of the contract, and the work must be completed within four years and six months after the approval of the plans.

CANADA.—The well-informed *Standard of Empire* states that reports are once more current that the Canadian Pacific intends to electrify some part at any rate of its system in the Rocky Mountains. The first experiment is to be made next summer, on the branch line into Phœnix, which will be run with power supplied by the West Kootenay Power & Light Co., in which the Canadian Pacific Railway is supposed to be interested. This company develops its power from the Bonnington Falls on the Kootenay River, not very far from Nelson. The Southern Pacific has electrified a portion of its system with success on the Sierra Nevada division, where the conditions are very similar.

HOLLAND.—The Nederlandsche Spaar en Incassobank, of Amsterdam, have applied to the Communal Council of Beverwyk for a concession for the establishment of an electric tramway from Amsterdam to Beverwyk and to Wyk an Zee en Duin. The permanent Deputation of Zeeland has proposed to the provincial Council not to support the demand for a subsidy made by the Breskens-Maldegem Steam Tramway Co. for the construction of a steam tramway from Cadzand to Oostburg, but rather to make an advance of funds, without interest, to a Dutch company to be formed for the construction and working of an electric tramway which will pass close to Retranchement on the Belgian frontier, and will go from Breskens to Knocke, with a branch to Cadzand and thence to Oostburg. The advance on the provincial funds should not be less than one-third of the cost of construction and material, nor exceed the sum of 339,000 florins (£28,250).

NORWAY.—The Norweigian Department of Public Works are about to undertake the construction of a narrow gauge branch railway from Myrdal, on the Christiania and Bergen Railway, to Fretheim, a distance of some 17 kilos. (about 10½ miles), of which about a mile is to be rack railway ("tangstangbane"). According to further particulars published, the weight of rails proposed is 20½ kilogs., and the motive power is to be electricity. The estimated cost of the undertaking is given as nearly £90,000.

RUSSIA.—A preliminary survey of the projected new electric railway between St. Petersburg and Imatra is nearing completion.

THE ELECTRICAL ENGINEERS (London Division).—Orders for week ending December 4, 1909: Officer Commanding, Col. R. E. B. Crompton, C.B. Monday, November 29, "A" Co., Technical Drill, 6.30 to 9.30 p.m.; Tuesday, November 30, "B" Co., Technical Drill, 6.30 to 9.30 p.m.; Wednesday, December 1, Gymnasium, 6.30 to 9.30 p.m.; Thursday, December 2, "C" Co., Technical Drill, 6.30 to 9.30 p.m.; Friday, December 3, "D" Co., Technical Drill, 6.30 to 9.30 p.m.; Saturday, December 4, week-end run at Coalhouse Fort, suspended until December 11, 1909.—(Signed) P. H. Campbell, Capt. R.E. Adj. for O.C., E.E., L.D.

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COMPANIES' MEETINGS AND REPORTS.

CORDOBA LIGHT AND POWER.

The Directors of the Cordoba Electric Light and Power Co. have declared a dividend of 2%.

ADELAIDE ELECTRIC SUPPLY CO.

Dividend announced at the rate of 6% per annum for the financial year ended August 31, 1909, on the 26,065 Ordinary shares of £5 each of the company issued up to that date.

COMPANIES REGISTERED.

FELD BROS. & CO., LTD.—Registered October 25. Capital £5,000, in £1 shares. Objects: To acquire the business carried on at 432-433, Mansion House-chambers, E.C., as Feld Bros.; to adopt an agreement with F. W. Sichtermann and A. Feld, and to carry on the business of manufacturers of and dealers in electrical appliances, lamps, burners, etc. Private company. Registered office, 432 and 433, Mansion House-chambers, Queen Victoria-street, E.C.

HOWE ELECTRICAL ENGINEERING CO., LTD.—Registered October 22. Capital £5,000, in £1 shares. Objects: To take over the business carried on at 16, Redeross-street, and 14a, Moor-street, Liverpool, and at 24, New-road, Blackburn, as the Howe Electrical Engineering Co. Private company. Registered office, Mersey Railway-buildings, 18, James-street, Liverpool.

SILICAWARE, LTD.—Registered November 18 by Cruesemann & Rouse, 85, Gracechurch-street, E.C. Capital £63,000, in £1 shares. Objects: To acquire interest in any patents relating to processes and apparatus for melting and electric furnaces, and for electrical fusing, refining and refractory purposes; to adopt an agreement with Dr. Wolf-Burckhardt and others, and to carry on the business of manufacturers of and dealers in such furnaces and apparatus and fusers, refiners and moulders of silica and ceramic substances; manufacturers of and dealers in electrical appliances and apparatus, crucibles, etc. Private Company.

CONTRACTS OPEN.

HOME.

DUBLIN.—United Tramways Co., Ltd.—Tenders for supply of general stores for the year ending December 31, 1910. By November 29.

LONDON.—London County Council.—Tenders for covering with asbestos tape about 2¾ miles of lead covered high and low tension cables in manholes. November 30.

OVERSEAS.

BELGIUM.—At the Town Hall of Waremme. For a concession to light the town with electricity. January 30, 1910.

HOBART (Tasmania).—Postmaster-General.—Telegraph and telephone material, etc. Part. as above. December 20.

LIEGE.—Electric lighting at Jupille. December 31.

LUCKNOW.—Municipal Board.—Tenders invited for a concession for the supply of electric energy, coal or oil gas, for house and street lighting, and other domestic or manufacturing purposes. December 31.

MELBOURNE.—Postmaster-General.—To supply coin attachments (for coins of different values) for telephones. Spec. No. 184. 370 50 c.p. metallic filament lamps, with bayonet cap fittings, for 110 volts A.C.; 630 25 c.p. ditto; 160 16 c.p. Linolite carbon filament lamps, 110 volts A.C.; 1,000 16 c.p. T.H. screw socket carbon filament lamps, 110 volts A.C.; and 100 32 c.p. metallic filament lamps, with bayonet cap fittings, 200 volts A.C. December 7.

MELBOURNE. — Railway Commissioners. — One single-phase turbo-alternator, etc. December 17.

MONTREAL.—The Saragnay Electric and Water Co.—Water tube boilers. December 1.

SAMARKAND.—Municipality.—Electric tramways. March 14, 1910.

SOUTH AFRICA,—Johannesburg Municipal Council.—For the supply of tramway poles, overhead material, electric cables and joint boxes. November 29.—Hardwood sleepers, vignole rails and fastenings. November 30.

SPAIN.—Llanes Municipal Authorities.—Supply of electric light. Concession for ten years. Local representation necessary. December 9.

SYDNEY.—Postmaster-General.—Switchboard apparatus for subscribers' premises. Particulars of all Australian contracts, 72, Victoria-street, Westminster, S.W. January 10, 1910.

TURKEY-Broussa Municipality.—For a concession for the installation of electric light and power, and for the construction of an electric tramway. December 13.

TENDERS ACCEPTED.

CANADA.—Contracts have been awarded for eighteen pumps which will be installed in connection with the Toronto waterworks extensions. Section A, awarded to Jens Orten Boving, London, England, $14,800, was for four pumps with a capacity of 13,500,000 gallons each, for the main pumping station. The highest tender was $52,200. Section B, John McDougall, Caledonian Iron Works, Montreal, $11,703, was for two pumps with a capacity of 5,000,000 gallons, for the high-pressure fire system at the main pumping station. The highest tender was $35,000. Section C, Jens Orten Boving, $6,500, was for four pumps with a capacity of 16,000,000 gallons each, for the high-level pumping station. The highest tender was $24,000. Section D, John McDougall, Caledonian Iron Works, $7,385, was for four pumps with a capacity of 6,500,000 gallons each, for the high-level pumping station. The highest tender was $18,400. Section E, Canadian General Electric Co., $4,822, was for four pumps with a capacity of 1,500,000 gallons each, for the Island pumping station. The highest tender was $14,500.

LONDON.—The Standard Engineering Co., Ltd., London, have secured the order in connection with the heating and ventilation of the new motor cab garage now being built by Messrs. Panhard & Levassor at Acton Vale, London, W. Messrs. Panhard & Levassor decided to adopt "Stanlock" multiple unit system after making very careful investigations in connection with existing installations, and after giving the system a trial in their own works. The building in question is approximately 600 ft. long by 300 ft. wide, and the scheme embraces not only the heating and ventilation of the garage itself, but also the office building, stores, and chauffeur's mess room, etc.

LONDON.—The Switchgear Co., Ltd., Manchester, having applied for the withdrawal of their accepted tender £3,517 4s. 2d. for provision of high and low tension switchgear, owing to an error in the quotations, the London County Council Highways Committee decided to accept the next lowest tender, that of Messrs. Johnson & Phillips, Ltd., Charlton, £3,625. The estimate of the Chief Officer of the tramways was £3,550.

SHANGHAI.—Messrs. Cryselco, Ltd., of Kempston Works, Bedford, manufacturers of the well-known "Cryselco" carbon and metal filament lamps, have received the contract for the supply of lamps to the Shanghai Municipal Council for the ensuing twelve months.

EDUCATIONAL.

We note from the report of the examiners on the results of the examinations, 1909, in connection with the Electrical Engineering section, Department of Technology, City and Guilds of London Institute, that the answers to the elementary papers show some improvement on the previous year; but there is a tendency to rely merely on memory, without fully understanding the principles involved. The sketches are very bad, however. In the ordinary grade, the report states, the answering to the paper on continuous currents is very poor, and from the occurrence of batches of consecutive answers exhibiting the same defects it seems probable that bad teaching is responsible for many of the failures. The sketches here, also, are very poor, showing in general no acquaintance with the elements even of engineering drawing. The answering to the questions on alternating currents is distinctly better. In Honours, the candidates depend too much upon formulæ taken from some pocket-book, but applied without discrimination. Further, they waste labour upon unimportant detail and neglect the important broad principles which count; applying, in fact, too much routine and too little common sense to the work. Many of them cover pages with generalities, and in some cases this gives the impression of being done to hide ignorance. In Section I. (Electrical Machine Design) not one of the candidates appears to have had any practice in actual machine design, and few have any grasp of the theory underlying it. In Section II. (Instruments) the answering is better, though the specialization of the different branches of instrument making seems to militate against the acquisition of an all-round knowledge. For example, none of the candidates showed any acquaintance with the design of solenoid electromagnets so often used on switchboards. In Section III. Generation and Traction, and Section IV. Distribution, the answers show a tendency towards improvement, but the training of the candidates is too often insufficient or defective. As in previous years, the attention of the school authorities might again be called to the necessity of obtaining as teachers practical men who are familiar with electrical apparatus and machinery and who are in touch with modern engineering practice. Unless the teachers of this subject are themselves electrical engineers, intending candidates cannot be adequately prepared for these examinations.

UNIVERSITY COLLEGE, LONDON.

A special advanced course of Lectures for Postgraduate Students, Telegraph and Telephone Engineers and Electrical Engineers on "The Theory of the Propagation of Electric Currents in Telegraph and Telephone Cables and in Electric Conductors," will be delivered by Professor J. A. Fleming at University College, beginning on January 19 next.

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PUBLICATIONS RECEIVED.

"Uppenborn's Deutscher Kalender für Elektrotechniker, 1910" (München and Berlin: Druck and Verlag von R. Oldenbourg).

"Practical Testing of Electrical Machines," by Oulton, A.M.I.E.E., and Norman J. Wilson, M.I.E.E., Assoc. Am. I.E.E. (Whittaker & Co. Price 4s. 6d.).

"Munro and Jamieson's Pocket Book of Electrical Rules and Tables" (Charles Griffin & Co., Ltd. Nineteenth edition, leather, 8s. 6d.).

"Transactions of the Faraday Society." The September issue forms a double number, and the contents include papers on "The rate of evolution of gases from homogeneous liquids," by V. H. Veley, F.R.S.; "A new electrical hardening furnace," by E. Sabersky, and E. Adler; "The relation between composition and conductivity in solutions of meta—and orthophosphoric acids," by E. B. R. Prideaux, M.A., D.Sc.; "The electro-analysis of mercury compounds with a gold cathode," by F. Mollwo Perkin, Ph.D.; "Experiments on the current and energy efficiencies of the Finlay electrolytic alkali-chlorine cell," by F. G. Donnan, J. T. Barker, and B. P. Hill; "The coefficients of absorption of nitrogen and oxygen in distilled water and sea-water, and of atmospheric carbonic acid in sea-water," by Charles J. J. Fox, and "The electromotive force of certain platinum compounds," by Percy E. Speilmann, Ph.D., B.Sc., as well as papers by Edward R. Taylor, W. Fielding, B.Sc., Ch. A. Keller, Gustave Gin, Henry J. S. Sand, Ph.D., D.Sc., Robert Beckett Dension, D.Sc., Ph.D., and S. Field, A.R.C.Sc.

"The Engineering Review" (London: High Holborn) has issued a second South American number this month. It is a large and handsomely illustrated edition, including a special South American supplement. This forms the complement of the special South American number published in August of last year, the main purpose of which was to place before British engineers and manufacturers the openings that exist in Latin America for the expansion of British trade. The supplement is addressed to the native buyer and user of machinery in his own language and should be in great demand.

"Electrotechnics," by John Henderson, D.Sc., F.R.S.E., A.M.I.E.E. (Longmans, Green & Co.). Price 3s. 6d.

CATALOGUES.

Messrs. H. G. Mayer & Co., of Aldersgate-street, London E.C., are sending out a new and revised list of Plania carbons suitable for open, enclosed and flame type arc lamps.

A pamphlet, describing and illustrating their traction meters, has been issued by Messrs. Ferranti, Ltd. The Ferranti traction meter is a modification of the Standard House service type, but is the same in general appearance and construction. To meet the heavy vibration, various improvements have been made, so that supporting springs are not required.

The "O.S." wiring system, section O-S "Metacase" conductors, is described and illustrated in a catalogue just issued by the Sun Electrical Co., Ltd. The system has been further extended and a considerable quantity of new fittings are listed.

An attractive pamphlet dealing with refined Trinidad bitumen, by A. E. Dussek, has been issued by the British Electrical Trade Supply and Bitumen Co.

We have received a set of "funny man" enclosure cards advertising the British Thomson-Houston Tungsten lamps. The designs of these cards are quite original and were evolved where the Tungsten lamps are made, at the B.T.H. Works, Rugby.

OBITUARY.

MR. A. H. WRIGHT RADCLIFFE.

The death is announced in London of Mr. A. H. Wright Radcliffe, formerly electrical engineer and contractor to the Corporation of Birmingham, and distinguished in the electrical world. From 1873 until 1892 he was in the service of the Corporation of Birmingham, and at the same time he carried on big contracts with several important railway companies. Mr. Radcliffe was the pioneer of the telephone in Birmingham, and, in conjunction with Professor Bell and the late Mr. Lawson Tait, first demonstrated the use of that instrument in the town on October 29, 1877. He was the first to introduce the use of electricity into coal mines, the initial installation taking place at the Tapton Colliery at Chesterfield in 1868. It may be remembered that on the occasion of the terrible explosion at the Risca Colliery in 1880, Mr. Radcliffe, who was on the spot at the time, gave his opinion—an opinion supported by Sir John Gavey and Sir William Preece—that the explosion was casued by a flash of lightning striking the headgear of the shaft, and thence travelling downwards. This theory was hotly contested at the time, but was eventually proved to be correct, and thus a new field of observation was opened up. Mr. Radcliffe was born at Chorley in 1837, and educated at Manchester Grammar School. During the Indian Mutiny he was for a time at Windsor Castle in charge of a special installation of telegraphic apparatus, placed there for the use of her late Majesty, Queen Victoria.

MR. G. CZOLBA.

The death occurred at Guadalajara, Mexico, of Mr. G. Czolba, engineer in charge of the construction of the transmission line of the Chapala Hydro-Electric and Irrigation Co., Ltd. He was 32 years of age and leaves a wife and child.

MR. F. SEDDON BOLTON.

Mr. Francis Seddon Bolton, of Edgbaston, Birmingham, and who was largely interested in the Kingsland electric traction system, passed away at the age of 81 years.

ELECTRICAL RULES FOR MINES.

COMPLAINT AGAINST COLLIERY MANAGERS.

At Dunfermline Sheriff's Court C. A. Carlow and H. Rowan, described as "managers and agents" appointed by the Fife Coal Co., were charged with having, between April 1 and August 7, permitted the use at the Co.'s Foulford Pit, Cowdenbeath, of electrical plant and apparatus which were not conform to the electrical special rules. W. E. Richardson, the certificated colliery manager at Foulford Pit, was also charged under a similar complaint.

Mr. R. S. Horne, advocate, Edinburgh, appeared for the respondents, who pleaded "Not guilty."

C. A. Carlow was called as a witness against Richardson, and Mr. Horne elicited his position in the Fife Coal Co. Mr. Carlow said he was responsible to the Board of Directors for the management of the affairs of the Company, but not responsible under the Mines Regulation Act. At every colliery where there was an electrical installation there was a man more or less skilled in electricity, and nine months ago the Company had appointed a Mr. Fraser, an electrical engineer, who was specially trained in colliery work, to have charge of all electrical plant. A year and a half ago they had commenced a process of making all the machinery conform to the rules independent of any instructions from the Mines' Inspectors, and during that time they had scrapped machinery to the value of thousands and thousands of pounds.

H. Rowan, examined by Mr. J. S. Soutar (Procurator-Fiscal), said he was an "agent" for the Foulford among other pits. He had not heard of Mr. M'Laren's letters of complaint dated January and May until the present proceedings were instituted.

In reply to Mr. Horne, witness asserted that Mr. C. A. Carlow had nothing whatever to do with seeing the rules enforced in the pits. Two years before Mr. M'Laren had directed the Company to make the machinery conform with the special rules he had given instructions to that effect, and when Mr. M'Laren wrote the improvements were still proceeding. From October, 1908 to January, 1909, between £300 and £400 had been spent on the plant at Foulford Pit, and what was complained of involved very little expense. The complaint was attended to immediately on his attention being drawn to it in August.

Robert M'Laren, Inspector of Mines for the Eastern District, said that just prior to his sending his January letter a case had been tried in Dunfermline, and the Sheriff held that notice should have been sent to the owners to comply with the regulations. He at once sent notices to 37 owners, among them being the Fife Coal Co. If Mr. Carlow, junr., had taken the trouble to look at the back of his notice he would have discovered that a number of pits, including Foulford, were specified.

Mr. Horne objected to this evidence, because in the letter in process there were no pits named, and the Sheriff upheld the objection.

Mr. Horne: As a Government Inspector, are you here to say that your assistants informed you of defects in electrical plant in Foulford Pit prior to January 30 and you have no note of these?

Witness: I do not have them here, but I have them at home.

Mr. Horne: Give me the date when you first got information from an assistant with regard to any of the matters now complained of.

Witness: 30th April, from Mr. Masterton. He complained that a gate end-box was not earthed, and that electric cables were not properly hung on the roadside. Subsequently he got information about the fuses, switch-box, and abrasions in the cables from Messrs. Nelson and Masterton, who made a joint inspection of Foulford Pit.

Mr. Horne contended that the case had broken down, in respect that more than three months had been allowed to elapse between the time the matters complained of arose and the institution of proceedings.

The Sheriff said that he thought the action admitted of more than one interpretation, and at that stage the proper course for him was to repel the objection, and let it come before the High Court.

John Masterton, Assistant Inspector of Mines, and Robert Nelson, Electrical Inspector of Mines at the Home Office, spoke to visiting Foulford Pit, and detecting the matters referred to in the complaint. Mr. Nelson said that he thought the inspection and maintenance on the part of the Company were inadequate.

The case for the prosecution then terminated. The Court adjourned until December 6.

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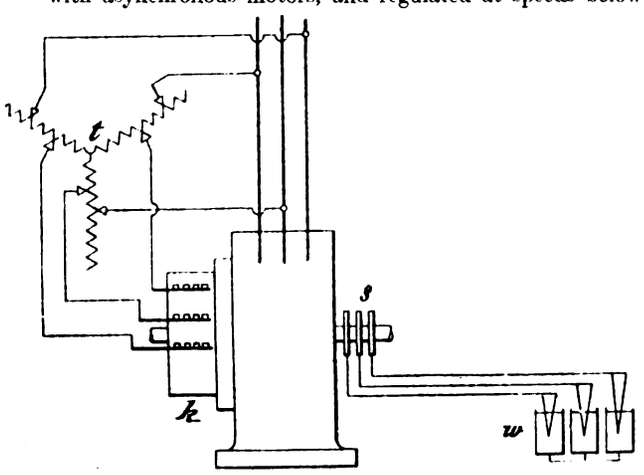
PATENTS.

Control of Polyphase Motors.

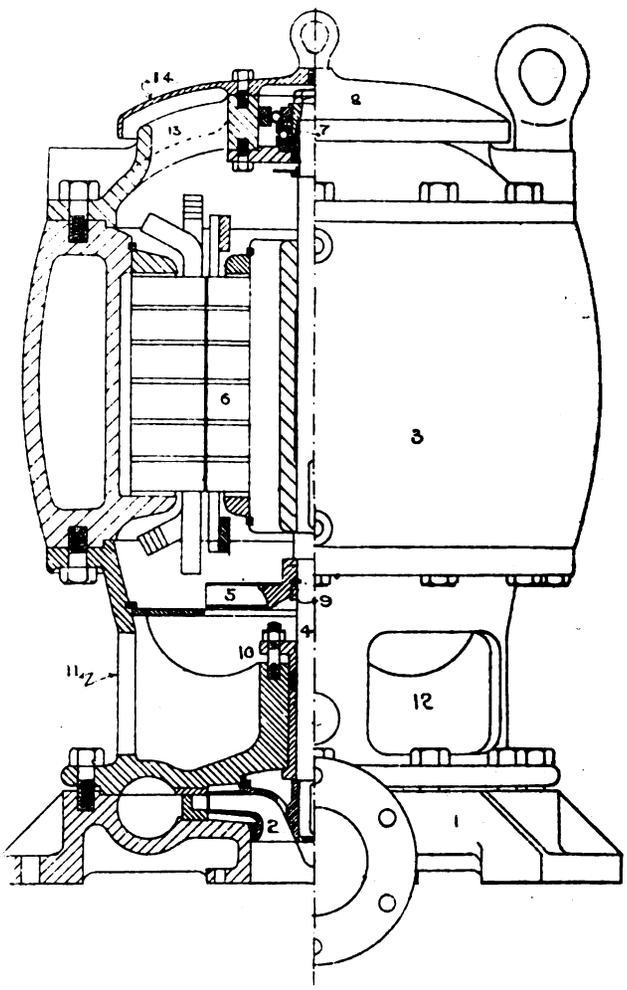
17370.—1909. The British Thomson-Houston, Co., Ltd., London. This is an improved method of speed regulation whereby the speed may be efficiently controlled over a range varying between plus and minus 20% of the synchronous speed. If it is desired to build polyphase commutator machines for 20% speed regulation they would spark badly at starting even with a reduced impressed voltage, and in order to obtain efficient and satisfactory starting of the machines it is necessary to employ large commutators, and this at present prevents machines being built larger than about 200 h.p. In the invention polyphase commutator machines are controlled by starting them as asynchronous induction motors, and after having attained a pre-determined speed the induction motor connection is broken and regulation of the machine then effected as a commutating motor. In the diagram the motor is only converted from an induction into a commutator motor in the neighbourhood of synchronism, but at starting, that is to say, at speeds much below synchronism, the motor is connected as an asynchronous motor with the commutator brushes raised, and is started and regulated as an asynchronous motor. The drawing shows a three-phase motor provided with slip rings *s* and a commutator *k*. The latter is, for example, fed from the line through a regulatable transformer *t* to which the stator is directly connected. By means of the resistance *w* the motor—with raised commutator brushes—is started in the manner customary with asynchronous motors, and regulated at speeds below



that of synchronism. At a determined speed the brushes are placed on the commutator and the resistance *w* is interrupted or adjusted to an increased amount. This new connection if only effected when the resistance *w* is already completely or nearly completely short circuited in order to prevent a high potential from the commutator during its employment. After changing the connections the motor can be regulated in the neighbourhood of synchronism by adjustment of potential or by shifting the brushes. The stator potential may be varied to start and regulate the machine as an asynchronous motor in which case, instead of the slip rings and brushes, another short circuiting device for the armature winding can be used. This device may be automatically operated by a fly-wheel regulator in such a way that on the attaining of a certain speed the short circuiting connection of the armature is interrupted. Also the placing of the collector brushes can be effected automatically in a similar manner. In the arrangement above described the commutator brushes must be raised at starting, otherwise the potential which appears at the commutator brushes would be high enough to cause destructive sparking.

Electrically Driven Rotary Pumps.

4928.—1909. A. B. Mallinson, Prestwich. The invention is a method of combining an electric motor and a rotary pump in such a manner that the two stationary components are in one casing and the two rotary components are fixed on a shaft-common to both. By this means all forms of couplings between the motor and the pump spindles are dispensed with, the construction is cheapened, the floor space occupied is diminished, and there is a higher efficiency of the combined machines. The method adopted also affords efficient means for ventilating the motor, and further permits of easy access to the wheel of the pump without any necessity for disturbing the pump body or the pipes connected to it. The diagram shows half in elevation and half in vertical section of this combined electric motor and rotary pump. The rotary pump 1 may be of any usual construction, having its wheel 2 arranged to revolve in a horizontal plane; above the rotary pump 1 is placed the electric motor 3, which is carried, for example, by an extension 11 of the pump body or by supports constituting a rigid connection between the rotary pump and the electric motor. The open spaces 12 in the extension 11 of the pump body, or the similar spaces between the supports employed as an alternative, may be covered with wire netting. The top cover 8 of the motor 3 is constructed with openings 13 to permit of the egress of air, while a cap 14 placed above them prevents the entrance of water which may fall on the outside. The wheel 2 of the pump 1 and the armature 6 of the electric motor are both secured to one and the same vertical shaft 4, which passes through the pump gland 10. The upper end of this is carried in a ball bearing 7



fitted in the top cover 8 of the motor 3. There is also fixed on the vertical shaft 4 a fan 5 which will cause a current of air to be drawn in through the openings 12 over the cold body of the pump 1, whereby the air will be cooled and then blown over and through the magnet windings of the motor 3 and over and through the armature or rotor 6, thoroughly ventilating them and finally escaping through the openings 13 in the top cover 8. The under side of the hub of the fan 5 is provided with an annular disc 9 which will check and throw off any water which may issue from the pump gland 10 and prevent the water from reaching the windings of the motor.

Telephone Exchanges.

6281.—1909. Siemens Bros. & Co., Ltd., Westminster. In telephone exchanges devices have been used by which, when the connecting plug is inserted in its jack or the enquiry switch is returned to normal position, a calling device is automatically connected with the called subscriber's line and is afterwards cut out by a damped relay. With this device at the exchange a call repeated at intervals is not required. Devices are also known in which, by means of a switch driven by the calling mechanism, a repeated call is given and in which the current for this call is cut off by the subscriber called. The present invention is an arrangement for periodically calling the subscriber required in telephone exchanges having two part parallel jacks. In this case the calling relay remains connected with the subscriber's line during speaking connection, and the calling device is automatically brought into circuit by inserting the connecting plug. When the subscriber lifts his receiver the calling current is cut off. The circuit of a relay which connects and disconnects the calling device and the subscribers' line is prepared by a relay having an earthed winding energised by a current which flows over one branch of the connecting cord when the connecting plug is inserted, the circuit being completed in the usual manner by an automatic switch at fixed intervals

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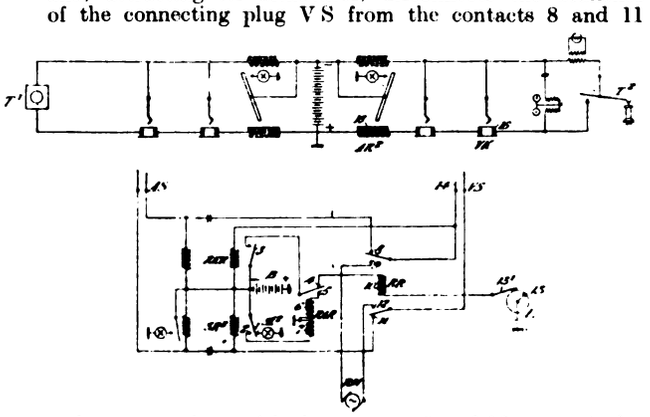
of time. In a previous patent Messrs. Siemens have described a telephone exchange in which, on insertion of the connecting plug, a relay is operated to close the circuit of a second relay, the function of which is to prepare the circuit of a relay that connects and disconnects the calling device and the subscribers' line. It will be seen that the exchange described in the specification fulfils the object of the present invention, but as the purpose of that exchange is to fulfil another object the arrangement is needlessly complicated by the existence of the second relay and also of a fourth relay upon which the completion of the circuit of the relay that connects and disconnects the calling device is dependent. The object is now attained with the use of fewer relays. The diagram illustrates one method. The call from the subscriber for example T^1, the enquiry by means of the enquiry plug A S, and the testing of the line of the required subscriber by means of the connecting plug V S are all effected in the usual manner. After enquiring and testing the line the exchange clerk inserts the connecting plug V S in the jack V K of the desired subscriber T^2. A current then flows from the battery B over winding of the relay R E R, the contact 14 of the plug V S, the socket 16 of the jack V K, and the winding 18 of the calling relay A R^2 to earth; relay R E R being thus energised, closes the contact 3 by attracting its armature. The circuit for the relay R R is now complete except at contacts 13, 13^1 of a switching device E, which consists of a rotating disc having an earthed contact 13 and a spring contact 13^1 pressing against its periphery and connected with the winding 10 of the relay R R. As soon as this periodically operating switch brings together the contacts 13, 13^1, a current flows from the battery B over contact 3, contact 4 of the relay R A R, winding 10 of the calling relay R R and contact 13 to earth; the relay R R is thus energised and, attracting its armatures, disconnects the branches of the connecting plug V S from the contacts 8 and 11



and connects them with the contacts 9 and 12 respectively, and thus with the leads of the calling device R M. In this manner, as long as the contacts 13, 13^1 are in contact, the calling device is connected with the leads of the connecting plug and an alternating current flows over the leads of the subscriber T^2, so that his bell is sounded. As soon as contact 13 leaves contact 13^1 the relay R R is no longer energised and its armatures fall away from the contacts 9 and 12, thus interrupting the bell circuit and return to 8 and 11 respectively. Until the subscriber T^2 removes his receiver and thus causes a continuous current to flow through his apparatus, these conditions remain, so that when the contacts 13, 13^1 meet again the bell is again sounded. However, as soon as the subscriber T^2 raises his receiver, during the calling interval part of the current flowing through his instrument passes by way of the plug V S and contact 11 through the winding of the relay S R^2 so that this relay attracts its armature from contact 1 to contact 2. The lamp S L^2 ceases to glow and the winding 7 of the relay R A R receives current; the armature of this relay is therefore attracted and the circuit for the calling relay R R is broken at contact 4, so that the bell circuit cannot again be closed. Simultaneously with the interruption of contact 4, contact 5 is closed, which puts into circuit the winding 6 of the relay R A R and thus provides a holding-on current for this relay R A R over the armature and contact 3 of the relay R E R. Since this holding-on circuit is independent of the receiver of the subscriber T^2 it remains completed even after the receiver has been again hung up and lamp S L^2 has begun to glow again owing to the de-energising of relay S R^2; hence relay R R remains without current after conversation is finished and the call bell circuit is not again completed. When the connecting plug V S is withdrawn from the jack V K, the relay R E R is de-energised and contact 3 is opened, so that the normal position is restored.

Insulating Former Wound Coils.

16985.—1909. Siemens & Halske, Aktiengesellschaft, Berlin. The strips of paper used for insulating the separate layers of self-contained former wound coils are provided with a rim. A strip of cardboard is inserted in the rim, whereby the strip is strengthened. Moreover, the windings are prevented from slipping sideways, and, further, the various layers can be made the same width.

Insulating Process for Electrical Machines.

19263.—1908. Felten & Guilleame, Lahmeyerwerke, A.G., Frankfort-on-Main. The parts to be insulated are coated with a layer of plastic material, which by subsequent treatment can be converted into a solid mass. Solutions of rubber or acetyl cellulose are two substances that may be advantageously employed for the purpose.

Limiting the Supply of Electrical Energy.

21779.—1908.—G. Wilkinson, Harrogate. The apparatus has a pair of contacts for opening and closing the electrical device. One of these contacts is actuated directly by the expansion and contraction of a wire forming a part of the circuit. The metal part of the instrument is constructed of metal having the same co-efficient of expansion as the wires themselves, whereby the mechanism is not unequally affected and disturbed in working by the changes in temperature.

Distribution of Electricity by Means of Transformers.

21955.—1908.—J. P. Annacker, London. The object is to obviate the loss of current which arises when no current is being taken from the secondary side of the transformer. For this purpose a second transformer is employed, the primary of which is across the mains of the primary side of the main transformer. The secondary of the second transformer is connected through a solenoid coil and relay winding across the main transformer. The action of the second transformer is such that when current is required from the main transformer suitable magnets are energised which switch on the primary winding of the main transformer across the supply mains.

Draining Manholes of Electric Circuit Systems.

23716.—1908.—D. Livingston & A. J. Smith, Boston, U.S.A. A main suction pipe, with a suction pump, extends through the conduit system. Each manhole has a suction pipe near the bottom fitted with a valve which is actuated by the rise and fall of the water.

Controllers for Electric Motors.

25721.—1908.—A. West, London. The controller has a plurality of contact discs disposed upon a common shaft. The discs are cut away where the contact is not required. These sections of disc cut in or cut out the resistance by a series of steps as required. A small auxiliary switch is provided at the breaking points where the sections leave the clip. The switch is held by the clips until a spring is so compressed that the auxiliary switch is thrown out with a positive quick movement. The auxiliary switch is sufficiently strong to carry the current for some time, so that the operator may leave the handle at the breaking point or move the handle of the controller slowly at any point without danger of arcing.

Receiving Installations for Wireless Telegraphy.

15354.—1908. W. Burstyn, Berlin. The installation is intended to collect through a certain period of time the small momentary energy which is available at the receiver, and then to bring the collected energy into operation. For this purpose a detector of the known kind is used, which is excited by the open or closed vibration circuit taking up the waves and either produces from the vibrations a continuous current by means of a rectifier, such as a Wehnelt tube or indirectly by a heat effect such as a thermo element, or releases such continuous current by an electrolytic cell and bolometer. This weak but lasting current is stored up in an accumulator and discharged from time to time through the indicating instrument.

Storing and Distributing Alternating Currents.

22044.—1908. A. M. Taylor, King's Heath. The primary object is the reduction of the cost of electrical energy purchased from an electricity supply undertaking. The object is obtained by producing means whereby the load circuits of any consumers of electrical energy can be disconnected from the system of supply during certain hours of the day when the load on that system is heaviest, and, therefore, can be supplied at a greatly reduced price during the other portions of the day. A battery unit having an E.M.F. which is a fractional part of that required for the low tension alternating current load circuits is installed to provide the electrical energy required during that portion of the day when disconnected from the system of supply. Each battery consists of a small number of cells of as great a capacity as necessary for the needs of the consumers' load circuits. Each battery unit is charged and discharged by means of a rotary transformer, which receives its supply from the high tension alternating current system, which it converts into direct current energy at a pressure suitable for the needs of the battery. The transformer acts reversibly as an alternating current generator when direct current energy is supplied.

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COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last prices. £
British Insulated and Helsby Cables, Ord. 1-100,000	5	7-7¼
—— 6 p.c. Cum. Pref., 1-100,000	5	6¼-6¼
—— 4½ p.c. Mortgage Debentures	100	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100	89-94
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 1-200,000 and 275,001-475,000	3	¼-⅜
—— 4 p.c. Mortgage Debenture Stock	100	48-52
Callender's Cable, Debentures	100	105-107
—— Ordinary	5	10-10¼
—— 5 p.c. Pref.	5	5¼-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1	¾-1
Dick, Kerr, and Co., Ordinary, 1,260,000	1	1-1⅛
—— 6 p.c. Cum. Pref., 1-305,000	1	1-1⅛
—— 4½ p.c. Debenture Stock	100	100-103
Edison and Swan United, "A" Shares, 1-99,261	3	⅝-⅞
—— "A" Shares, 01-017,139	5	1-1⅛
—— 4 p.c. Deb. Stock, Red	100	66-71
—— 5 p.c. 2nd Debentures	100	81-84
Electric Construction, Nos. 1 to 112,100	2	¾-⅞
—— 7 p.c. Cumulative Pref.	2	1¼-1⅜
—— 4 p.c. Perp. 1st Mort. Deb.	100	62-67
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100	68¼-74¼
General Electric Company (1900) 5 p.c. Cum. Pref.	10	8-8¼
—— 4 p.c. 1st Mort. Deb. Stock	100	83-87
W. T. Henley's Telegraph Works, Ordinary	5	12-12¾
—— 4½ p.c. Preference	5	5¼-5⅝
—— 4½ p.c. Debentures	100	106-108
National Electric Construction Co., 1-170,000	1	⅜-½
Telegraph Construction and Maintenance	12	34½-36
—— 4 p.c. Bonds	100	101-103

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Bournemouth and Poole, Ordinary	10	9½-10
Brompton and Kensington, Ordinary	5	6¼-7¼
—— 7 p.c. Preference	5	6¼-7¼
Canadian General Electric Co., Common Shares	$100	114-119
—— 7 p.c. Cum. Pref. Stock	$100	116-119
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100	97-100
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5	3¾-4¼
—— 4½ p.c. Cum.. Pref., 1-80,000	5	4¼-4¾
—— 4 p.c. Debenture Stock, Red.	100	98-101
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5	3¾-4¼
City of London, Ordinary	10	10 10¼
—— 6 p.c. Cumulative Pref.	10	11¾-12¾
—— 5 p.c. Debenture Stock	100	121-124
—— 4½ p.c. 2nd Deb. Stk. Red.	100	100-103
County of Durham Electrical Power Distribution Co., Ordinary, 1-50,000	5	1¾-2
—— 5 p.c. Preference, 1-50,000	5	2¾-3¼
County of London Elec. Supply, Ordinary	10	7¾-8
—— 6 p.c. Cum. Pref.	10	10¾-11¼
—— 4½ p.c. Debentures Prov. Certs. Al pd., Rd.	100	105-108
—— 4½ p.c. 2nd Debentures, Red	100	98-101
Edmundson's Electricity Corporation, Ord., 1-80,000	5	⅜-5/16
—— 6 p.c. Cum. Pref.	5	¾-⅞
—— 4½ p.c. First Mort. Deb.	100	57-60
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100	91-94
Kalgoorlie Electric Power and Lighting, 6 p.c. Non. Cum. Pref., 1-150,000	1	⅝-11/16
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000.	5	7-7½
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100	95-98
London Electric Ordinary	3	1¼-2
—— 6 p.c. Pref.	5	4¼-5¼
—— 4 p.c. 1st Mortgage Debenture Stock, Red.	100	93-97
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	50-55
Metropolitan Ordinary, 100,001-300,000	5	3¾-4¼
—— 4½ p.c. First Mortgage Debenture Stock	100	106-109
—— 4½ p.c. Cum. Pref.	5	4¾-5
—— 3½ p.c. Mortgage Debenture, Red.	100	83¼-86¼
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,050 ($500) M 1-4,400 ($1,000)	—	80¼-82¼%
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb. Red	—	98-100
Newcastle-upon-Tyne Electric Supply, Ord., 1-50,000 and 57,010 to 137,500	5	4-4¼
—— do. 50,001 to 57,009	5	4-4¼
—— do., 5 p.c. Pref., 1-137,500 Non. Cum.	5	4¾-5¼
Notting Hill Electric Lighting	10	12¼-13¾
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	6-6¼
—— 4 p.c. Debenture Stock	100	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1	1¼-1⅜
—— 6 p.c. Non-Cum. Pref., 1-100,000	1	1⅜-1⅞
—— 5 p.c. Debenture Stock, Red.	100	103-106
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5	5¼-5½
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5	6¼-6⅞
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	—	105¼-107½%
Smithfield Markets Electric Supply, Ord., 1-12,000	5	¾-1⅛
South London, Ordinary	4	2¾-3
South Metropolitan Electric Light and Power Ord.	1	5/16-9/16
—— 7 p.c. Cum. Pref.	1	1 1/16-1 3/16
—— 4½ p.c. 1st Mort. Deb.	100	100-103
St. James's and Pall Mall, Ordinary, 101-20,080 and 40,081 to 60,100	5	8¼-9
—— 7 p.c. Pref. Non. Cum.	5	7-7¼
—— 3½ p.c. Deb.	100	84-88
Urban Electric Supply Co., Ordinary	5	¾-⅞
—— 5 p.c. Cumulative Preference, 50,001-100,000	5	1⅛-1⅜
—— 4½ p.c. First Mort. Debenture Stock, Red.	100	7⅛-7⅝
Westminster, Ordinary	5	8⅛-8⅜
—— 4½ p.c. Cum. Pref., 110,101-191,879	5	4¼-5¼

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 5 p.c. Cum. 1st Pref., 1-640,000	5	4 7/16-4½
—— Debenture Stock, Red	100	90-91½
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1	¾-⅞
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1	¾-⅞
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	87-90
British Columbia Electric Railway Co., Ord. Def.	100	144-149
—— Ord. Pref.	100	121-125
—— 5 p.c. Cum. Perpetual Pref. Stock	100	107-110
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	102-104
—— 4½ p.c. Vancouver Power Deb.	100	102-105
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10	⅞-1
—— 6 p.c. Cm. Pf., 30,001-60,000	10	2¼-2⅜
—— 5 p.c. Perpetual Debenture Stock	100	84-87
—— 4½ p.c. 2nd Deb. Stock	100	58-62
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100	97-99
Calcutta Tramways, Ord., No. 1 137,610	5	4¼-5
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5	4¾-5
—— 4½ p.c. 1st Deb. Stock, Red.	100	101-104
Cape Electric Tramways, Nos. 1-491,222	1	3/16-7/16
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5	4¾-5¼
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100	96-100
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5¼-5¾ xd
—— 4 p.c. Deb. Stock, Red. (1985)	100	98-101
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12¾-13¾
London United Trys (1901) 5 p.c. Cum. Pref.	10	2¾-2⅞
—— 4 p.c. 1st Mt. Db. Stock, Red.	100	67-70
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	1/32-3/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1	1⅛-1⅜
—— 4½ p.c. Deb. Stock, Red.	100	93-96
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100	100¼-103¼
Provincial Tramways Co., Ordinary, 1-24,912	10	4-4¼
—— 6 p.c. Cum. Pref., 1-10,000	10	10-11
San Paulo Tramway, Light, and Power Co.	$100	153-156
—— 5 p.c. 1st Mort Deb, Red. (1929) 1-12,000	$500	102-104
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1	¾-⅞
—— 4 p.c. Deb. Stock, Red. (1940)	100	69-73
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5	¼-⅜
—— 6 p.c. Cum. Pref., 1-46,261	5	1¾-2¼
—— 4½ p.c. 1st Deb. Stock, Red.	100	81-85

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100	61-63
—— 4 p.c. Pref.	100	84-86
—— " " deferred	100	44-46
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	101-103
City and South London, Consolidated Ordinary	100	29½-30½
—— 4 p.c. Debenture Stock	100	100-102
—— 5 p.c. Pref. Stock '91	100	108-110
—— " " " '96	100	104-107
—— " " " '01	100	100-103
—— " " " '03	100	96-100
Underground Electric Railways of London, 5 p.c. Prior Ln. Bds.	—	100-101

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price £
Amazon Telegraph Co., 1-25,000	10	3-3¼
—— 5 p.c. Debs., Red., within 1-1,609 Red	100	99-102
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000	96-98
Anglo-American Telegraph Co., Ordinary	100	60-62
—— 6 p.c. Preferred Ordinary	100	101-102
—— Deferred Ordinary	100	21¼-22¼
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100	87¼-89¼
Direct Spanish Telegraph Co., Ordinary	5	3-3¼
—— 10 p.c. Cum. Preference	5	8-8¼
—— 4½ p.c. Debs., 1-600	50	100¼-102¼
Direct United States Cable Co.	20	13-13¼
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 p.c. Mort. Debs., within 1-8,000 (1913)	25	99-101
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	—	—
Eastern Extension, Australasia and China, 1-300,000	10	11¾-12¼
—— 4 p.c. Mort. Deb. Stock, Perp.	100	102-104
Eastern Telegraph Co., Ordinary Stock	100	126¼-129¼
—— 3½ p.c. Preference Stock	100	84-86
—— 4 p.c. Mortgage Debenture Stock	100	102-104
Great Northern Telegraph Co. (of Copenhagen)	10	28¾-29¾
Marconi's Wireless Telegraph Co., Nos. 1-394,190	1	⅞-1
National Telephone, Preferred	100	107-108¼
—— Deferred Stock	100	120-122
—— 6 p.c. Cum. First Pref.	10	10¾-11
—— 6 p.c. Cum. Second Pref.	10	10¼-10⅝
—— 5 p.c. Non. Cum. Third Pref.	5	5¼-5⅜
—— 3½ p.c. Deb. Stock, Red.	100	98-100
—— 4 p.c. Deb. Stock, Red.	100	100-102
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100	100-102
West Coast of America, 1-30,000 and 53,001-53,008	2½	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	100-102
West India and Panama Telegraph Co., Ordinary	10	⅞-1⅛
—— 6 p.c. Cum. 1st Preference	10	9-9¼
—— 6 p.c. Cum. 2nd Preference	10	9-10
—— 5 p.c. Debs., Red., 1-800	100	102-104
Western Telegraph Co., 1-207,930	10	12¾-14
—— 4 p.c. Debenture Stock, Red.	100	103-106

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THE Electrical Engineer.
A JOURNAL OF ELECTRICAL ENGINEERING.
WITH WHICH IS INCORPORATED "ELECTRIC LIGHT."

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NOTES.

DURATION OF METALLIC FILAMENTS.

Mr. F. H. Reakes Lavender placed before the Birmingham Section of the Institution of Electrical Engineers an extremely valuable paper, giving the results of personal researches in metallic filament lamps. The comparative tests were most carefully carried out. As regards tantalum lamps, he says that, "taking current at 5d. per unit as an average price, and the lamps run at rated voltage, then it pays to throw the lamp away as soon as the candle-power has fallen to 3% below its original value. This result appears startling at first, considering the large initial cost of the lamp. However, by the time this point is reached the lamp has been burning for 1,500 hours at the best possible efficiency for the given potential difference at its terminals, so that the cost of the lamp per candle-power hour has become small." He found that if lamps are run at a low voltage, though slightly less efficient, they last much longer. He says that in practice it is good policy to overrun the lamps from 2 to 6%. With tantalum lamps there is a slight rise of efficiency, then a slow drop to the end, the rapidity of the drop being largely dependent on the voltage. With tungsten lamps there is little rise of efficiency from the initial stage, often a drop from beginning to end, the drop at first being rather sudden, then slow and steady. As might be expected, the tests are all in favour of metallic as against carbon filament lamps, this being the more apparent the higher the price of current.

MENDING FILAMENTS.

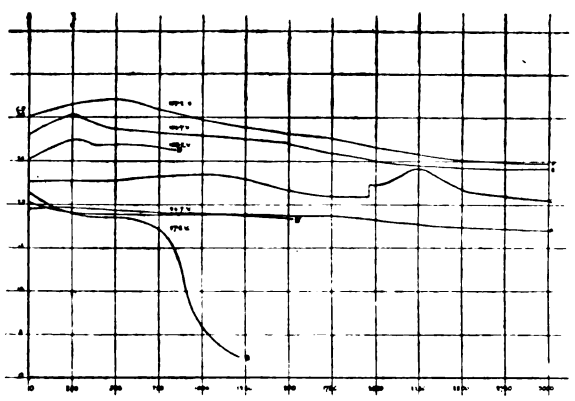
Mr. Lavender gives due credit to manufacturers for their successful efforts to overcome the rather excessive brittleness of the metallic filaments, partly by toughening the filament and largely by better methods of distributing and anchoring them. He remarked that the life of a damaged lamp may be prolonged by an easy method of mending. This is done by carefully shaking the lamp while alight until the loose end comes into contact with another part, when the circuit is direct and the parts welded. This can be done with both tungsten and tantalum lamps, but it is not very effective in the latter case, partly, he thinks, because of the shortness of the loops and consequent increased mechanical strain on the point, and partly owing to the lower temperature. Whatever the cause, such welded tantalum filaments always remain extremely fragile. Normally, however, tantalum are tougher than tungsten lamps.

VARIATIONS.

As regards variation of candle-power, this was altogether in favour of the metallic filaments. The various series of lamps were run with a variation of 3% and above normal voltage. While the metallic filament lamps showed a candle-power variation of from 20·9 to 23·4, that of carbon filament lamps showed a variation of 34%.

TUNGSTEN LAMPS.

There is no secret in the matter that the tungsten lamps used for these tests were Boddy's "Metalik," and it will be interesting to give particulars of the high results obtained. Clear bulbs were used, the voltage was 100, watts 32. Six lamps were taken and run at six different voltages, namely, 95, 97·5, 100, 102·5, 105, 107·5 volts respectively. They were burnt continuously night and day, week-ends included. In the daytime energy was obtained from the University power station off the 110 volt lighting-mains. At night (for about 17 hours) the lamps were switched over on to the battery. The lamps were run as far as possible under the usual commercial conditions. No special automatic voltage regulation was used. The lamps were suspended from flexible cable, 9 in. apart. They were taken out of their holders and into an adjoining room to be photometered twice a week. A Bunsen grease-spot photometer was used with a scale of 400 cms. The c.p. measured was the horizontal in one direction. The lamps were always fixed in the photometer stand in the same position with regard to the standard lamps. The



pip end of the bulb was at the top. A sheet is appended showing the life curves obtained from the lamps. The actual voltages at the lamp terminals were slightly lower than the figures given above, owing to the drop in the flexible leads, etc. The correct values are marked on the curves. With regard to the life of the lamps the following figures were obtained :—

Lamp No.	Votage at terminals	Life in hours.
A	94·7	3,000†
B	97·2	1,500
B^1	97·2	1,225
C	99·6	3,000†
D	102·2	850
E	104·7	3,000
F	107·2	3,000

Lamp No. C fractured after 1,970 hours, but the filament was welded together again. The accompanying diagram gives the results in a very striking manner.

LIGHTING CONTRACT RATES.

Appropriately enough Mr. G. Wilkinson opened the discussion on Messrs. Handcock and Dyke's paper, for Harrogate has had a remarkable experience. There the small consumers are charged a fixed rate of 11s. per lamp per annum, this being fixed with the avowed purpose of bringing the advantages of electric lighting and the metallic filament lamp within the reach of the less wealthy members of the community. As the result of their policy the Corporation has secured the cream of the total possible business, and the slump following the introduction of the metallic filament has ceased, as the total number of units generated within the last seven months has been only 2% less than the amount sold during the corresponding

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period of the previous year. Yet they had added 622 lamps during the month of October. It appears that even if a consumer used his lamps for eight hours a day the undertaking did not lose under the contract system. Mr. Pearce, of the Electric Cable Supply Co., raised the point that it was difficult to keep the cost of wiring below £1 per customer, but he acknowledged that his company had laid down 6,000 lamps as a direct outcome of the cheapening of the consumers' lighting bill. Dr. Gisbert Kapp took the view we advanced last week in these notes, that the paper would help to develop the electrical industry.

NATIONAL INDUSTRIAL EDUCATION LEAGUE.

Mr. R. Applegarth, who was so long associated with the Right Hon. W. E. Forster and the Right Hon. A. J. Mundella in furthering popular education, and so well known in connection with industrial enterprise and progress, is taking steps to organise a National Industrial Education League. The idea is to organise public opinion so as to secure for boys before leaving the primary schools a sound elementary industrial training, whereby they would be fitted to follow, with credit to themselves and with benefit to the nation, such occupations as they were best fitted for. It is a thoroughly practical notion, and one which all who are interested in national welfare will welcome. Certainly many of those busy with the different phases of electrical industry constantly feel that our present system of national education is lacking, owing to this very fact that boys are kept long at the desks without being trained to use their hands, eyes and intelligence in the actual making of things. We wish well to Mr. Applegarth's efforts and will do all that lies in our power to further them.

BRITISH CARBONS.

It is satisfactory to know on the authority of Mr. McKenna, M.P., that all the carbons used by the Admiralty for electric searchlights are of British make, and that the manufacturers in this country are equipped to meet with any sudden demand. As a matter of fact, the efficiency of our manufacturing side is far greater than scaremongering Members of Parliament would, for their own fell purposes, lead the innocent public to believe. Where we are somewhat amiss is in the organisation of our marketing arrangements, more especially as regards the export trade.

TELEGRAPHING PICTURES.

In another column a brief abstract of Mr. T. Thorne Baker's paper on the art of telegraphing pictures will be found. It is not a little remarkable that so long ago as in 1847 Bakewell had successfully invented a process for transmitting pictures by telegraph. But he was in advance of his time, for then the quickest way of reproducing pictures was by wood engraving. Practically Mr. Baker's system is based on that of Bakewell. But, and there is the splendid advance, Mr. Baker has succeeded in reducing the time for preparing a film to 25 min., and the time for adjusting the film to the transmitter to 30 sec. Greater things are, however, in store, for Mr. Baker is busily trying to solve the problem of transmitting pictures by wireless telegraphy. If he succeeds, then we may actually witness reproductions of scenes taking place in New York within a few hours of their occurrence.

ELECTRIFIED TRAMWAY TROLLEY STANDARDS.

It will be remembered that in May last a passenger on the Wolverhampton District Electric Tramway met his death from electric shock, probably as the result of his head lying against the iron back of the seat, and his hob-nailed boots being in contact with the trolley standard, which had become electrically charged. Apparently there was no abrasion of the insulation, but the fault was attributed to the presence of a chip of metal in the taping with which the brass bolt was insulated. Unfortunately, the "red lamp warning" failed owing to a discontinuity of the wiring of the lamps. The Board of Trade now advise a daily testing to see that the trolley standard insulation is in order, and the adoption of a magnetic blow-out fuse giving an audible signal. Pending the adoption of such an equipment, the Board suggest that the lamps should be bridged with a suitable fuse, and the whole signal device tested at least once a week.

TRACKLESS TROLLEY SYSTEM.

It is with regret that we notice, from a return recently issued, that in no less than five instances where local authorities or companies sought Parliamentary consent to tramway schemes, while the general schemes were sanctioned, the clauses seeking powers to adopt the trackless trolley system were struck out.

FARTHING FARES.

The British Electrical Federation are putting forward a novel scheme of charging for tramway rides, mainly with a view to popularise tramways by making the "fares fair." It is pointed out that while a uniform penny fare is economically impossible, the present almost universal system of arranging penny stages often leads to unfairness, and, consequently, to a less frequent use of tramways. The idea put forward is to make an initial charge of one penny, but to mark off the stages into quarters, each such division being charged for at the rate of a farthing. It is held that in this way many more people would use tramways, both for long and short distances. The question of change would be got over by issuing books of tickets, which would be taken by conductors in payment. One result of this would be, of course, to give rise to an enormous increase of stoppages between stages. This would probably entail delay, and also extra wear to the mechanism of rolling stock and of the rails. After all, the fast electric tramway cannot be run economically on the same principles as omnibuses. While they have their advantages, they also have certain limitations, which, by the way, do not apply to the trackless trolley system.

ELECTRIC HOUSE, CATFORD.

It is difficult to conceive of a more direct way of bringing the magic of electricity to the intimate attention of householders than that adopted by the South Metropolitan Electric Light and Power Co., Ltd., who have equipped a ten-roomed villa, "Electric House," 111, Bromley-road, Catford, from basement to garret with electricity. The villa is actually in occupation, so that it is run on the normal domestic lines, but with the inestimable boon of carefully wired rooms, whereby current can be put to every device to save labour and ensure comfort. The kitchen is fitted with electric ovens and other cooking apparatus; water ranging in temperature from tepid to boiling is on tap in kitchen, scullery, bed, and bath rooms by means of "Thermol" and kindred appliances. There are electric radiators, stoves, and foot-warmers, electrically-driven fans, irons and sewing machines with electric attachments, urns and coffee pots in the dining room, shaving water pot, curling tongs and electrically-heated hair drying combs upstairs, cigar lighters, and small motors for various domestic purposes; while each room shows a different method of effective lighting. To the housewife and her handmaiden "Electric House" will bring constantly recurring new and delightful revelations. Consequently, it should prove good business.

EUROPE'S HYDRAULIC POWER.

According to Herr Koehn, Europe's available hydraulic power is distributed thus: Austria, 6,460,000 h.p.; France, 5,857,000 h.p.; Germany, 1,425,900 h.p.; Great Britain, 965,000 h.p.; Italy, 5,500,000 h.p.; Norway, 7,500,000 h.p.; Sweden, 6,750,000 h.p.; Switzerland, 1,500,000 h.p. No statistics are available so far as Russia is concerned, or as regards the Balkan States, where, however, there are great possibilities.

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LONG DISTANCE TRANSMISSION ON OVERHEAD LINES.*

By PROFESSOR E. W. MARCHANT, D.Sc., Member, and E. A. WATSON, M.Sc., Student.

The transmission of electrical energy over long distances is a problem which, not unnaturally, has received far greater attention in America than on the Continent of Europe. The plentiful supply of cheap coal in England has rendered the consideration of long-distance transmission schemes almost unnecessary, since, in most cases, it is as cheap to carry coal as it is to transmit electrical energy. In a country, however, where coal is not plentiful, but where water-power is abundant, and where it is possible to obtain wayleaves at a reasonable rate, transmission of electrical energy becomes economically possible over very long distances.

The two great developments which have taken place within the past few years are located respectively at the Niagara Falls and on the Pacific slope of Western America. At Niagara there is a very large supply of water, estimated to produce a total horse-power of from 7 to 10 millions, and, at the present time, there are five power stations for the supply of electrical energy, giving a maximum output of 320,000 h.p. These supply power over a distance of 150 miles. Very shortly this distance will be extended to 250 miles, and a system of distribution will be in operation which, if it were installed in England, would supply the whole country with the electrical energy it required from one central station.

The effect of this vast source of power on the industrial development of the district in which it is placed has been

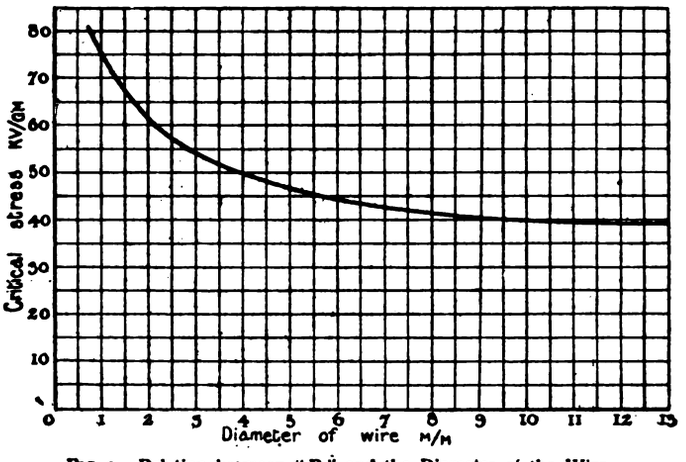

FIG. 2.—Relation between "R" and the Diameter of the Wire.

enormous. The great manufacturing city of Rochester receives all its energy from Niagara, while the tramways of Syracuse, Geneva, West Seneca, the interurban lines Syracuse, Lake Shore and Northern, Syracuse and South Bay, Rochester and Geneva, Rochester and Mount Monir, Buffalo, Lockport and Rochester, Buffalo and Hamburg, and Buffalo and Dunhill, all obtain their supply of power from the same source. In Canada, Toronto is now using Niagara power for its tramways and lighting, and a project is in course of completion for extending the transmission to Hamilton and London. At the present time it is estimated that a population of 40 million people reside within the area which represents the field of distribution for Niagara Falls, and in future years, as the electrification of the railways progress, it is certain that the Niagara district will become an unrivalled centre for manufacturing industries. The transmission of power from Niagara represents an almost unique case, since in no other single place in the world (except possibly at the Victoria Falls of the Zambesi) is there located so vast a supply of power.

On the Pacific Coast the problem has been of an entirely different character. Large towns have sprung into existence chiefly as the result of mining and agricultural enterprise, and as fuel is expensive the supply of electrical energy for lighting and tramways from water-power has led to the development of many comparatively small powers, the energy from which is distributed sometimes, for as great a distance as 250 miles. The chief centres of power supply on the Pacific Coast are the Puget Sound District, containing Vancouver, Seattle, Tacoma, and the other cities in the vicinity, and that in the neighbourhood of San Francisco. A similar state of affairs exists in Colorado, where, for example, a water-power of only 10,000 k.w. has been developed for the supply of electrical energy to the city of Denver, 160 miles distant.

One of the most interesting of these systems is that for the supply of electric power to the city of San Francisco, which is under the management of the Pacific Gas and Electric Co. No less than eleven water-powers are connected to this system, some of only 100 k.w. capacity, the power for which is obtained from water used for irrigation purposes; these are coupled in parallel on a single network, covering in all an area of 30,000 square miles, extending nearly 250 miles along the Pacific Coast, and supplying power and electric light to the towns and villages within its district. The total length of 60,000 volt overhead line on this network is over 1,000 miles. Such a system as this would only seem to be economically possible in a district where fuel was exceptionally dear, and it is interesting to note, therefore, that although coal is far from plentiful, there is a large supply of fuel obtained from oil wells in the neighbourhood of Bakerfield and Los Angeles.

The development of the water-power has not been due entirely to the cost of fuel. A great factor in making these systems a commercial success is undoubtedly the low price of land and the cheap rate at which wayleaves can be obtained; the cost of land given for certain transmission schemes did not exceed £60 per mile of line.

Many water powers, involving large capital expenditure in the conveying of water to the reservoirs, have been developed. The longest distance over which water is carried is at the Electra station, where the distance from the source of supply to the reservoir is 30 miles. There are, however, many other cases in which water is carried several miles before it can be used for power purposes. At Electron the station which supplies Tacoma and Seattle, the water is carried in a wooden flume along the side of the Puyallup Canyon for 10½ miles to the reservoir. At Island Bar the new station of the Great Western Electric Power Co., water has to be brought through a concrete-lined tunnel 2½ miles long, while at the Centerville station of the Pacific Gas and Electric Co. the water is conveyed in an open ditch for a distance of 9 miles from the tail-race of the station at De Sabla.

A study of these stations makes it evident that many water-powers in this country which have hardly been considered as of practical utility may ultimately be developed, to the great benefit of the surrounding district, provided that the necessary wayleaves for the transmission lines can be obtained at a reasonable rate. In this connection too great emphasis can hardly be laid on the advantage which a new country possesses in having land which can be used for purposes of this kind without payment of heavy dues, though it may be hoped that even in this country, when the great economic and industrial advantages of a cheap supply of electrical energy are thoroughly understood, it may be possible to use transmission lines over distances much greater than have hitherto been attempted. The standing charges involved in the payment of wayleaves is a very heavy tax on a station, particularly in a small station such as most hydro-electric stations must necessarily be in England.

In order that economical transmission of electric power may be made over long distances it is, of course, necessary that a high voltage should be employed. The standard pressure at present in use is 60,000 volts 3-phase. This pressure is used nearly all in transmissions of 50 miles and over, and appears to give rise to no practical difficulties in operation. The first station to use this pressure was put in operation almost five years ago, and among the earliest are the station of Electron, on the Puget Sound, and that at the De Sabla River in California. The transmission lines for this pressure are entirely overhead and are run with a clearance of 6 ft., the insulators being usually supported on wooden poles. In several cases stations have been designed for pressures up to 110,000 volts; in many of these, lower pressures are being used until the load on the station is sufficiently large to necessitate the higher pressure being employed. The station at Island Bar commenced operation at 110,000 volts on

* Abstract of paper submitted to Institution of Electrical Engineers, Manchester Section, Nov. 30.

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October 1, 1909, along its transmission line of 153 miles, while that of the Central Colorado Power at Shoshone has been in operation at a pressure of 90,000 volts since May, 1909. The efficiency of transmission over these distances is usually figured at 90%, and it can, of course, be maintained nearly constant as the load on the station increases by raising the working pressure.

Higher voltages are undoubtedly possible at the higher altitudes of Colorado and the Nevadas than could be used on similar installations in our great manufacturing districts; but, allowing for all effects of climate and atmosphere, there is no doubt that there is no great technical difficulty involved in the use of much higher voltages than have hitherto been attempted in this country.

Technical Considerations.

(*a*) *The Limit of Transmission Voltage.*—In the early plants the voltage which could be employed on the line was limited by the insulation of the transformers which fed it. Improvements in transformer design and insulating material and the adoption of oil immersion soon raised this until the limit was the line insulator, which was then of the ordinary pin type.

With the advent, during the last few years, of the so-called suspension-type insulator any number of which may be placed in series, this limit has been removed so that, at the present time, the possible voltage is only limited by the production of a corona or brush discharge from the line itself.

This corona is due to the electric stress produced in the neighbourhood of the wire by the electrostatic charge which it carries being greater than the air can stand. Disruption of the zone of air next the wire takes place accompanied by light, sound, and chemical effects, and a serious loss of energy. A corona on a high-tension line must never be allowed, as the power loss which accompanies it will amount to a very considerable figure.

The stress which will be produced in the air at the surface of a transmission line depends on three factors:—

1. The potential difference between lines.
2. The diameter of the wire.
3. The distance apart of the wires.

The following expressions give the electric stress in terms of these factors:—

1. Two parallel wires:—

$$\text{Stress} = \frac{V}{2a \lg_\epsilon \frac{d}{a} \sqrt{1+\left(\frac{d}{2h}\right)^2}}.$$

2. One wire and earth:—

$$\text{Stress} = \frac{V}{a \lg_\epsilon \frac{2h}{a}}$$

(where V = line voltage; d = distance apart of wires; h = height above ground; a = radius of wire).

3. Three wires at corners of a triangle (ordinary 3-phase arrangement):—

$$\text{Stress} = \frac{V}{\sqrt{3} \lg_\epsilon \frac{d}{a} \sqrt{1+\left(\frac{d}{2h}\right)^2}}.$$

These formulæ are only approximate, but hold with quite sufficient accuracy when the distance apart of the wires is large compared to their diameter.

They only apply when the potentials of the system are symmetrical—that it is to say, in the case of a 2-wire system when the potentials of the two wires are equally plus and minus and in the case of a 3-wire system, when the lines are fed with a balanced 3-phase supply and the neutral-point is earthed. Any deviation from these conditions will inevitably increase the stress on one of the wires, the stresses given being the least which can possibly exist.

The value of the electric stress which can be allowed in the neighbourhood of a transmission line is not a constant for all conditions, but depends on a good many factors, some of which have not been very definitely investigated. In the first place, it has been demonstrated beyond any doubt that it depends to some extent upon the size of the conductor, rising as the conductor size decreases according to the curve shown in Fig. 2. This is especially noticeable for small wires, but for wires of the sizes ordinarily used in transmission work the range is only small. Secondly, the electric strength of the air is known to become less as the atmospheric pressure is decreased, so that at high altitudes a corona is more easily formed than at low ones, the relation between electric strength and air pressure being given approximately by the expression:—

$$R = R_o\left(0{\cdot}2 + 0{\cdot}8\,\frac{p}{760}\right)$$

where p is the pressure in millimetres of mercury.

A similar lessening of the electric strength is also produced by an increase of temperature, the law being linear in this case also.

The condition of the surface of the wire and the presence of water vapour and floating impurities in the atmosphere affect the electric stress allowable in a way which is not yet fully understood.

The voltage of discharge from a perfectly clean wire seems to be little affected by the presence of water vapour in the atmosphere, but if the wire be dirty not only does the discharge in any case occur at a lower voltage, but the voltage is lowered still further if water vapour is present. For this reason there has been considerable discrepancy between the results obtained by various workers on the subject. Laboratory tests made on clean wires have given values of the critical stress 50% or more greater than actual tests on transmission lines in manufacturing districts, where the wires would soon become dirty; whereas, tests on lines in remote mountainous districts, such as the Rocky Mountains in Colorado or the Sierra Nevadas in California, have given figures agreeing very closely indeed with laboratory tests.

For the present it is suggested that the figures given in Fig. 1 should be used combined with a factor of safety which should have, approximately, the following values:

Large towns or industrial districts especially near sea-level, *e.g.*, Lancashire, etc. ..	1·8–2·0
Ordinary open English country	1·5
Mountainous or other districts far from any source of contamination of the air.. ..	1·2

The systems which use a working voltage approaching the possible maximum are as yet but few in number. The ordinary 60,000 volt plant, of which there are numerous examples throughout America, does not approach the limit, except it be on an occasional short feeder of small diameter. The main transmission line of a 60,000 volt scheme, even if of copper, is rarely less than 000 B. and S. or ·47 in. diameter, and very often an aluminium conductor of considerably larger size is employed.

The lines which are at present being worked at voltages approaching the limit are as follows:—

1. The Great Western Power Co.'s plant, at Island Bar, California, 110,000 volts, which is said to have been tested at 150,000 volts without any sign of luminosity.
2. The Central Colorado Power Co., at Shoshone, Colorado, working at 88,000 volts, to be raised to 110,000 when the load requires, and already tested at that figure.
3. The Grand Rapids, Muskegon, plant, working at 100,000 volts. Photos have been published showing a luminosity on this line, but it is doubtful if there is a true corona.

The authors give a table showing that the plant of the Great Western Power Co., Island Bar, has a voltage of between 110,000 to 150,000; the conductor being 3·0 B. and S., spacing 300 cm., altitude 800 ft., stress 24·2 to 33·0 k.v. per cm., and the factor of safety, allowing for altitude, 1·50 to 1·11. The Central Colorado Power Co.'s plant of 110,000 voltage, has a conductor of 7-strand cable, 2·0 B. and S., with hemp core, the spacing being 300 cm., the altitude 6,000 ft., the stress 23·2, and the factor of safety allowed 1·34. The Grand Rapids plant, with conductor 4·0 B. and S., gives a spacing of 300 cm., the altitude being 1,000 ft., the stress existing being 19·6 and the factor of safety allowed 1·87.

It will be seen that, allowing for altitude, the plant which is working the nearest to the limiting voltage is that of the Central Colorado Power Co. This line is in a mountainous district, where the air is very clean and the rainfall

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slight, so that the factor of safety is probably sufficient, even though some parts of the line rise to more than 10,000 ft. above sea-level.

Although theoretically a line at a high altitude should discharge at a lower voltage than one at sea-level, this is often offset by the greater purity of air at high altitudes, and the way in which the surface of the wire retains its original smoothness.

(*b*) With the exception of the few comparatively small plants installed in France and Switzerland, all the modern transmission schemes employ 3-phase alternating current. Though there are certain cases in which direct current would possibly be the more suitable, the ordinary conditions found on the American Continent appear to be better satisfied by the 3-phase alternating-current system.

Undoubtedly for a very long transmission from a remote source of power, such as a waterfall to a large city or industrial area, the Thury system of direct current transmission has many advantages.

In the first place, the working voltage with a direct current line may be much higher than that which is possible with an alternating-current one, as the effects which limit the alternating voltage available, such as the corona, depend not upon the R.M.S., but upon the maximum value of the voltage used.

The charging current of the line in an alternating current transmission is a factor needing serious consideration, especially when a frequency of 60 (frequently used in the States) is adopted.

The possibility of resonance (not really very serious) and the danger of interference with telephone and telegraph circuits also militate against the use of alternating currents.

On the other hand, the elasticity of the alternating current system, with its parallel method of working, renders it very suitable for the large networks of power lines which are springing up all over the American Continent.

Although it is quite possible that this could be done equally well by the Thury system, it is very doubtful whether any engineer would be justified in installing it in such a case until considerably more experience had been obtained with the existing plants.

It seems very doubtful whether the Thury system will ever be introduced in America, as alternating currents are employed almost universally for everything except railways, and the general conditions governing the supply of electric power are—as is natural to a large, newly settled, and as yet sparsely populated country—very different to those which prevail on the Continent of Europe.

All the installations to be described in this paper use the 3-phase alternating current system, with, in almost all cases, parallel operation of two or more stations on the same network. In some cases nearly all the powers generated was sent to the far end of the line before being used, but in others the station fed into a large distribution system in the neighbourhood.

(*c*) The question of frequency is somewhat akin to that of the choice between direct and alternating currents, and, like it, is settled more by the question of standardisation than by any other consideration. Undoubtedly for any given conditions of length of transmission line, nature of load, and power required, there exists a frequency which will give the best possible results, but which cannot in general be adopted.

The standard frequencies on the American Continent are 25 and 60 ∞, the latter being used almost universally for lighting purposes. It is, however, distinctly too high for a really sound long distance transmission. In some cases the transmission is at 25 ∞, and frequency changers are employed. Practice, however, seems to vary in different parts of the country, the Niagara plants, for example, all generating at 25, while 60 is standard on the Pacific Coast and in most other parts.

There seems to be a great aversion to using 25 ∞ current for lighting, although in one or two towns, such as Buffalo, this is done.

The large plants on the Pacific Coast all use 60 ∞, and have very large charging currents. One plant in particular, which will ultimately operate a line 153 miles long at 110,000 volts, will have a charging current corresponding to an output of nearly 15,000 k.v.a. In at least one case, and probably in many, the question of the charging current due to the high frequency has limited the value of the transmission voltage employed. In this case the line is 77 miles long, and the pressure employed 70,000 volts, the charging current corresponding to 3,000 k.v.a. It was stated that, were it not for the high value of the charging current, the voltage would have been taken still higher.

In another case 60 ∞ current supplied from a large network is transformed to 25 ∞ for distribution to the rotary converter sub-stations of an electric railway company.

It seems unfortunate that the excessive standardisation prevailing among the manufacturers of electrical machinery should cause the adoption of such an admittedly unsatisfactory frequency as 60 cycles per second. The conditions in America are such that the frequency of generation must also be used for ordinary private lighting, but there is no doubt that quite satisfactory results can be obtained with frequencies much lower than the 60 ∞ standard, which would be far more suitable for transmission over long distances.

(*d*) *Parallel Operation.*—The operation of a number of widely distributed central stations on a common distributing network has presented few difficulties in actual practice. The methods adopted for synchronising the machines are similar to those employed in the country, rotary synchronisers being most commonly used. In many cases waterpower plants are running in parallel with steam turbines through 100 miles of line, and no difficulty from hunting has been met with.

The latest practice to facilitate good synchronising is by the use of pneumatically controlled switches. These have been installed at the Island Bar station of the Great Western Power Co., and are much quicker in operation than any other form of switch yet put into service. As a matter of fact, the time lag of a switch can always be allowed for by a skilful switchman, but the new switch has the advantage of being independent of the judgment of the operator.

The only phenomenon which is likely to produce hunting with such a system is a short circuit, and on some systems these are of very frequent occurrence. With water turbines and steam turbines there is no cyclic irregularity which could be emphasised by resonance with the period of swing of an alternator. With a large station, having a number of hydroelectric units in parallel there is some risk of hunting, if the units are separately governed and the governors are too quick acting, but this is not so likely to occur with hydroelectric plants as with steam-driven sets. As a matter of fact, synchronising through a long transmission line is a much easier matter than synchronising in a central station. The reactance of each leg of a 60,000 volt line 100 miles long, with wires of 000 B. and S. 7-strand cable 6 ft. apart, is 34·3 ohms, the resistance 25·6 ohms, giving an impedance of 42·6 ohms. This impedance acts in the same way as the coreless choking coils, which have recently been fitted in some stations to assist synchronising, and cuts down the cross-currents which would otherwise flow when a bad phase is made to very much smaller dimensions.

The practice of switching-in machines without synchronising is not common in hydroelectric stations, though in the General Electric Co.'s works at Schenectady synchronous motors and converters are put into circuit in this way, the motors being fitted with copper damping rings to give the necessary starting torque and bring them up to speed.

(*e*) *Line Protection.*—The protection of the overhead line against lightning stroke and atmospheric discharges is a matter of great importance. American engineers state that this problem is one of the most serious that they have to face, and the opinion is very generally held that no so-called lightning arrester is effective in protecting a transmission line against the effect of lightning stroke. The lightning arresters formerly in use were those of the well-known Würts pattern, or the carbon rod spark arresters. In nearly every station that was visited, however, both at Niagara and on the Pacific Coast, these arresters are being displaced by those of the electrolytic type, recently described by Mr. Peck.* These arresters are kept charged by being connected every other day direct to the overhead line, but normally they are arranged with a spark-gap between them and the line. Even on a long line arresters are fitted only at the central station and at the sub-stations, the extra safety gained by fitting them at intermediate points being discounted by the increased risk of breakdown due to their use.

* Proceedings of the Institution of Electrical Engineers, vol. 40, p.

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The most effective protection against lightning is undoubtedly the earthed wire. During a recent very severe lightning storm near San Francisco, the only transmission line that was not put out of service was one having an earthed wire arranged above the line. Not only does the earthed wire act as a screen against the electrostatic effect by charged clouds moving in the upper regions of the atmosphere, but it also provides a path to earth more direct than that of the line wire over the whole length of the transmission line, and thus prevents a lightning stroke from striking the transmission line. In most cases where the earthed wire is fitted, however, the best practice is to connect a lightning arrester of the ordinary type to the line as an additional safeguard.

Troubles from lightning are much less likely to occur on a high-voltage transmission line than on those working at 20 or 30 kilovolts on account of the more effective insulation of the line. The screening effect of the earthed wire may be estimated as follows :—

If H be the distance between one of the line wires and earth, H′ the distance between the centres of the earthed line and the transmission line, R the radius of the transmission-line wire, R′ that of the earthbed wire, all these quantities being expressed in the same units, then the ratio between the voltage which would exist at the transmission line if the earthed wire were absent and the voltage which actually does exist is given by—

$$\frac{V'}{V} = \frac{\lg_e \frac{H'}{R'} \lg \frac{H'(H+H')}{(H+H')(2H+H')} + \lg_e \frac{H}{R} \lg_e \frac{R'(H'+R)}{(H+H')(2H+H')} + \lg_e \left(\frac{2H}{2H+H'}\right) \lg_e \frac{R'(H'+R)}{H'(H+H')}}{\lg_e \frac{2H}{R} \cdot \lg_e \frac{H'(H'+R)}{(H+H')(2H+H')}}$$

This expression represents the minimum screening action which is obtained by an earthbed wire, on the assumption that the total charge in the transmission line is the same whether the earthed wire is present or not. The actual screening action will probably be much greater, but the amount of it can hardly be estimated exactly as it depends on the shape and location of the charged cloud.

In no stations are the water-jet dischargers, in which an electrostatic charge is conveyed to earth through a water jet playing against the line, installed. With the high voltage used, it is obvious that the resistance of the water, if there is to be no considerable leakage current, would have to be so high that it would not be sufficiently conducting to get rid of an electrostatic charge with any great rapidity.

(*f*) *Asynchronous Generators.*—It has been suggested at various times that asynchronous generators consisting of ordinary induction motors run above synchronous speed could, with advantage, be employed in many transmission systems. This is especially the case in large networks fed from a number of stations. On some of these networks where there are many small water-powers the use of such a small generator has many advantages. It is extremely robust and mechanical in construction, and quite simple in operation ; it needs no exciter and has no rubbing contacts. It can be thrown straight on to the line without synchronising, and it can be short-circuited with immunity. It requires, of course, that the current at the station shall lead on the voltage in order to supply the necessary magnetising component. This is not generally a disadvantage, as on all high-tension long-distance transmission lines the heavy charging current will look after this. An asynchronous generator connected to a line of sufficient capacity will excite itself and furnish power without the use of any synchronous machine to set the step, and on this account care should be taken that the magnetic circuit of such a machine is not worked at too low a density. If an asynchronous machine be taken whose voltage magnetising current characteristic is given by a straight line, *i.e.*, if the iron is unsaturated there will always be found a critical value of connected capacity at which the machine just excites. Any increase of the capacity will cause the voltage to rise until the magnetic circuit becomes saturated, and if this occurs much above the normal working voltage, serious damage may result.

Asynchronous stations feeding into networks generally have their governors arranged so that they work steadily at full load all the time. The variable portion of the load is taken care of by ordinary synchronous generators driven by water-wheels, or sometimes by steam turbines.

An interesting example of the use of asynchronous machines is given by the exciter sets in many of the generating stations of the Pacific Gas and Electric Co. In these sets a water-turbine or Pelton wheel, a direct current generator, and an induction motor are all coupled together. In case of a heavy load on the generator, the induction motor helps the water-wheel, while, if the load is light, power is returned to the line by the induction motor running as generator. No governors were provided, the speed being controlled entirely by the induction motor. Synchronous machines had been tried, but had given trouble by breaking step.

The possibilities of asynchronous machines, and their advantages in many cases over generators of the ordinary type, are recognised by some of the leading engineers of the large American systems.

(*g*) *Telephone Interference.*—An efficient system of telephones is a matter of fundamental importance in the operation of a large network, and the question of telephone interference is, therefore, one which requires most careful consideration. In the case of a transmission line at 100,000 volts and over, no attempt appears to have been made to run the telephone lines on the same pole as those that are used for the transmission line. With 60,000-volt schemes the usual practice is to arrange the telephone line about 10 ft. below the transmission line, and to support it on insulators on the same poles. In order to avoid mutual induction effects, the telephone lines are transposed at frequent intervals. Transposition of the telephone line is, however, not sufficient to prevent induction, as the inductive effect from the three main lines are sufficiently different in magnitude on the two telephone lines to give large currents along the whole length of line. Electromagnetic induction may be almost completely avoided by transposing both the transmission line and the telephone line. The transposition of the transmission line is effected by using special pairs of towers at intervals of about 3 miles ; in most cases the lines are transposed by the third of a revolution at each transposition point—*i.e.*, wire (1) is put on insulator (2), wire (2) on insulator (3), wire (3) on insulator (1) at the first transposition ; at the next, wire (1) is transposed to insulator (3), and so on ; while at the third transposition wire (1) comes back to insulator (1). With these precautions the telephone is sufficiently satisfactory, even over a line of 150 miles in length.

If the neutral point of the 3-phase system is earthed, this arrangement serves as an efficient safeguard against electrostatic effects, but where Δ-connected transformers are used, and there is no definite earth-point provided, these effects may be very large.

In order to obviate them as far as possible at the telephone, the wires are connected by a split-choking coil at the ends of the line, and the centre point of this coil is connected to earth.

In most of the large installations the telephones are brought to a controlling station, from which all instructions as to the operation of the various plants are issued by a "load dispatcher." The "load dispatcher" gives instructions to each plant as to the number of units which are required to be in operation at the station ; all breakdowns of the line are reported to him, so that he knows exactly what sources of power are available for the supply that is required.

(*h*) *Star* v. Δ *Connection.*—The arrangement of the transformer on the high-tension network is one in which considerable discrepancy of practice appears to exist. At the present time there seems to be a decided preference in favour of Δ connection. Briefly stated, the relative advantages of the two methods of connection are as follows :—

Advantages of Δ : (1) If one of the phases breaks down the other two will supply power to the extent of two-thirds of the capacity of the transformer ; (2) if an earth occurs on one leg of the transmission line it does not affect the running of the system provided the insulators on the other two wires are sufficiently large to stand the concatenated pressure of the system.

(*To be continued*).

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HIGH POTENTIAL, HIGH FREQUENCY.*

By FRANK P. VAUGHAN.

The production of high potential, high frequency currents by the use of condenser discharges is by no means new. The following apparatus and experiments may be of interest, however, as they are becoming more and more of commercial importance, due to their use in wireless telegraphy, etc. For the benefit of those readers to whom some of the terms used in the following article may not be familiar, the writer will endeavour to explain some of them.

Alternating currents met with in commercial use are, relatively speaking, of low frequency. If, however, the frequency were from 1,000 to 100,000 they would be known as high frequency currents. When the frequency rises to a value of a million or so, they are generally called electric oscillations. When an alternating current of very high frequency exists in a circuit and continues uninterruptedly, it is usually called a persistent or undamped electric oscillation (such as are used in wireless telephony).

In the following experiments, however, we are concerned with an alternating current of very high frequency, which consists of separate groups of alternating currents, each group beginning with the same amplitude, but then damping down more or less rapidly to zero, and, after an interval of rest, beginning again. These are known as damped electric oscillations. The rate at which the amplitude dies away in each train is called damping. A train of very few oscillations, say, five or six, is called a highly damped train, and 100 or more a feebly damped train.

These high frequency currents do not follow the same laws as low frequency currents, and when using thick copper wires to convey high frequency currents, the effective resistance may be very much greater than for continuous or low frequency currents. On the other hand, if the wire is of small diameter, then even for high frequency currents this increase in resistance, due to the concentration of the current at the surface of the wire, is not very serious. For this reason, stranded wires, made up of twisted fine insulated copper wires, should be used. There is another point, however, in connection with the above. When a wire is coiled into a helix of many close turns, its high frequency resistance is considerably greater than for the same wire stretched out straight.

Inductance, which, with capacity, plays such an important part in alternating current work, may be described as having a certain kind of inertia analagous to the inertia of water in a circuit of pipe. If an electric current in a circuit is made to change in value, a portion of the electromotive force acting upon the circuit must be used to cause the current to change. In the same way, a force over and above that required to overcome frictional resistance must act upon a moving body to accelerate it. The inertia of a body is measured by the force required to accelerate it at the unit change in speed per second, and the inductance of a circuit is measured by the electromotive force required to cause a current in the circuit to change at the rate of one ampere per second. The inductance of a circuit depends on its geometrical form, and is determined by the amount of linkage of flux that takes place within itself when one ampere flows in the circuit. The inductance is therefore increased by closely coiling the circuit. A circuit is said to have an inductance of one henry when one volt (over and above that required to overcome the electrical resistance) will cause the current to change at the rate of one ampere per second. The inductances met with in practice are generally small and, in high frequency work, of an order of thousandths and millionths of a henry.

Capacity (electro-static) may be defined as the quantity of electricity which must be imparted to a given body or conductor as a charge, in order to raise its potential a certain amount. The capacity of a condenser or conductor is not unlike the capacity of a vessel filled with a liquid or gas. A certain quantity of liquid will fill a given vessel to a level, dependent upon the size or capacity of the vessel. In the same manner a given quantity of electricity will produce in a conductor or condenser a certain difference of electrical level or difference of potential, dependent on the electrical capacity of the conductor or condenser. A condenser whose potential is raised one volt by a current of one ampere flowing into it for one second has a capacity of one farad. Like the henry, however, this unit is much too large for practical use, and in high frequency work the capacities are of an order of thousandths and millionths of a farad. The discharge of a condenser through a circuit possessing self-inductance or electrical inertia under certain conditions is oscillatory; that is to say, the electricity flows backwards and forwards in the circuit several times before the condenser becomes finally discharged. According to Sir Oliver Lodge, the rate of oscillation for a pint size Leyden jar or condenser is 10,000,000 per second. For jars of larger capacity the rate is less rapid.

Electric Resonance.—If an oscillatory current has a periodic or alternating electro-motive force set up in it, and if the frequency of this e.m.f. agrees with the natural frequency of the current, then an immensely greater current will be produced than if the periods do not agree. This increase in amplitude of the alternating current created in the circuit by exact syntonizing or tuning the frequency of the impressed e.m.f. with the natural frequency, is said to be due to electric resonance.

It is a familiar experiment that we can set up a very considerable amplitude of vibration in a pendulum by administering to it small blows, provided these are timed to agree exactly with the natural period of the pendulum. In the same manner, oscillations of great amplitude can be created in a heavy elastic beam supported at both ends, by very gentle blows given at the right intervals in the centre. The earliest methods of producing high frequency oscillations were probably due to Lord Kelvin (but are better known by the striking experiments of Tesla)

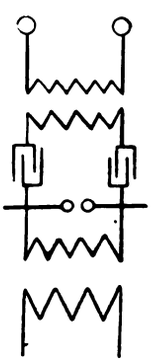

Fig. 1.

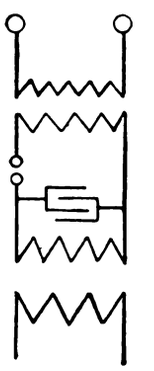

Fig. 2.

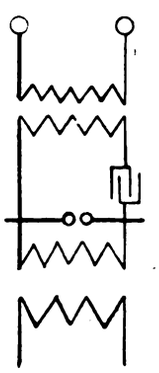

Fig. 3.

who showed that if a condenser be charged to a high potential and discharged through a circuit having inductance (or electrical inertia) and low resistance, a train of damped oscillations would be created at every discharge of the condenser. As a mechanical analogy, we may compare the charged condenser to a weight attached to a spring, which has been pulled away from its position of rest. To discharge the condenser, let go the weight, and it begins to oscillate backwards and forwards, and after marking a greater or less number of oscillations, finally comes to rest. The number of oscillations per second will depend upon the strength of the spring and the mass of the weight, which correspond with the capacity and self-induction in our electrical circuit. The number of oscillations before the weight finally comes to rest is determined by the friction which tends to stop the weight, or by the resistances and other losses in the electrical circuit.

It is necessary to arrange the circuit for the production of trains of damped electric oscillations by condenser discharges, so that the inductive circuit is in series with the condenser. This usually consists of one circuit of a transformer, containing no iron, called an air core transformer. Two circuits are wound one over the other, and highly insulated from each other; one of these is called the primary, the other the secondary. The primary circuit is arranged in series with a condenser and spark gap. This being the circuit in which electric oscillations are set up by the discharge of the condenser, the oscillations in the primary induce other oscillations in the secondary, and if the secondary has a greater number of turns than the primary, the secondary voltage will be greater than that of the primary in a known ratio. Professor Fleming

* Abstract from the *Canadian Electrical News*.

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determined experimentally that if the two circuits are loosely coupled, that is, the primary and secondary circuits being more or less widely separated and tuned in resonance, the damping being negligible, the ratio of transformation is determined entirely by the capacities in the two circuits; but when the circuits are closely coupled but not tuned in resonance, the ratio is determined by the relative number of turns on the two circuits. The apparatus may be connected in several ways, as in Figs. 1, 2 and 3, although the results obtained differ but little.

Fig. 4 shows the general arrangements of circuits and apparatus used by the writer, the connections being the same as in Fig. 2. Sixty-cycle alternating current is taken from the local company's lighting mains at 107 volts. A low equivalent lightning arrester, 1, and Wurts choke coils, 2, are used to prevent any high frequency discharges getting out on the line. 3 represents the main switch and fuses; 4, telegraph key; 5, open magnetic circuit choke coil, the number of turns being adjustable; 6, adjustable magnetic circuit choke coil; 7, slate switchboard with fuses, main switch, voltmeter, ammeter and double pole, double-throw switch for connecting the primaries of high potential transformer in series or multiple; 8, oil insulated high potential transformer giving 8,000 or 16,000 volts; 9, choke coils mounted in transformer box to protect secondary coils from high frequency surges; 10, safety discharge gap to protect transformer in connection with choke coils; 11, two-plate glass condensers, one of about ·021 micro-farads, and one of about ·012 micro-farads, adjustable in single plates; 12, adjustable disc spark gap; 13, large high frequency coil; 14, small oscillator with adjustable primary turns; 15, wireless jigger or oscillation transformer inductively coupled to aerial, 17; 16, tuning coil for adjusting wave length.

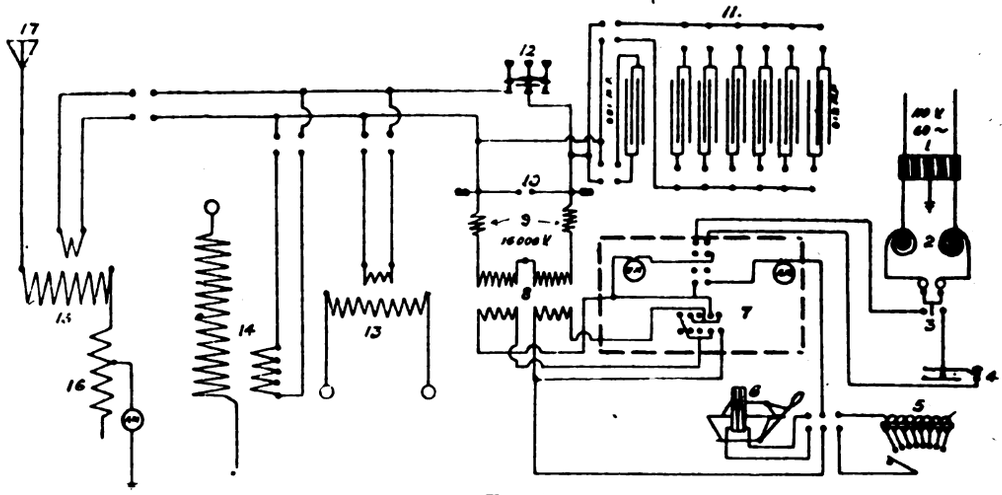

FIG. 4.

The high potential transformer consists of a core type transformer, having a primary and secondary wound on each leg. The primary consists of 260 turns of No. 15 B. & S. double silk magnet wire, 130 turns being wound in two layers on a hard fibre spool on each leg. The secondary consists of 20,000 turns of No. 32 B. & S. double silk magnet wire, wound in 40 sections on micanite spools, 20 sections in each half, having $\frac{1}{32}$ in. of micanite between sections and $\frac{5}{32}$ in. of micanite between primary and secondary, and $\frac{1}{4}$ in. micanite between end of spools and iron. The transformer is placed in a wooden box containing boiled linseed oil, in which is also placed two choke coils, one in each lead of the secondary, consisting of two hard fibre spools, each wound with $\frac{1}{2}$ lb. No. 28 B. & S. D.C.C. magnet wire.

Considerable difficulty was at first experienced, due to high frequency surges getting into the secondary of the transformer and causing breakdowns of the insulation. This was finally eliminated by placing choke coils in the secondary leads of the transformer and shunting them with a discharge gap. The condensers consist of one fixed condenser of about ·021 micro-farad capacity, made up of 21 sheets of glass 16 in. by 24 in. by $\frac{1}{8}$ in., with 20 sheets of thin tin 14 in. by 22 in., and one adjustable condenser of about ·012 micro-farads capacity, made up of 13 sheets of glass 16 in. by 24 in. by $\frac{1}{8}$ in., and 12 sheets of thin tin 14 in. by 22 in., both of the above being placed in wooden boxes, and a compound of beeswax, paraffin wax, resin and a little engine oil to keep same from becoming brittle, poured into the boxes while hot. This construction has given excellent results, and has never had a breakdown in over two-and-a-half years' use. The spark gap consists of two zinc discs, one being stationary and the other adjustible by turning the three adjusting or levelling screws. A number of experiments were made with different kinds of spark gaps, but the one mentioned above was finally adopted as giving the best results without the use of a magnetic blow out, or air blast. The discharge across the spark gap is practically a short circuit across the secondary terminals of the transformer, and if this arc discharge is not suppressed or broken up, there will not be a true oscillatory discharge in the condenser circuit (or only a very weak one), for the reason that as the arc discharge holds, the secondary terminals of the transformer are reduced in potential. Until the arc is destroyed, therefore, the spark gap cannot build up a sufficient difference of potential to give a fresh charge to the condenser. However, with the arrangements used and with sufficient choke in the primary of the transformer, the discharges are found to follow each other in very rapid succession, travelling all over the surface of the discs. Professor Q. Majorana, who was successful in obtaining a spark rate of 10,000 a second, says: "By placing a choke coil of considerable inductance in the supply circuit, a large number of secondary discharges may be obtained for every alternation of the primary current, particularly when the discharge voltage is kept relatively low by the use of a short gap. The moment the spark commences, the total primary voltage comes on the choking coil, the supply current suddenly falls, and the energy is no longer forthcoming for the maintenance of the arc."

When the arc has been extinguished the voltage again divides itself between the choking coil and the primary of the transformer, and hence, as the primary voltage continues to increase, the induced secondary voltage may again rise sufficiently to cause a spark. The action then repeats itself. The self-inductance of the transformer diminishes, the primary current suddenly rises, the choking coil begins to act, and checks the supply of energy so suddenly that the second arc also breaks. Spark after spark thus follows, and all the more rapidly as the primary voltage nears its maximum, but after this has been passed the intervals between them increase until a point has been reached, when they leave off until after the commencement of the next alteration. A large number of discharges is therefore obtained at every alteration by the aid of the choking coil. The inductance and capacity of the secondary system also influence the number of discharges obtainable during an alteration. The less the inductance and capacity of the conductors connected to any given oscillator, the greater the number of discharges obtainable per second, and, likewise, if the inductance and capacity of an oscillator be reduced, the rate of sparking will be increased.

An interesting point stated by some authorities, and which I believe has been proved by means of the oscillagraph, is that the instantaneous value of the current in secondary of the transformer does not exceed an ampere, this difference being caused by the difference in the duration of the phenomena.

The high frequency coil is constructed of two cardboard cylinders, one being 8 in. in diameter by 24 in. long, on which the secondary is wound, and which consists of a single layer of No. 32 B. & S. double silk magnet wire, wound the full length of the cylinder in a single layer, the other being 11 in. in diameter and 24 in. long, on which the primary is wound, and which consists of a single

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layer of 10 turns of insulated copper strip, 1 in. wide, which is wound on the central portion of the cylinder.

The secondary is placed inside the primary cylinder and supported concentrically, leaving 1½ in. oil space between the two cylinders. The ends of the secondary winding are brought out, enclosed in hard rubber and glass tubes. The coil is placed in an oil-tight box containing 12 gallons of linseed oil. The primary winding would have been better if composed of a large number of fine insulated wires braided together, as they offer less resistance to high frequency currents than a solid wire, although the copper strip answers the purpose very well. In the construction of high frequency transformers which are used for the production of high potentials in the secondary circuit, and which sometimes contain a large number of turns, there may exist great differences of potential between turns, necessitating high insulation, and it has been found that the only construction that will stand, is that in which the primary and secondary are wound in a single layer, and the coil immersed in a highly insulating oil, this being the only insulation that can be depended upon for the permanent insulation of high frequency currents, unless the apparatus is made on a scale excessively large for the length of discharge to be obtained.

The small oscillator consists of two cardboard cylinders placed one above the other and connected in series. The lower cylinder is 24 in. by 8 in., having 325 turns No. 20 B. & S. bare copper wire; the upper cylinder is 11 in. by 5in., and wound with 152 turns of No. 20 B. &. S. bare copper wire with a string between the turns, making 477 turns in all. This comprises the secondary. The primary consists of a number of turns of 1 in. flat copper strip, wound one over the other, with an insulating strip between the turns. This has an outside diameter of 15 in., the number of turns being adjustable by a connection which is slipped in between the turns. The primary is connected in series with a spark gap and condenser. One end of the secondary is grounded, the other terminates in a rod with a small brass ball at the end. The above oscillator is in resonance with two turns in the primary and a capacity of about ·007 micro-farads and takes 15 amperes in the primary of the high potential transformer, the primaries being connected in multiple and the secondary giving 16,000 volts. The primary of the oscillator, being placed at the lower end of the secondary, forces, as it were, the high frequency discharge to the free end of the secondary. It is very necessary that the two circuits be tuned in resonance, otherwise the results obtained are disappointingly small. No results are obtained unless the lower end of the secondary is grounded. At the free end of the secondary of the oscillator the potential is a maximum, the current increasing and the potential decreasing as we move toward the lower end, the current being a maximum at the grounded end.

The large oscillator consists of a large cardboard cylinder 12 in. by 60 in. long, wound with 862 turns of No. 20 B. &. S. bare copper wire The primary consists of a number of turns of 2 in. copper strip and is constructed in the same manner as the small oscillator described. The primary has an outside diameter of 21 in. and is in resonance with about ·012 micro-farads capacity and six turns in the primary, taking about 20 amperes in the primary of the high potential transformer, the primaries being connected in multiple and the secondary giving 16,000 volts.

These oscillators can be connected in series by being placed one on top of the other, but, owing to limited space, the writer has been unable to try the results obtainable with this arrangement. A large number of very interesting experiments can be made with the apparatus described. One, which is particularly interesting to those who are only familiar with low frequency currents, is the impedance which high frequency currents present to solid conductors. If we connect the apparatus as in Fig. 5, A being a solid copper rod ½ in. or so in diameter, we are enabled to illuminate incandescent lamps of 50 to 100 volts across the loop formed by the copper rod, although this is practically a short circuit to low frequency currents. One of the peculiarities of high frequency currents is their ability to pass to objects from one terminal of the apparatus even if the object be highly insulated, and there are a number of experiments which can be performed just as well with only one connection to the high frequency coil. Perhaps the most interesting experiments are the beautiful discharges that are obtainable with a high frequency coil, especially if conducted in a dark room.

A number of different kinds of discharges are obtainable by the adjustment of the choke coil, spark gap, and the amount of capacity in circuit, from a flaming discharge to the thread-like discharge of a static machine. In fact, it is possible to imitate the discharge of a static machine so that the difference is not discernible. Beautiful brush discharges are obtainable by cutting down the capacity so that no discharge takes place, separating the discharge rods, and placing them in a perpendicular position. A solid sheet of blue flame fills the space between the rods and a strong brush discharge takes place from the rods and the 2 in. balls at the end of the rods. Vacuum and Geisler tubes are brilliantly lighted some distance from the coil, due to the strong electro-static field set up. Very good results are also obtained from the high frequency coil with X-ray tubes, which is capable of exciting some of the largest tubes on the market. The experiments with the small oscillator are particularly interesting in that they allow quite a large current to be passed through the body with very little sensation being felt. It has been stated by a number of authorities at different times that $\frac{1}{10}$th part of an ampere at low frequency passed through a vital part of the body, would cause death, yet by the use of high frequency currents we are enabled to pass one-half an ampere or more with hardly any sensation being felt. The small oscillator gives a brush discharge at the free end six or seven inches long, and by holding in the hand a metal rod, thick white discharges eight or nine inches long can be drawn from the end of the secondary. It is necessary to hold a piece of metal in the hand, otherwise a stinging sensation is experienced.

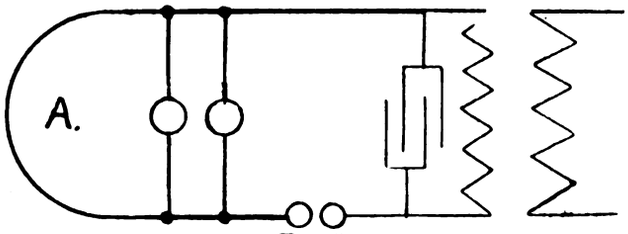

FIG. 5.

If a 16 c.p. lamp taking one-half an ampere be held between two people, one of them touching the oscillator with a metal rod, and if the rod be moved toward the grounded end, the current is increased and a point is reached near the end where the lamp burns up to candle power. If a piece of fine wire be substituted for the incandescent lamp as described above, it can be melted by the current flowing between the two people. In the same manner a nernst glower fastened to the end of a metal rod, can be brought up to incandescence. This experiment takes a little time, as the discharge will jump across the refractory material, and it is necessary for it to become warmed up and become more or less conducting before it will come up to candle power. This sometimes takes three or four minutes.

An X-ray tube held in the hand close to the end of the oscillator, is brilliantly excited by the current passing through the body, and excellent results are obtained with a fluoroscope used by another person.

An ordinary oil lamp can be lighted by touching the oscillator as described, and with a finger of the other hand touching the wick of the lamp. It is also possible to light a cigarette held in the mouth and touched with a rod as described. This experiment was tried by the writer, and was decidedly uncomfortable, as the discharge jumps to the tongue and mouth. Geisler and vacuum tubes held in the hand four or five feet away are brilliantly lighted. Another experiment which is very perplexing to those not familiar with high frequency phenomena is the insertion of a 110 volt, 16 c.p. lamp in series with the grounded end of the secondary, which burns up to candle power, being practically on an open circuit.

Either the above or a hot wire ammeter is used by the writer to adjust the circuits to resonance. There are a number of other interesting experiments, but they

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are too numerous to mention. The large oscillator described may be used in a smilar manner, but owing to the larger capacity necessary to bring it into resonance, which lowers the frequency, it was found that, while it was possible, the current passing through the body produced more or less muscular contraction and was very unpleasant.

PARLIAMENTARY.

WIRELESS TELEGRAPHY.

In the House of Commons, on the Engineering Laws Continuance Bill being read a third time, Mr. Claude Hay asked the Postmaster-General for information in respect of the terms upon which he had taken over certain of the stations of the Marconi Company.

Mr. Buxton (Postmaster-General) replied that the Act had worked satisfactorily, and there was no reason, so far, for making any change in regard to it. It was possible that in view of the purchase by the Government of the Marconi and Lloyd stations, the Act might have to be altered a year or two hence. When that time arrived probably a more comprehensive Bill would be introduced to deal with the situation. In the bargain with the Marconi and Lloyd Companies the long-distance stations had been left out, as they could not be regarded as being yet on a really commercial basis. This new feature in our electrical communications was, in his opinion, going to be greatly extended during the next few years. The Government had made a very good bargain in securing the plant and patents of the companies for £15,000.

SEARCHLIGHT CARBONS.

Mr. Starkey asked the First Lord of the Admiralty whether the Admiralty purchase the greater part of the carbons for the electric searchlights of warships from Germany; and whether, in the event of the foreign supply not being available, manufacturers in this country would be able to meet a sudden demand.

Mr. McKenna said the answer to the first part of the question is in the negative; the whole of the carbons purchased by the Admiralty for searchlights of his Majesty's ships are made in this country. The answer to the second part of the question is in the affirmative.

PICTURES BY TELEGRAPH.

Mr. T. Thorne Baker, a well-known fellow of the Royal Photographic Society, and chief of the *Daily Mirror* picture telegraphing organisation, in the course of a lecture on "Telegraphing Pictures," delivered before the Royal Society of Arts, described his own system. He uses a Caselli transmitter. A metal drum is revolved by an electromotor at the rate of one revolution in two seconds. To this drum the half-tone photograph is attached. In Mr. Baker's case, the picture is printed in fish glue upon lead foil. The metal drum is connected to one end of a battery (about 60 volts), the other end of the battery to one end of the telegraph or telephone line. A steel tracer or style is attached to the other end of the telephone line, and presses against the glue picture as it revolves spirally on the drum. As the style travels over the inequalities the current is broken, so that a series of dots and dashes are produced. He has succeeded in introducing an improved mechanism for the style, the "needle" being so balanced that vibration or "chattering" is rendered impossible. The receiver is very simple, and is, in appearance, the *facsimile* of the transmitter. A piece of chemically prepared paper is wrapped round the (metal) cylinder, and the current received is passed through the style into the cylinder, *viâ* the paper. Every time current flows, a chemical mark appears on the paper by electrolytic action, as in the Bakewell telautograph. But the paper is sufficiently sensitive to record five or six hundred dots a second; while the receiver is fitted with simple regulating gear by means of which the distortion of the currents caused by their passage through a long-distance line can be completely overcome. The arrangement is seen in the next slide. At the sending station we have a metal drum revolving, and a style travelling laterally so as to trace a spiral path across it; a single line half-tone photograph is wrapped round the drums, and the lines in the picture act therefore as interrupters of the current sent into the telephone line. At the receiving end, the style feeds the paper with current, decomposition is effected, and a dot appears each time the sending style comes in contact with the lead foil, *i.e.*, when it is between two lines. A weaker current also flows through the style and drum in the opposite direction. The battery used to supply this current is divided into two components. In series with each is an adjustable inductance with soft iron core and an adjustable resistance, one end of each resistance being joined; one end of each battery goes to the receiver, so that the whole arrangement acts as a shunt on it, or on the line. Between the sliding contacts of the resistance is a variable capacity.

It is evident from line tests that when an intermittent current with a period is transmitted, such as happens in the transmission of a half-tone photograph, secondary surges are set up differing in phase from the original waves, since without the line compensator I have described, there is an elongation of each dot, gradually tapering off in the manner of a wave-train. By sliding along the various contacts in the "balancer" it is easy to make the dots come crisp and clear, so that the receiver, ordinarily sluggish and completely useless on a long line, becomes exceedingly rapid. The ordinary receiver as used by Bakewell would be valueless for the work.

The necessity for, and great value of, the variable condenser, only became apparent when I began to transmit pictures by the telectrograph from Paris to London, where we have the submarine cable to deal with. I had previously, made it a part of the balance from theoretical motives but it appears to be essential when working over a distance of any magnitude.

Mr. Baker went on to ask: "And now a word as to the future. When shall we telegraph pictures from New York to London? I think that by means of this sensitive selenium apparatus Professor Kokrn is likely to find a practical solution, while personally, by way of experiment, I am trying to solve the matter by means of wireless—but I speak of the matter with considerable reservation." He had used a wireless arrangement which had given the most promise of success so far; he was at the present moment working out some modifications of it which entirely change its character.

SMETHWICK ELECTRICITY SUPPLY.

ANNIVERSARY CELEBRATION.

The fifth anniversary of the inauguration of the Smethwick Electricity Supply was celebrated by the staff of the Smethwick and Oldbury Electric Light and Power Supply, with a smoking concert at the *Waterloo Hotel*, Cape-hill. Mr. Reilly (Muntz's Metal Co.) occupied the chair, and among those present were Mr. R. W. Cramp (general manager), Mr. O. C. Power (assistant manager), Mr. J. A. Mahood (resident engineer), Mr. R. Humphries and Mr. Ashworth (Tramway Co.), Mr. G. D. Vickers, Mr. Whitehouse, Mr. Perrett (engineers, Power Station), Mr. P. R. Blake (City of Birmingham Tramway Co.), etc.

Proposing "Success to the Smethwick and Oldbury Electric Light and Power Supply," the Chairman mentioned that they started at the Power Station five years ago with one customer, and they supplied 900 units; while they had 300 customers to whom they had supplied 31,000 units.

Mr. R. W. Cramp, in replying said that their success had been greatly enhanced through the wisdom and forethought displayed by the local manufacturers in adopting electrical machinery. Smethwick, is not the workshop of the world, constituted a considerable part of that workshop. They had great advantages with regard to electrical power, compared with some districts. Referring to what they had accomplished. Mr. Cramp said they not only turned out 31,000 units daily, but they were anticipating a considerable increase, and consequently were making preparations to nearly double their plant.

ELECTRICAL TREATMENT ACTION.

In the King's Bench Division, Miss Mary Jane Stephens brought an action against the Dowsing Radiant Heat Co., Ltd., to recover damages for injuries she sustained by reason of the alleged negligence of the defendants' servants in their administration of high-frequency electrical treatment. The jury returned a verdict for the plaintiff, with £60 damages, and judgment was entered accordingly, with costs.

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CONTENTS.

	PAGE
Notes	775
Long Distance Transmission on Overhead Lines	777
High Potential, High Frequency	781
Parliamentary	784
Pictures by Telegraph	784
Smethwick Electricity Supply	784
The Coming Expansion	785
Correspondence	786
Electric Projects for 1910	786
B. T. H. Continuous Current Ampere-Hour Meter	789
Patent Arc Lamp Lowering Gear	789
Electricity at Devonport Dockyard	789
Tantalum Lamps in Italy	790
Economic Electric Stove	790
New Type of Motor Starter	790
An Unbreakable Insulator	790
Dimensions of Busbars, Cable Sockets, etc.	790
Ashton Electrician's Failure	791
Technical Problems, with Solutions by Practical Men	791
South African Railways Through Rates	794
Tyneside Notes	795
Midland Notes	795
Lancashire Notes	795
American Notes	796
German Notes	798
Lighting & General Notes	799
Traction Notes	800
Companies' Meetings and Reports	800
Contracts Open	801
Tenders Accepted	801
Catalogues and Lists	801
Personal	802
Diary	802
Belfast Tramway Scheme	802
Publications	802
South London Elevated Electric	803
Electrical Driving of Textile Factories	803
Patents	804
Companies' Stock & Share List	806

THE COMING EXPANSION.

Gratifying signs of revival of trade are to be seen on all sides. There is a steady if slow expansion in the electrical industries at home, more particularly n connection with small projects, though ambitious schemes for amalgamation and power supply are not wanting. Enquiries from abroad are also on the increase, and the Colonies are beginning to buy more freely. It is true that in Australia the desire to foster local manufactures is being pushed at times to extreme limits, often to the point of seriously prejudicing the supply stations, tramway and telephone undertakings; but even in the Commonwealth the demand for apparatus that cannot be manufactured out there is reviving. Canada is also developing her manufactures, though there we see the municipalities showing a wise policy of seeking the best appliances obtainable. This means that Great Britain is doing rather more than maintaining her foothold in the Canadian market. Unfortunately, the electrical appliance trade is not very well organised, and for lack of local representatives, holding stocks of a variety of smaller appliances, the American manufacturers, owing to their better commercial equipment, frequently succeed in capturing most desirable orders that might well have come to this country. This is a matter which should be looked into seriously, all the more so as the policy of electrification of mines, metal working, timber and other factories is being boldly taken up. Turning to home matters, the long list of applications to the Board of Trade for Provisional Orders, and the proposals to apply to Parliament during the next Session for Acts to carry out various electrical projects, particulars of which we published last week, and again in this issue, shows a most welcome return of activity. Of course, there is many a slip 'twixt the cup and the lip. Every projected application is not persevered with, and many an application may meet with scant success. Even when an application is successful, much may occur to nullify the enterprise: it may be postponed or dropped

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altogether. Nevertheless, these 45 projects for 1910 look well for the coming industrial expansion. On going through the schemes severally, we find still greater reason for gratification, for the plans laid bare show unmistakeable evidence of a most healthy life in the electrical business, and those trades to which electricity in its many phases ministers. We may here give a brief analysis of these projects. Classification is somewhat difficult, owing to the fact that in many, indeed, we may say in most of the cases, powers are sought for expansion in more than one direction. In one case we find a power company (the Yorkshire Electric Power Co., Ltd.) anxious to promote a Bill giving it greater latitude to increase its capital and expand its business, either on its own responsibility, or in combination with other bodies. There are nine tramway schemes, some new, but mostly plans for extensions; and four electric railway projects. A decidedly significant fact is that no less than four gas companies wish to obtain permission to branch out into the business of generating and supplying electricity for illuminating purposes. Of the twenty-three projects for electric lighting and general electrical development, not a few are associated with the policy of municipal lighting authorities desiring to increase electric facilities at the expense of gas. This shows, indeed, on which side victory lies, adding emphasis to the recent startling development of the Welsbach Co. As regards the people at the back of the projects, it will be found that three of the schemes—all of them important—are being promoted by private individuals, seventeen by companies, and twenty-one by municipalities, or other local authorities. There are a few instances of companies ceding their concessions to local bodies, and also of local bodies seeking the enterprise of companies to take over and develop their powers. It is to be noted that private enterprise shows a tendency towards co-operation and amalgamation, a method of securing economy and greater efficiency more within their reach than it is within the easy grasp of local authorities.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

LIGHTNING CONDUCTORS.

Sir,—You have been good enough to send me copies of The Electrical Engineer containing your note and the letters of your correspondents.

The signature of the letters of October 8 raised doubts in my mind as to whether Sir Oliver Lodge's work on Lightning Conductors was correctly quoted, so before replying I wrote to Sir Oliver as to his opinion, and give his reply: "I am surprised to see that a sentence on page 50 of my book was capable of being misinterpreted but only because the next sentence has been omitted." The quotation goes straight on: "But so long as a conductor is straight (and a lightning conductor must, of course, be straight), so long, etc., thereby showing that anything said about zigzagging referred to experiments and not at all to what was practicable or desirable in lightning conductors."

The object of thus leaving out the remainder of the extract is in accord with the tone of his letters of October 22, and I think he owes Sir Oliver, who bye-the-bye did sign the 1905 Report, an apology for the trouble I have been obliged to give him.

I may point out that my book "Modern Lightning Conductors," was never put forward as the official report of the Lightning Research Committee; however, the information which it contains has caused such interest in the subject that I am now engaged on a second edition, which Messrs. Crosby Lockwood hope to publish early next year. Yours faithfully,

Killingworth Hedges, M.Inst.C.E.

Westminster.

Hon. Secretary of the Lightning Research Committee of the Royal Society, R.T.B.A., and Surveyors Institution (1901-1905).

ELECTRIC PROJECTS FOR 1910.

(*Continued from page* 762.)

Middlesbrough Corporation.

Application by the Middlesbrough Corporation for an Act for further powers with regard to Gas and Electricity supply, including powers to supply meters, cookers and fittings and to reduce illuminating power of Gas.

Frimley Electric Lighting.

The Urban District Council of the urban district of Frimley, Surrey, intend to apply to the Board of Trade for a Provisional Order to authorise the Council to generate and supply electricity for all public and private purposes as defined by the Electric Lighting Acts within the whole of the urban district of Frimley.

Morecambe Tramways Co.

The Morecambe Tramways Co. intend to apply to Parliament in the ensuing Session for leave to bring in a Bill to reconstruct and alter Tramway No. 2, authorised by the Morecambe Tramways Act, 1886 (hereinafter called "the Act of 1886") in so far as such reconstruction or alteration may be necessary to adapt such tramway for the use thereon of mechanical, steam, petrol, electrical or other motive traction, and to execute all such works in any street or road as may be necessary for that purpose; for the Reconstruction, Alteration and Adaptation of Tramways for that Purpose; Provisions as to Capital and Internal Affairs of the Company; Application of Funds, etc.; Dissolution and Winding up of Company; Agreements with Local Authorities and others; Repeal, Alteration, Incorporation and Amendment of Acts and other Purposes.

Salford Corporation.

The county borough of Salford, by certain clauses in an "Omnibus" Bill, seek powers for the Corporation to recover in any court of summary jurisdiction payment for and in respect of the hire of gas and electric meters, motors, gas stoves, and for and in respect of work done by the Corporation in the fixing and repairing of such meters, motors and stoves, and to prescribe or apply such procedure as may be found necessary or desirable for such recovery; to provide that engines, dynamos, fittings, apparatus and appliances let by the Corporation on hire to consumers, whether or not fixed or fastened to any part of any premises in which they may be situate, or to the soil under any such premises, shall not cease to be the property of or to be removeable by the Corporation, and shall not become the property of or be liable to be disposed of by the owner of such premises or soil, or by any mortgagee who may enter into possession under or foreclose any mortgage or charge; to exempt any engines, motors and dynamos and any gas fittings or any electric fittings let by the Corporation on hire from liability to be taken in distress and from being taken in execution or in bankruptcy proceedings.

Rhondda Urban District Council.

The Urban District Council will seek powers for the Construction of Tramways; Gauge and Motive Power; Application and Repeal of Enactments Relating to Existing Tramways and Substitution of New Provisions; Crossing and Passing Places; Junctions; Temporary Tramways; Shelters and Waiting Rooms; Working of Tramways by Council; Use of Electrical or Mechanical Power; Working Agreements; Granting of Leases by Council of Tramways; Further Provisions as to Purchase of Tramways; New Roads and Street Improvements; Provisions in Respect of Construction, Maintenance and Repair of Certain Works by Taff Vale Railway Co., etc.

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CHIPPING NORTON GAS AND ELECTRICITY.

Application for an Act to incorporate a Company with power to supply gas and electricity for all purposes, public and private, to and within the borough of Chipping Norton and the parishes of Over Norton and Great Rollright, in the county of Oxford; to empower the Company to purchase the undertaking of the Chipping Norton and District Electric Light and Power Co., Ltd., free from all obligations; to empower the company to erect and maintain a generating station for the supply of electricity.

RADCLIFFE ELECTRIC LIGHTING.

Application to the Board of Trade by the Lancashire Electric Power Co., Manchester, for a Provisional Order to authorise the Undertakers to produce, store, sell and supply electricity for all public and private purposes, within the urban district of Radcliffe, in the county of Lancaster. It is proposed that the electric lines and works shall be laid down within two years after the commencement of the Order in certain roads and streets.

WIDNES ELECTRIC LIGHTING.

Application is intended to be made by the Mayor, Aldermen and Burgesses of the borough of Widnes, in the county of Lancaster, to the Board of Trade for a Provisional Order to amend the Widnes Electric Lighting Order, 1901; to empower the Corporation to break up within the borough of Widnes certain streets and roads not repairable by the Corporation; to authorise and empower the Corporation (if thought fit) to supply electricity in bulk within the borough of Widnes and also in any districts or areas outside such borough, and for such purposes to confer on the Corporation all the powers of the Electric Lighting Acts with respect to the breaking up of roads, railways or tramways in such borough, districts or areas; also for provisions with respect to transfer of powers, etc.

YORKSHIRE ELECTRIC POWER.

Application by the Yorkshire Electric Power Co. for leave to introduce a Bill to alter and regulate the capital and borrowing powers of the Company; to confer special powers upon the Company with respect to the creation and issue of capital authorised; to authorise the Company to lay electric lines in any street or road laid out, but not repairable as a highway by the inhabitants at large.

HANDSWORTH URBAN DISTRICT COUNCIL.

Application by the Urban District Council of Handsworth, in the county of Stafford, for an Act to enable the Council, to construct, form, lay down, maintain and work in the district new tramways, such new tramways to be constructed on a gauge of 3 ft. 6 in. The motive power to be used on the new tramways is animal power or electrical power, to be applied by means of motors in the engines or carriages or communicated by electric lines in or underground or overhead, or steam, gas, air or other mechanical power applied by means of locomotive engines, or by motors in the carriages, or by means of wire or rope cables worked by stationary engines. Also to empower the Council on any of the Council's tramways to substitute single or interlacing lines for double lines or double or interlacing lines for single lines or double or single lines for interlacing lines, and to empower the Council when any road in which a tramway is laid is altered or widened to reconstruct such tramway in such position as they think fit or the intended Act may authorise or prescribe.

BRIXHAM ELECTRIC LIGHTING.

Application by R. A. Lister & Co., Ltd., of Dursley, in the county of Gloucester, to the Board of Trade for a Provisional Order to authorise the Company to generate and supply electric energy for lighting, heating, power and all other purposes in the urban district of Brixham and the rural district of Totnes, in the county of Devon, or some part or parts thereof; to authorise the Company to construct generating stations and other works and conveniences, and to lay down or erect electric lines, posts and any other apparatus, and to open and break up streets, roads and public places, ways, footpaths, tramways, railways, sewers, drains, pipes and wires within the area of supply.

BISHOP'S STORTFORD, HARLOW AND EPPING GAS AND ELECTRICITY.

Application for an Act for the amalgamation of Bishop's Stortford and District Gas Co., Harlow and Sawbridgeworth Gas Co. and Epping Gas Co.; vesting in Amalgamated Co. of Undertakings of Ongar Gas Co., Ltd., Newport (Essex) Gas Co., Ltd., and Much-Hadham Gas Co., Ltd., and Dissolution of those Companies; power to Purchase Undertaking of Dunmow Gas Co., Ltd.; power to Supply Electricity and Erect Generating Stations; powers to deal in Gas and Electric Stoves, Fittings, Machinery and Appliances; to acquire Patent Rights.

NOTTINGHAM CORPORATION.

Application by the Mayor, Aldermen and citizens of the city of Nottingham for an Act to empower the Corporation to construct tramways. The proposed tramways are intended to be constructed on a gauge of 4 ft. 8½ in., or such other gauge as may be approved by the Board of Trade; it is not proposed to run thereon carriages or trucks adapted for use upon railways. The motive power proposed to be employed upon the tramways will be animal power or electrical, steam or other power not being animal power or partly by one such power and partly by another. Also to provide that the proposed tramways shall form part of the existing tramway undertaking of the Corporation; and to extend the time limited by the Act of 1905 for the construction of such of the tramways authorised by that Act as have not yet been constructed.

HAVANT GAS AND ELECTRICITY.

Application for an Act for the dissolution of Havant Gas Co., Ltd.; incorporation of new Company; transfer of undertaking; acquiring lands for generating electricity, etc.

MIDDLETON CORPORATION.

Application for an Act conferring further powers on the Corporation of Middleton as to further provisions concerning the gas and electricity undertakings of the Corporation; gas testing; free wiring; supply in bulk; supply to premises outside borough, etc.

RAWTENSTALL CORPORATION TRAMWAYS.

The Mayor, Aldermen and burgesses of the borough of Rawtenstall, in the County Palatine of Lancaster, intend to apply to the Board of Trade for a Provisional Order to enable the Corporation to construct tramways. The tramways will be constructed on a gauge of 4 ft. or such other guage as may be determined, and it is not intended to run thereon carriages or trucks adapted for use on railways. The motive power to be used upon the tramways will be animal power or any mechanical power (including in that expression steam, electric or any other motive power not being animal power), or partly one such power and partly another, and the Order will empower the Corporation for that purpose to supply and use electrical energy from any generating station of the Corporation, and to erect, place, make, and maintain works, engines, machinery, dynamos, and apparatus for the production, storage, and supply of energy or other power, and to lay down, erect, construct, maintain above, upon, and below the surface of the ground, and to attach to houses and buildings mains, lines, pipes, conductors, cables, ropes, brackets, boxes, apparatus and things necessary or proper for the transmission of electricity or other power and the working of the intended tramways or any of them by electricity or other power.

MILNROW URBAN DISTRICT TRAMWAYS.

The Milnrow Urban District Council intend to apply for a Provisional Order to authorise the Council to construct tramways.

DAWLISH ELECTRIC LIGHTING (AMENDMENT.)

The Electric Supply Corporation, Ltd., whose registered office is situate at Salisbury House, London-wall, London, intend to apply to the Board of Trade for a Provisional Order to provide for the transfer by the Company of all or any of the rights, powers, privileges, authorities, obligations and works of the Company under the Dawlish Urban District Electric Lighting Order, 1903, and the existing Order to the Dawlish Electric Light and Power Co., Ltd. (hereinafter called "the Dawlish Co.") and to constitute the Dawlish Co. the undertakers for the purposes of the existing Order; to amend, alter or repeal all or some of the provisions of the existing Order, and in particular to amend section 6 thereof by extending the period in that section mentioned within which distributing mains are to be laid down within the area of supply as defined in the existing Order.

WARRINGTON CORPORATION.

Application for an Act containing further provisions as to the gas, water and electricity undertakings of the Corporation; free wiring; supply of electricity in bulk, etc.

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WARNING.

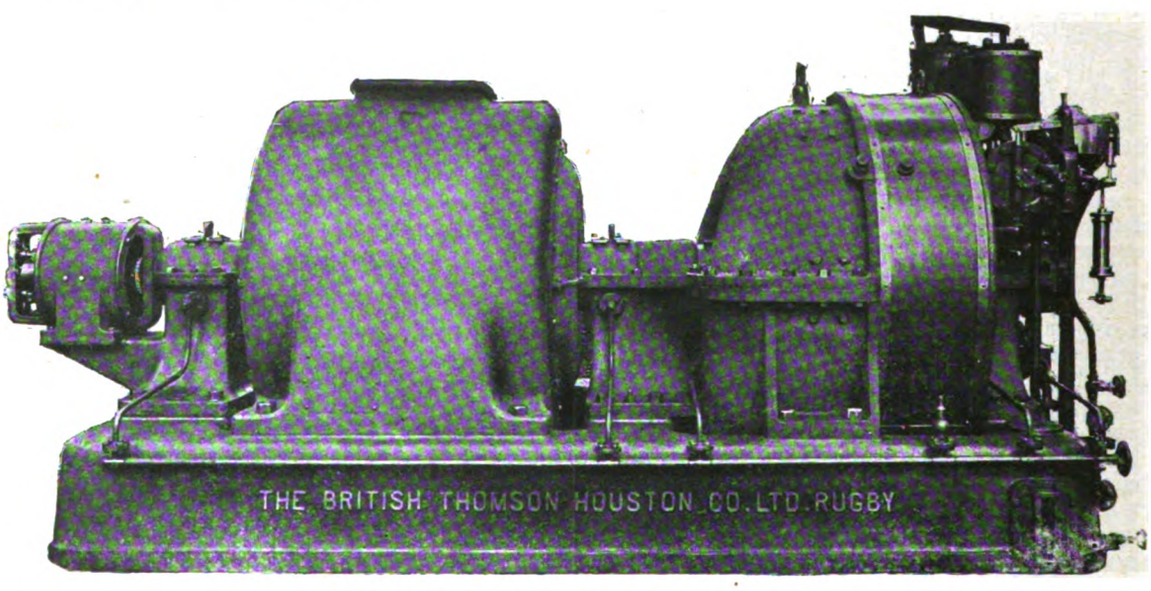
B.T.H. IMPULSE STEAM TURBINES.

CURTIS PATENTS.

The well-known Curtis Turbines are Impulse Turbines in which the steam is expanded in a series of stage nozzles with abstraction of the velocity acquired in each expansion by intervening stage wheels.

These Turbines are sold in Great Britain exclusively by **THE BRITISH THOMSON-HOUSTON COMPANY LIMITED,** and their **LICENSEES.**

Sellers and Users of infringing Turbines are hereby notified that they will be proceeded against.



1000 KW. CURTIS TURBO-GENERATOR.

THE BRITISH THOMSON-HOUSTON COMPANY LIMITED have sold a total of 67 Curtis Steam Turbines aggregating a capacity of 85,000 Kilowatts.

All of these Turbines have been manufactured or are now in course of construction at their Rugby Works.

Supplied in all sizes—either vertical or horizontal.

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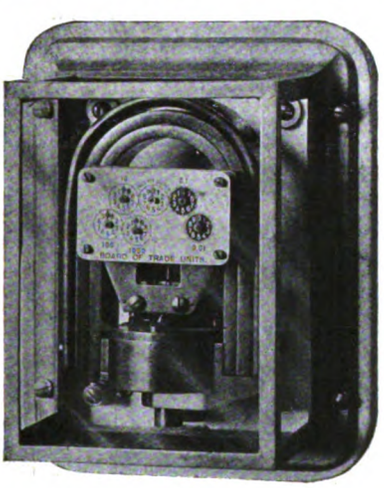
PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

B. T. H. CONTINUOUS CURRENT AMPERE-HOUR METER.

We illustrate below a new mercury type ampere-hour meter for switchboards which is being placed on the market by the British Thomson-Houston Co., Ltd., of Rugby. The new meter is similar in general construction to the popular house service meter of the same type and is likely to be in great demand. The instrument is mounted on a frame which also carries the terminals and fixing studs, and is supplied with a glass and metal cover. It is suitable for mounting direct on the switchboard panel without the necessity of employing a sub-base. The standard finish of the metal cover is nickel, but a copper or black oxidised finish can be supplied. The meter is supplied with a current shunt external to the case. Dials of either the "Clock" type or "Cyclometer" type can be supplied as required.

The principle underlying the action is that of an ordinary electric motor, the permanent magnet providing the magnetic field in which the copper cup acts as the conductor or armature, commutation being effected by the mercury in which the cup is immersed. The current is led into the mercury bath at the top and out at the bottom on the extreme edge of the cup, passing through the strongest and most condensed part of the magnetic field produced by the permanent magnet. The meter is calibrated



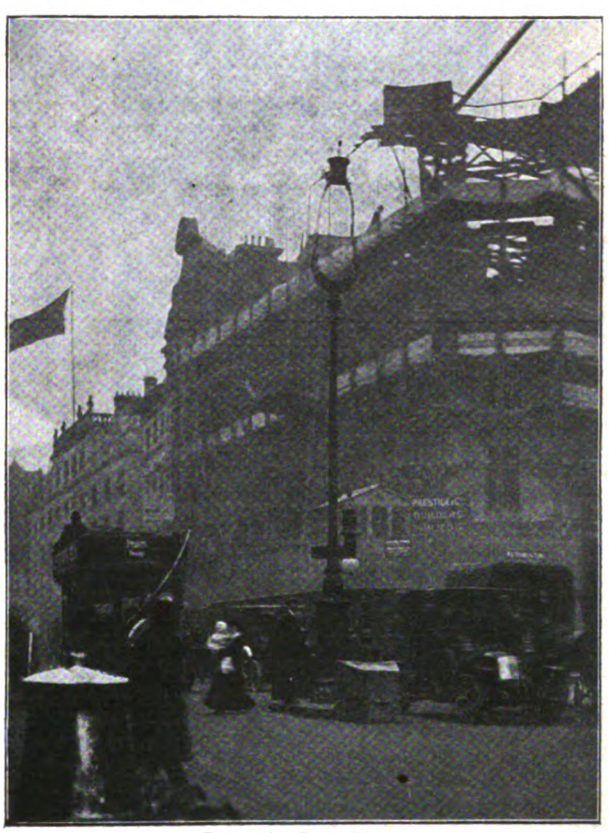
Type M.S. Switchboard Meter, on Marble Base.

by altering the electrical circuit, and not by distorting the magnetic field, the former method giving a very permanent calibration. Mercury friction has been practically eliminated by working with very high torque and strong braking forces.

The mechanical friction is very small owing to the extremely light pressure on the jewelled bearing. This is obtained by counter-balancing the weight of the moving element by the thrust of the mercury, thus ensuring long life for the pivot and jewel. The total losses in this meter have consequently been reduced to an extremely low figure. The mercury sealing device is carefully designed, and when sealed for transportation, the packing securely clamps the spindle and completely fills the air space around it. This renders it impossible for the mercury to leak, the chamber being completely sealed. The meters are supplied for any voltage up to 600 inclusive, and the dial can be arranged to read either in ampere hours or k.w. hours on a constant voltage.

PATENT ARC LAMP LOWERING GEAR.

Recent contracts obtained by the London Electric Firm, George-street, Croydon, for their "Patent one working part" arc lamp lowering gear, include:—87 for the St. Marylebone Borough Council, consisting of single and double swan necks and centre carrier gears, for Oxford-street and Upper Regent-street; 72 for the Ealing Corporation, consisting of swan necks and centre



Patent Arc Lamp Gear.

carriers on traction pillars, and on lamp pillars with tank transformer bases; 80 for the Swansea Corporation, comprising swan necks, trolley arms, and span wire gears. The centre pole gears are "converted lyres," and the accompanying illustration shows the Regent-street gears, which are representatives of the whole.

ELECTRICITY AT DEVONPORT DOCKYARD.

Messrs. Cowans, Sheldon & Co., Ltd., Carlisle, have installed an electric crane of 160 tons capacity at the Keyham extension of Devonport dockyard. It consists of a tower 109 ft. in height and 46 ft. square to the centres of the main columns, carrying cantilever girders about 220 ft. long and 28 ft. deep at the centre. The construction of the tower and cantilever was entrusted by Messrs. Cowans to Messrs. A. & J. Main & Co., Ltd. The crane, although nominally of 160 tons lifting capacity, has been tested by the Admiralty with a load of 240 tons. Loads of 160 tons are taken at 95 ft. radius, 80 tons at 105 ft radius and 50 tons at 128 ft. radius. The electrical equipment was provided by the British Westinghouse Co., and the motors are all of the totally enclosed series-wound multipolar type, working with direct current at 440 volts. The ropes are of extra special plough steel quality, supplied

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by Messrs. T. & W. Smith, Ltd., of Newcastle-on-Tyne. During the official trials by the Admiralty authorities the deflection at the front end of the cantilever when lifting 160 tons at 95 ft. radius was $4\frac{3}{4}$ in., and $7\frac{3}{4}$ in. with a load of 240 tons. A similar crane of 200 tons capacity at 105 ft. radius has been ordered from Messrs. Cowans by the Japanese Government for Kure Dockyard, and they are building a third, also of 200 tons capacity, for the dockyard at Yokosuka.

TANTALUM LAMPS IN ITALY.

We reproduce below the design of an attractive showcard issued by Messrs. Siemens Bros., Dynamo Works, Ltd., for advertising the noted "Tantalum" lamps in Italy.

ECONOMIC ELECTRIC STOVE.

A very useful apparatus, which bids fair to become highly popular with consumers of electric current, is the Economic Electric Stove. The device, which is being supplied by Messrs. Siemens Bros. Dynamo Works, Ltd., is suitable for voltages from 100 to 250 for d.c. or a.c. circuits and has many points to commend it for general use. Neat in appearance, it is offered at a low price and owing to the small current consumption and long life, the maintenance costs are moderate. The device is suitable for cooking, roasting, ironing, toasting, etc., and ordinary household utensils may be used as in the case of the gas stove. It gives off no offensive fumes, no smoke or soot, and requires no cleaning whatever. Moreover, it may be used as a radiator for heating of rooms, greenhouses, etc., and being constructed of aluminium where possible it can be easily removed from one room to another. The heating element can be cheaply and easily renewed.

NEW TYPE OF MOTOR STARTER.

Messrs. A. Reyrolle & Co., Ltd., have recently put on the market a new type of starter, up to 2 h.p. only, which is something of a departure from their well-known standard type fitted with their patent resistance, and we are advised that they have designed this new starter in response to a demand for cheap but well-finished apparatus of this description.

Their latest type is totally enclosed, and has oil immersed resistances. They are fitted with no-voltage release only, and have a powerful magnetic blow-out on all steps, and the amount of burning on the contacts is thus a minimum even under severe working conditions.

AN UNBREAKABLE INSULATOR.

A composition insulator has been produced by a Dunedin resident. He claims that it is unbreakable, and that the greater portion of the materials from which it is made are probably only to be found in New Zealand. The composition is applicable for all classes of insulation. It has been tested on the telegraph lines during the past sixteen months with satisfactory results. Patents are being obtained throughout the world.

DIMENSIONS OF BUSBARS, CABLE SOCKETS, ETC.

The Fig. 1 gives standard dimensions to suit various currents. The busbars are of rolled copper, and the end of the stud is burred over after it has been screwed in. The dimension *C* gives the thickness for slate, but, of course, this would vary with area of the slate. The cable sockets would be of gun-metal, and although the drawing shows it straight, it is common practice to bend it, as in Fig. 2 :—

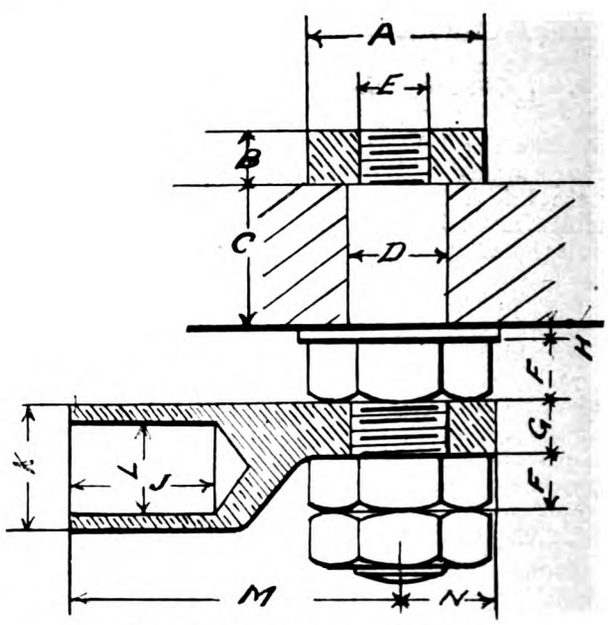

FIG. 1.—DIMENSIONS OF BUSBARS.

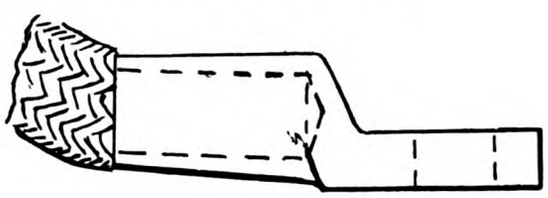

FIG. 2.

Ampr's	Nearest Cable. Std.	Nearest Cable. dia.	Rolled Copper Busbar. A	Rolled Copper Busbar. B	Slate. C	Spindle. D	E	F	G	H	J	K	L	M	N
15	7/17	·168	7/8	1/8	1	1/4	1/4	1/4	3/16	1/32	1/2	3/8	3/16	1 1/4	1/4
25	7/16	·19	7/8	1/8	1	3/8	5/16	3/8	1/4	3/32	3/4	7/16	3/32	1 1/8	3/8
50	12/17	·28	1	3/16	1 1/4	7/16	5/16	3/8	1/4	1/32	3/4	9/16	5/16	1 1/4	7/16
75	19/17	·36	1	3/16	1 1/4	1/2	7/16	7/16	1/4	1/32	7/8	5/8	3/8	1 1/8	1/2
100	19/15	·40	1 1/4	1/4	1 1/4	9/16	3/8	7/16	5/16	1/16	1	3/4	1/2	2 1/4	9/16
150	37/15	·50	1 1/4	1/4	1 1/4	5/8	3/8	1/2	3/8	1/16	1 1/8	7/8	9/16	2 1/4	5/8
200	19/11	·58	1 1/2	5/16	1 1/4	11/16	1/2	1/2	3/8	1/16	1 3/16	1	11/16	2 3/8	11/16
300	37/15	·72	1 5/8	3/8	1 1/4	3/4	1/2	9/16	7/16	1/16	1 3/8	1 3/16	3/4	2 3/8	3/4
400	61/13	·82	1 3/4	3/8	1 1/2	7/8	1/2	5/8	1/2	3/32	1 1/2	1 5/16	1	2 7/8	7/8
500	61/12	·93	1 5/8	7/16	1 1/2	1	5/8	5/8	9/16	3/32	1 5/8	1 7/16	1 1/8	3 1/4	1
600	91/13	1·01	1 7/8	7/16	1 1/2	1	5/8	3/4	9/16	3/32	2	1 1/2	1 3/16	3 1/2	1
800	61/10	1·15	2	1/2	1 1/2	1 1/8	5/8	7/8	5/8	3/32	2 1/4	1 5/8	1 1/8	4	1 1/4

E.K.S.

RADIOTELEGRAPHY AT NEWCASTLE.

At the close of Professor H. Stroud's address to Newcastle Local Section, Institution of Electrical Engineers, on November 22, (as reported in the ELECTRICAL ENGINEER, November 26), through the co-operation of Mr. A. Sorensen, a demonstration was given showing how the Poulsen waves, being made intermittent at the transmitting station at Cullercoats, actuated an ordinary spark receiver. This demonstration was of interest as showing how stations equipped with the Poulsen arc sender only, can communicate with not only Poulsen stations, but also with ships and other stations equipped with the ordinary spark receiver.

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ON WAR OFFICE LIST.

IMPORTANT NOTICE—

WANTED KNOWN—

That the **Greatest Improvement** and LATEST DEVELOPMENT in TUNGSTEN METAL LAMPS NOW ON THE MARKET, is

BODDY'S "METALIK" of

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14 British C.P. 100 to 130 volts.
22 „ „ 200 „ 260 „

THE LOWEST CANDLE POWER HITHERTO OBTAINED and is THE MOST EFFICIENT LAMP with THE STRONGEST FILAMENT AND LONGEST LIFE THE WORLD HAS YET PRODUCED.

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The Company transacts all the principal classes of Insurance business on advantageous terms, including

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Loss of Profits following fire, Workmen's Compensation, Fidelity, Guarantee, Burglary, also undertakes the duties of Executor and Trustee.

ELECTRIC LIGHTING.

The Company has always encouraged the development of Electricity, and the well-known "Phœnix Fire Office" Rules for Electrical Installations are in use throughout the world. Copies will be supplied free on application to the Head Office.

G. H. RYAN, General Manager.

ASHTON ELECTRICIAN'S FAILURE.

The examination in bankruptcy took place, at the Ashton Bankruptcy Court, of Eric Eaton, electrical engineer, recently carrying on business in George-street, Ashton. Debtor stated that he commenced business as an electrical engineer on June 12, 1907, at premises in Mossley-road, with a capital of £40 savings. He removed to George-street, in September, 1908. On January 15, 1909, he executed a deed of assignment for the benefit of creditors generally in favour of Mr. Ernest Broadbent, accountant, Ashton. The trustee had since carried on the business, and he had acted as manager at a salary of 30s. a week, and 35s. a week since his failure. The causes of his failure were lack of capital, bad trade, and losses on contracts. His liabilities to unsecured creditors amounted to £235 5s. 3d., and to preferential creditors £7 17s. 5d., assets, furniture and fixtures £20, stock-in-trade £82, utensils £27 13s. 3d., book debts £65 5s. 7d., total £194 18s. 7d. The examination was closed.

TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

"If thou hast knowledge, let others light their candle at it."

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should be *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

QUESTIONS.

Question No. 1212.—Owing to the great improvements that have been made this last few years in metallic filament lamps and their manufacture for H. V. circuits and large and small candle powers, a great many supply undertakings are seriously considering the advisability of changing over their street lighting from arc lamps to that of some kind of cluster of metallic filament lamps placed on lower posts and at more frequent intervals, thus giving a more even distribution of light (although, perchance the total c.p. may be less). State the pros and cons of street lighting by metallic filament lamps V. open type, 10 amp. arc lamps and give, if possible, a list of towns where arc lamps have been changed over.—"D. E. J."

Question No. 1207.—Explain briefly the principles of construction of the pure repulsion motor, particularly that type where the starting, etc., is performed by movement of the brush arms. State the conditions under which speed regulation is obtained, the method of starting and stopping, and the method of operating. Does torque vary with speed, and can the motor hold the load when standing still, or is a brake required? Is there any way of stopping sparking at starting other than by the two winding method? Would a supplementary brush trailing a little behind the principal brush, with the short-circuited coil between the two, bridged by capacity, be of any use?

Answer to Question No. 1207 (*awarded* 10*s.*).—The construction of a repulsion motor consists essentially of a laminated slotted stator carcase, with no salient poles, wound exactly as for use as a one-phase induction motor. For reasons apparent later, the number of poles should be, if possible, such as to make the normal speed of a motor nearly the synchronous speed of the supply frequency used. Since both the stator and rotor of a repulsion motor

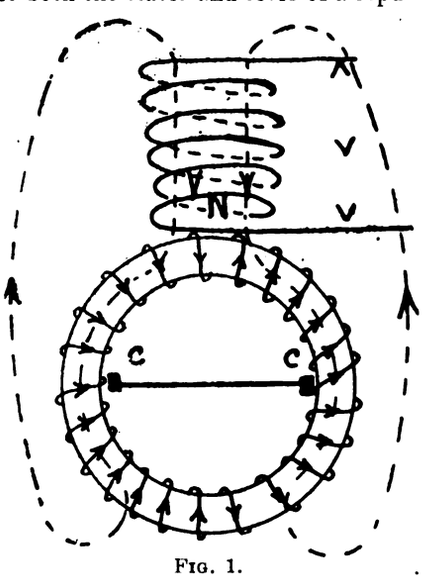

FIG. 1.

have to carry a flux which is the resultant of the field produced in the stator by the supply current and a cross flux produced by the rotor current, and which, under normal running conditions, is usually about 1·4 times either of these component fluxes, it follows that the iron sectionof the stator

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yoke and rotor core must be proportionately greater than would be necessary in a simple series machine where the whole flux concerned is that due to the stator.

The rotor of a repulsion motor is identical with a ring wound direct current armature, but the commutator may now be considerably smaller since the brushes and commutator bars have only to carry the "exciting" rotor current, instead of the current corresponding to the full output of the machine, as is necessary in series motors. The number of poles on the rotor is absolutely unconnected with the stator voltage, but limitations are imposed by the heavy current which must flow from the commutator if too few poles are employed, or by the high reactance

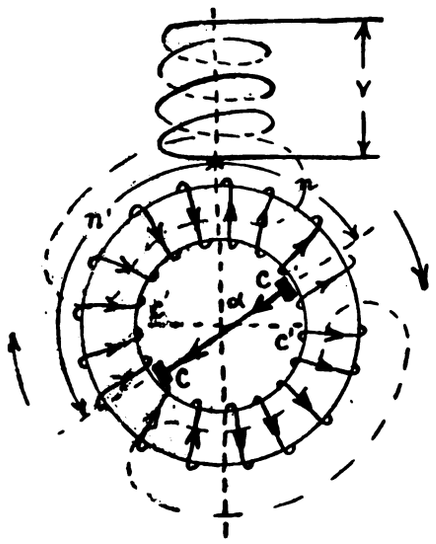

FIG. 2.

volts and consequent sparking which follow the use of too many turns per segment. Though flashing over between brushes is not possible on repulsion motors since the brushes are always short circuited, there exists considerable p.d. between certain adjacent commutator bars and between adjacent armature conductors, so that the rotor insulation required is heavier than in squirrel cage induction motors.

Theory of Repulsion Motors. Fig. 1 represents diagrammatically the electrical conditions of a repulsion motor. Consider first the brushes to be in the position shown, and the stator flux to be increasing, then the currents induced in the rotor winding are as shown, and have therefore no *nett* effect. If, however, the brushes be displaced as in Fig. 2, then a current will flow *viâ* C.C. since the winding at these points is no longer at equal potential. The number of conductors in which an E.M.F. is induced in one direction is less than the number in which

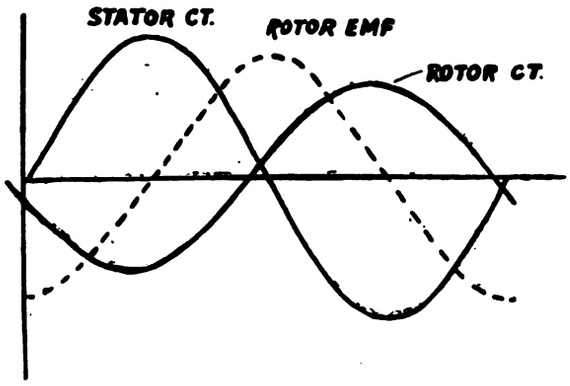

FIG. 3.

an opposing E.M.F. is induced. The rotor E.M.F. so induced is 90° out of phase with the stator field and current (see Fig. 3). There being much leakage flux between the stator and rotor windings, a considerable lagging of rotor current on E.M.F. occurs (see Fig. 3). Thus the stator and rotor current are nearly in phase, and therefore produce the motor torque, which is here clockwise (the torque is always in a direction opposite to that in which the brushes are displaced from perpendicularity to the axis of the stator field).

When the armature is running, an E.M.F. of rotation is induced in the rotor by the stator field, but, as shown in Fig. 4, the only effective E.M.F. is that induced in the conductors between A B and A^1 B^1. The bars lying between A^1 B and A B^1 neutralise each other so far as E.M.F. to rotation is concerned. On the other hand, the segments A B, A′B′ are idle in respect of induced E.M.F., while A′B, A B′ are operative for this purpose. The smaller the angle α, Fig. 4, the higher must be the motor speed to generate in the fewer effective armature conductors the necessary back E.M.F. of rotation required to choke down the current to the value required by the load. When $\alpha = 0°$ the rotor speed is limited only by the bearing friction, windage, etc.

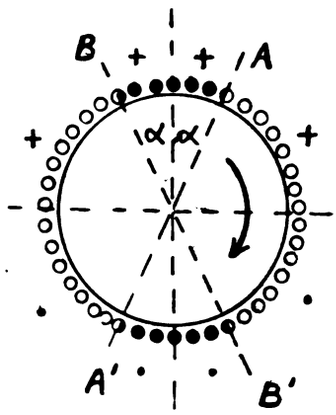

FIG 4.

Though repulsion motors may race as badly as series motors on light load if the brushes be not moved to suit the latter conditions, there is for every brush position (except $\alpha = 0°$, Fig. 4) a limiting rotor speed. The mean torque of a repulsion motor is proportional to sin 2 θ (where θ equals the angle between the brush axis and the rotor field axis), hence the torque is zero when $\theta = 0°$ or 90°, a fact which is evident from Figs. 1 and 4, since in these positions the brushes short circuit points of equal potential, and hence no rotor current flows. When $\theta = 0°$ the rotor is in unstable equilibrium, whereas when $\theta = 90°$ the equilibrium is stable.

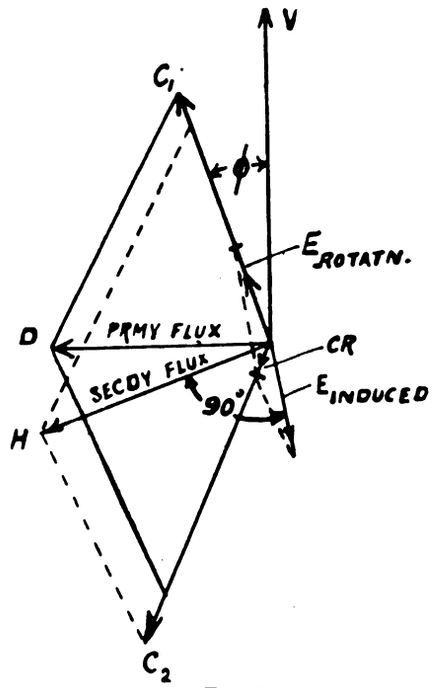

FIG. 5.

It follows that when θ lies between 0° and 90°, the rotor tends to move from the unstable to the stable position, but the brush axis being fixed, this endeavour simply results in continuous rotation of the armature. The rotor E.M.F. of rotation is in phase with the stator flux and hence the stator current (see Fig. 5).

As a result of this fresh E.M.F., which is only present when the machine has started from rest, the resultant rotor E.M.F. is swung round till it is more nearly in phase with the secondary flux O.H., Fig. 5. As a consequence O.C.^{2} becomes more nearly perpendicular in phase to O.C.^{1}, meanwhile decreasing in magnitude, since the torque

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varies with the cosine of the angle between O.C.[1] and O.C.[2] it follows that as O.C.[2] moves round the torque gradually decreases. Ultimately O.C.[2] is perpendicular to O.C.[1], and the resultant torque is nil under these conditions; the limiting speed of the motor for this particular setting of the brushes is then reached.

In traction and hoist work, it is frequently convenient to use two field coils as in Fig. 6, the speed then being regulated by varying the number of turns of these coils in circuit. Distant control is obviously more conveniently effected electrically than by mechanical movement of the brushes. A further advantage of employing two such field coils is that by making the component F (Fig. 6) very strong, the secondary current may be swung right through the 90° position, and hence will produce, with O.C.[1], a negative torque, *i.e.*, very powerful braking.

Instead of varying the strength of the field F as above to obtain braking, it is, of course, feasible to move the brushes through the neutral position, and give α a negative value.

Yet another method of reversing repulsion motors, which is convenient as enabling easy remote control for lifts, etc., consists in fitting the stator with a three-phase winding and supplying one phase alternating current to two terminals 1, 2, for forward running and to 3–2 for reverse running. The *effect* of all the methods suggested is, of course, the same, viz.,to vary the relative inclination of the rotor and stator magnetic axis. The E.M.F. of rotation induced in the rotor not only influences the torque, as explained above, but also increases the power factor of the running

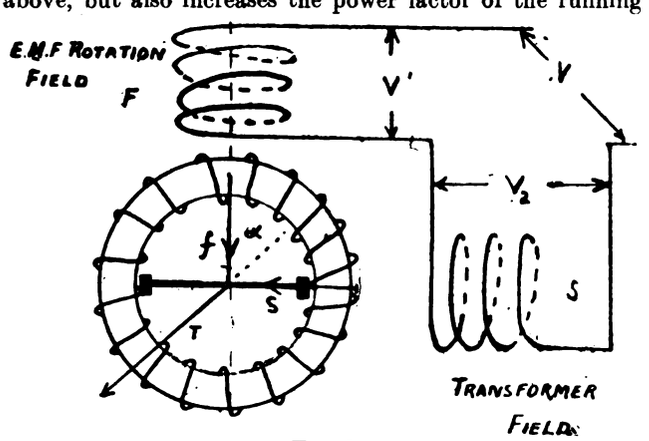

FIG. 6.

machine, and makes it superior in this respect to all other single phase motors. On starting, the power factor is, of course, merely that of the motor winding, and may be 40%, but on running up to speed it is easy to secure a power factor of 96%, or even higher, and with a reasonable gap length.

When running near synchronous speed, the repulsion motor is inherently a sparkless machine, a most important reason why the normal speed of the machine should be as nearly equal the synchronous as possible. On starting, however, there is liable to be a heavy current rush and consequent sparking, just as in a series motor. This trouble is usually overcome by the use of a double winding. Simpler methods tending towards the same results are, however, the use of narrow brushes as possible, and the use of some such arrangement as *Latour's* double brushes.

By the use of narrow brushes, the number of coils short circuited at any moment, and hence the value of the short circuit current is reduced, while the added advantage is obtained of reducing the negative torque on starting, the latter being due to the current flowing in the shorted coils. At synchronous speed there is no current induced in the shorted coil, and sparking is therefore impossible.

Latour's double brush arrangement referred to above is illustrated in Fig. 7. The four insulated brush arms are carried from one frame so that the whole group is moved together. The component of the stator field, which is ordinarily responsible for the currents induced in the shorted turns, now enters and leaves the rotor outside the arcs covered by the shorted brushes.

Summarised, the chief advantages of repulsion motors are :—

1. Suitability for traction work, owing to the high voltages for which the stator can be wound. No current has to be fed into the rotor, hence the sparking difficulties, which limit the voltage of ordinary a.c. commutator motors are not longer experienced.

2. Further suitability for traction and hoisting loads by reason of the very high starting torque available and subsequent "series" characteristics. A repulsion motor gives its maximum torque on starting.

3. The power factor of repulsion motors is exceptionally high.

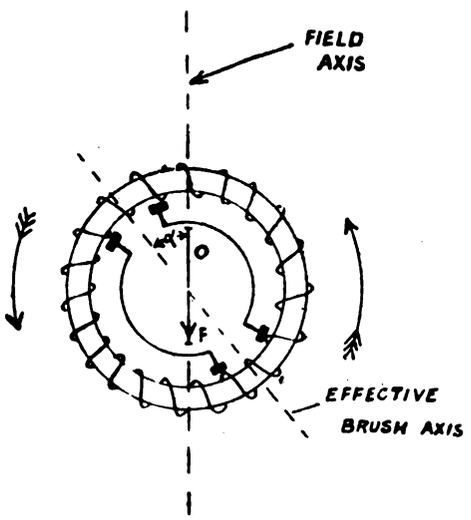

FIG. 7.

4. For any given brush position there is a definite limiting speed, the repulsion motor resembling the direct current shunt machine in this respect.

5. Speed and torque control is easily effected either by brush movement or by the use of two field windings.

6. The motor can be used as a powerful brake providing due allowance for the increased service be made in fixing its rating.

7. The construction electrically and mechanically is simple, and the motor is suitable for very rough service.

As all the good features of repulsion motors are most apparent when the machine runs at nearly synchronous speed the latter should be made to coincide with the normal speed required as nearly as possible.—"L. C.'

Answer to Question No. 1207 (*awarded* 5*s.*).—The repulsion motor has been experimented with by various designers for some years and has now been developed into a very satisfactory a.c. machine. Its chief advantages are high starting torque, high power factor, and capability of running on high voltages without sparking, together with the important attributes of easy control and mechanical robustness. The stator is a laminated structure and is wound like an ordinary induction motor stator so as to be excited by single phase alternating current. The rotor is essentially a direct current ring armature and commutator, but instead of current being fed into this winding, as is done in series machines, the two commutator brushes at 180° pitch (in 2 pole machines), are short circuited and the current actually flowing in the armature winding when the machine is up to speed, is that due to the resultant of an E.M.F. of induction and an E.M.F. of rotation.

Referring to Fig. 1, which diagrammatically represents the electrical conditions in a repulsion motor, the alternating single-phase field OT through the rotor may be resolved into two components OA, OB, respectively coincident with and perpendicular to the brush axis BB. Towards the field OA, the armature behaves like the short circuited secondary of a transformer and strong induced currents therefore flow round the winding. The nett effect of OB, as regards induction, is nil, since the E.M.F.'s induced by it in the two halves of the winding are equal and opposite. Now, when the armature is revolving there are two induced E.M.F.'s in the winding due to its revolution in the fields OA, OB. Of these E.M.F.'s OA is inoperative, so that the effective E.M.F.'s are that *induced* by OA and that *generated* by OB. The resultant of these two E.M.F.'s is the E.M.F. required to overcome the ohmic resistance of the winding.

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In the case of a series motor the torque is proportionate to (stator current)^2, while the field is unsaturated, but in a repulsion motor the torque varies with the displacement angle α, Fig. 1, of the brush axis from the field axis OT, and since, to secure a torque, the two components OA, OB must exist simultaneously, it follows that there are two positions of zero torque, viz., when $\alpha = 0°$ (*i.e.* OB = 0) and when $\alpha = 90°$ (*i.e.* OA = 0). Also the torque should, theoretically, be a maximum when the angle $\alpha = 45°$, but owing to inequalities in the field strength, this maximum is usually reached when $\alpha = 60°$ to 70°. Owing to the rotor winding of a repulsion motor being connected to the stator only by a magnetic coupling, the ordinary limit of 200 volts on the stator usually imposed on a.c.

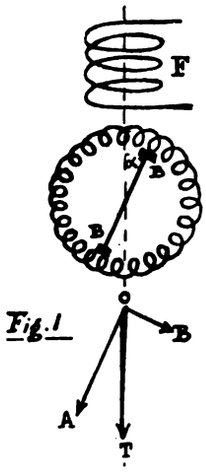

Fig. 1.

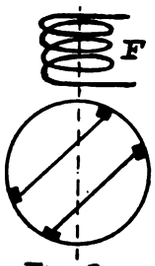

Fig. 2.

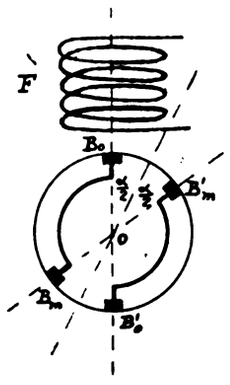

Fig. 4.

commutator motors by sparking consideration no longer applies. The brushes being short circuited in the case of a repulsion motor no flashing over, etc., is possible.

Latour's device for minimising sparking is frequently a satisfactory substitute for two winding arrangements. Four sets of brushes are used and connected as in Fig. 2. All the brushes are mounted on one frame (being suitably insulated therefrom) and moved together as required for speed and torque control. Sparking is considerably reduced by the double short circuit for, whereas in Fig. 1 the short circuited coils were exposed to the full inductive action of the component OB of the stator field (this being the component which causes serious sparking) the flux between the magnetic axis of the rotor and the brush position no longer threads the shorted coils but passes in and out of the rotor core outside the arcs spanned by the shorted brushes.

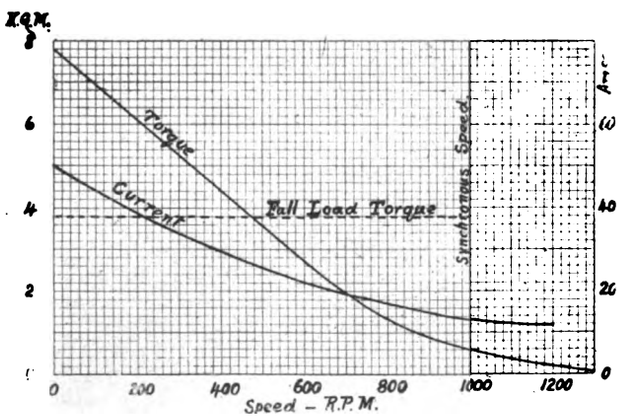

Fig. 3.

Although only certain parts of the rotor winding of a repulsion motor are ever usefully employed at a given moment, it is possible, on account of this intermittent loading, to work the conductors at a correspondingly higher current density than is permissible in ordinary machines so that the nett utilisation of material is about the same.

The starting torque of a repulsion motor is remarkably high, its subsequent speed torque characteristic being very like that of a series machine in so far that the speed drops as the load rises. The repulsion motor is consequently very suitable for traction and hoisting and similar duties. The general type of the current—and torque—speed curves of a repulsion motor is as in Fig. 3 (which gives actual test curves). It will be seen that a starting torque of twice the full load torque is obtained with a current which varies from 50% to 80% in excess of the full load current.

If the a.c. supply be cut off from a repulsion motor and the machine be driven by the load, its field will "build up" just as in a series motor, and hence a powerful braking effect will result. If necessary, the brush short circuit piece can be simultaneously opened and a variable resistance inserted to enable the control of the braking effect. When the car or hoist is *stationary* a brake is necessary to hold the load.

Speed regulation by brush movement:—By altering the inclination α of the brush axis BB (Fig. 1), the relative magnitude of the components OA, OB, is varied: if the component OB be increased, the E.M.F. of rotation for a given r.p.m. is augmented while the induced E.M.F. is decreased owing to the weaker component OA. Hence, increasing OB lowers the speed at which the rotor current vector becomes perpendicular to the primary (stator) current vector, *i.e.*, limits the maximum speed obtainable. If $\alpha = 90°$, OB is maximum and speed is zero, while if $\alpha = 0°$, OB = 0 and the speed is infinite (were it not for brush, bearing and air friction losses). Since a very small brush movement causes a considerable speed variation, it is frequently preferable to employ two stator field coils, actually producing the components OA, OB (Fig. 1), and to vary the excitation or rather number of turns in these coils so as to alter *in effect* the brush axis of the rotor. The brushes are stationary in such a case and distant control of the motor is more conveniently effected.

Deri's arrangement of double brushes is as shown in Fig. 4. $B_oB^1{}_o$ are fixed, whereas $B_mB^1{}_m$ are moveable (together). The rotor magnetic axis bisects the angle $B_oOB^1{}_m$ and a movement $\alpha°$ of the axis B_m $B^1{}_m$ moves the magnetic axis only through $(\frac{\alpha}{2})°$, hence the speed sensibility to brush position is considerably reduced.

The suggested device for reducing sparking would hardly be practicable: better arrangements for the purpose are Latour's double brush equipment already illustrated, and the use of as narrow brushes as possible so as to reduce the short circuit currents flowing under the latter. To enable the use of narrow brushes the material employed should be good soft high conductivity carbon. —"WREN."

SOUTH AFRICAN RAILWAYS THROUGH RATES.

THE ADVANTAGE OF SHIPPING VIA DURBAN.

In view of the growing demand for electrical machinery and appliances in South Africa, it is welcome to learn from the Natal Governement Agency that, as from January 1. next, the preference in railway rates from Delagoa Bay to railway stations in the Transvaal between Germiston and Klerksdorp inclusive, will be reduced in favour of Durban as follows:—

Intermediate Class by	2/11 per ton.
" "B" "	1/3 " "
In Rough, Rough "B" and "C" classes	2/1 per ton.
Imported produce, fencing, fertiliser classes	10d. " "

This is in addition to the reduction effected on July 1 last, which was as follows:—

Intermediate Classes ..	by 2/11 per ton
" "B" " ..	" 2/11 " "
Rough Goods "B" & "C"	" 2/1 " "
Fencing, fertilisers, imported produce	" 10d. " "

The intention of the further reductions is to divert a portion of the trade at present travelling by Delagoa Bay, it having been found that the reduction made on July 1 last was insufficient to accomplish that object.

Attention is directed to the advantage of consigning goods *via* the Port of Durban as the effect of the further revision in rates is that the difference in favour of Delagao Bay will be only 4s. to 5s. per ton, after allowing for the additional shipping freight and expenses at the latter port, which difference is outweighed by the superior facilities for wharfage, handling, trucking and transportation of consignments of all descriptions at the Port of Durban.

Full information will be supplied on application to the Commercial Agent, Natal Government Agency, 26, Victoria-street, S.W.

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ELECTRICAL PROGRESS AT HOME & ABROAD

FROM OUR SPECIAL CORRESPONDENTS.

TYNESIDE NOTES.

NEWCASTLE.

The local bye-laws in the city of Newcastle regarding electric advertising are so stringent that they greatly discourage the display of outdoor signs, although there are a considerable number of these on view. The tendency is, however, in this city to revert to facia or window signs which, being within the frontage of the buildings, do not come under the powers of the Corporation for sign rentals, and a large number of firms, as, for example, the Sorosis and other boot companies, are drawing attention by means of such signs to their wares. The Sunbeam Lamp Co., of Gateshead, has recently introduced an ingenious advertising device, which is both displayed at their showrooms and which has already been well taken up. This consists of a circular mirror similar to a shaving glass, the metallic coating of which is so extremely fine that, in combination with an 8 c.p. lamp and flasher, advertising matter placed at the back of the mirror is shown through. There is, therefore, an alternate reflector and advertising medium which is already finding considerable favour here.

New Telephone Equipments.

The British Helsby Cable Co., Ltd., who have recently practically doubled their Prescot works for the purpose of extending their telephone work into general competitive trade, have recently been placing upon the Newcastle market some very fine examples of post office and other pattern telephones. As they have already had several contracts for post office telephone work, their experience in this direction is enabling them to supply a very fine equipment, which has recently been on view at their Newcastle offices.

New Electric Organ Blower.

Messrs. Robson & Coleman, electrical engineers, Newcastle-upon-Tyne, have recently placed upon the market an electrically driven organ blowing apparatus upon somewhat novel principles, an example of which they are now showing at their showrooms and depôt at the Haymarket. This consists of main and auxiliary air chambers of the bellows pattern, the auxiliaries being operated by means of crank gearing, virtually making them into air pistons. The crank gearing is driven by means of an electric motor, which is automatically stopped and started in relation to the position of the top cover of the main air chest. This is effected by means of a flexible rope attached to the main air chest passing over a drum attached to a shunt and series face plate type of controller. The first action of the downward movement of the air chest cover is to switch the motor in on the series starting coils. When a radial lever attached to the rope drum has traversed a certain distance it picks up, by means of a magnetic device, the arm of this series and shunt controller. The first stops bring the motor up to speed, while the remaining stops operate the shunt control. It is found that a constant supply of air is obtained by this means under very widely differing and sudden calls from the organ. Messrs. Robson & Coleman have also a device for operating on alternating current circuits.

MIDLAND NOTES.

BIRMINGHAM.

Among the Smethwick firms who have recently adopted electric power is that of E. G. Wrigley & Co., tool makers and gear cutters, of Foundry-lane. Their works are situate in the district supplied by the Birmingham and Midland Tramways Power Station. The present consumption of this firm is about 80,000 units. In the main shop there are 10 lines of shafting. Of these eight are driven each by a separate motor, and the remaining two by one motor. Two are of 20 h.p., one of 15 h.p., and six of 10 h.p. There is also a 25 h.p. motor in the hardening shop, and one of 12 h.p. driving ventilating fans. All the motors in the main shops are of Westinghouse make, and of the three-phase induction type, with head rings. The squirrel-cage type of construction has not been adopted for the 10 and 15 h.p. motors, as the regulations of the power company do not allow the use of this type for motors of more than 5 b.h.p. The high-tension switchboard consists of a standard panel supplied by the British Thomson-Houston Co., and contains a three-pole oil brake switch with trip coils to each phase, the currents for the operation of these being derived from the secondaries of the current transformer. From this switch mains are taken to the primaries of three single-phase 75 kw. transformers, which transform the pressure from 5,000 to 400 volts. The sub-mains are carried along the walls by means of polished teak battens at frequent intervals, and to these they are secured by porcelain cleats.

Special Rates for Power.

The energy consumed is measured on the L.T. side, so that the consumer does not pay for the energy lost in the transformer, and Messrs. Wrigley are taking the current at the special rate based on energy consumed by ¼ b.h.p. of motors installed. With their consumption, Messrs. Wrigley have to pay on this scale ·731d. per unit, a saving as compared with the flat rate in similar cases of ·14d. per unit, or about £46 per quarter. The motors run at a speed of 710 revolutions at full load. In spite of the high motor load factor, the cost, so far, has been found to work out at less than that of running the two gas engines which the motors have supplanted. The installation has been carried out under the direction of Messrs. Moffett & Rosher, Consulting Electrical Engineers, of Temple-row, Birmingham. It is noteworthy that in this, as in several other recent cases in the Midlands, the power which has been replaced by electricity has been that of gas engines.

Electrical Developments.

Messrs. Thomas Smith & Sons, of Saltley, who are engaged largely in the manufacture of hammers and edge tools, have recently had installed 13 motors, replacing two gas engines and one old-fashioned beam engine, supplying power to the polishing shops and other departments on the tool side, and driving emery wheels, wood-turning lathes, ventilating fans and other machinery. The motors are all of the Westinghouse squirrel-cage type, and are driven by the Corporation current transformed from 5,000 volts to 440 volts. So far there are nine motors at work of from 1½ to 45 h.p., making a total of 110 h.p., while another 45 h.p. will shortly be at work on the tool side of the works. The installation is to some extent experimental, but the results have been so far satisfactory, and it is probable that before long electricity will be adopted throughout the works. Experience of the present motors shows that as compared with gas the cost of electricity, running for running, is about the same. But the convenience of application, and the saving of space and of labour in attention have in themselves justified the change, while, owing to the large number of machines which have to be used intermittently, the cost of the work actually done has been materially reduced. An example of the advantages of electricity in an establishment of this kind is afforded by the case of a handle polishing shop. Here, in order to use economically a machine driven from a shaft, it would be necessary to keep two women at work, one preparing and the other polishing. The amount of work, however, does not require the constant employment on this particular job of two pairs of hands. With an electric motor one woman can now profitably employ the whole of her time, as when she is preparing there is no power running to waste.

Electricity Replaces Gas.

Another firm which has replaced its gas engines by electrical motors supplied by the Corporation is that of J. D. Brooks & Co., Ltd., leather goods manufacturers, of Great Charles-street, Birmingham. The current is supplied from the high tension mains and delivered by three-phase transformers, oil insulated, to sub-stations in the basement. At present there are 11 motors of three-phase squirrel-cage type of various makes, including the Siemens, E.C.C. and Westinghouse, and varying from 20 h.p. driving a line of shafting to 1 h.p. for polishing spindles. The wiring is carried throughout in conduit. Messrs. Moffett & Rosher designed the whole scheme, and it has been carried out under their supervision. The firm, which employs about 700 hands, report that a far higher efficiency has been obtained than with the gas engines, especially in operations in which small and intermittent applications of power are required. One gas engine is still running, but will be replaced shortly by electricity, a scheme for a considerable extension of the present installation being now under consideration.

LANCASHIRE NOTES.

MANCHESTER.

Business has not improved during the past week. Since the number of big electrical contracts and orders for purely electrical plant and accessories get fewer, manufacturers have had to turn their attention more to creating a demand for electrical goods in the older trades. Several local firms are already well on the way to specialising in this sort of work. Electromotors, Ltd., supply yearly many machines of all kinds to machine tool makers, etc., to be built into lathes, mills, etc. Both the British Westinghouse Co. and the Lancashire Dynamo & Motor Co., have made a very careful study of electrical "storage" systems, in which use is made of fly wheels, in connection with the electrical application of power to winding, rolling mills, and other services in which large power has to be developed to meet the intermittent demand.

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There is still room for considerable development in the application of the electric drive to machinery hitherto worked by the usual mechanical drives. A great engineering and machinery exhibition is to be held in the Exhibition Hall, Deansgate, Manchester, next October. This show will give manufacturers the opportunity of exhibiting examples of electrically driven machines of all kinds. The Secretary of the 1907 Manchester Gas Exhibition will be the Manager, and every effort will be made to make the show thoroughly representative of Lancashire, Yorkshire, and the North generally.

Electricity at the Ship Canal.

Naturally, electric light is the only artificial illuminant used. There are many interesting applications to power work to be seen at the various docks. Electric cranes run along the quays and transfer the cargo from the ships to the warehouses. Formerly the crane man was stationed in the "box" and operated the crane in accordance with signals from the men below. Lately, however, this method has been improved upon, and the crane man now takes up his position on the quay, where he can best see the load, and operates the crane accordingly through a portable relay switch which he carries with him. The connection to the switchgear and motors on the crane is by a trailing flexible cable. The relay switch weighs only a few pounds. Results show that material is more expeditiously handled, with greatly minimised risk of accidents, than with the old method, while the capacity of each crane has been increased by about 20%, owing to the saving of time resulting from the crane man acting directly from the quay.

Students' Section.

A visit was paid to the Oakamore works of Messrs. T. Bolton & Sons, Ltd. Some 30 members attended and were greatly interested in the various applications of electricity.—On Tuesday Messrs. Blackmore and Newman read a very interesting paper on "The Testing of Electrical Machinery," in which they reviewed the general lay out of test beds, the instruments best suited for each test, and the most useful commercial tests to make.

AMERICAN NOTES.

NEW YORK.

Steel manufacturers in this country are watching with keen concern the progress of electrical smelting. Though the process is still more or less in the pioneer stage, its practicability is beyond all doubt, and for that reason the fact that official announcement was made in New York this week of the plans of the Electrical Steel Company, of Canada, has aroused unusual interest. The first of the Company's electrical furnaces, which will be capable of generating 6,000 degrees of heat as compared with the maximum blast furnace heat of 2,000 degrees, is to be erected on a 50 acre site at the junction of the Welland Canal and the Welland feeder on the Canadian side of the Niagara frontier. The Company's plans for its mammoth plant are completed under the Ramage system. Articles of incorporation have been secured with head office in Toronto and a branch office in Buffalo. The men behind the industry have large interests in steel and iron in the Pittsburgh section. The officers elected are: President, Tyson S. Dynes, St. Louis, Mo.; vice-president, George G. Goodrich, Saratoga, N.Y.; secretary, A. S. Ramage, Ph.D., the last named having designed the plant. Work on the billet mill, the initial building, will begin in a few days. The Falls Power Company will supply one thousand horse power for the operation of the mill. The daily output will be 1,000 tons, which will require 2,000 tons of ore daily. Five vessels are already under contract to deliver ores before the close of navigation, for it is anticipated that the mill will be ready for testing before the opening of navigation next season. Next year other mills will be erected for the making of finished products in iron and steel.

The Advance of the Turbo-Generator.

In connection with your recent articles on the turbo-generator, some editorial remarks in the leading electrical journal here may be quoted as indicating the trend of expert opinion on this side of the Atlantic. They are based on the conspicuous example of putting the steam turbine to its best use, which has been afforded by the installation in the subway power-house of the Interborough Rapid Transit Company of the 5,000 kw. exhaust steam turbo-generator which was recently described in these notes. The *Electrical World* observes that unless American builders take a brace, in the use of superheaters, the turbine may yet occupy the whole field to the exclusion of the older engine in all important plants. "Anyone who has built power plants fully realizes the dead level to which a stolid complacency in standardization has reduced most builders of reciprocating engines. With very few exceptions they have thus far refused to make use of modern improvements and have contented themselves with 100 deg. or so of superheating, steadfastly refusing to accommodate their designs to anything better. The result is that the turbine makers, more progressive from the very novelty of their work, are rapidly pushing ahead and beating out plants that they could not compete with save through the lack of enterprise of their rivals. While five-stage turbines are common, triple-expansion engines are scarce in power plants. An ordinary compound engine is not in competition with a multi-stage turbine, and engineers unmindful of the uniform loads to be had in a great modern power station have been unduly cautious in going to triple expansion. Perhaps one should not be ungrateful for this on the ground that by this negligence the turbine has been enabled to make more rapid progress, so that on the whole the art may have advanced. Certain it is, that the turbine is making wonderful progress all along the line, especially in marine work."

A Magnificent Opportunity.

The writer goes on to point out that the turbines' best hold seems to be in the utilization of exhaust steam, which it will be remembered, is the great feature of the Interborough plant already referred to. "The very fact that many very important reciprocating engine plants are inefficiently organized as respects high expansion gives the turbine a magnificent opportunity. The linking is not quite so direct as in ordinary triple-expansion practice; but perhaps the very flexibility of the connection is a material advantage once the governing problem is satisfactorily dealt with. The gain in space, too, is highly advantageous especially in a plant well crowded with machinery, so that there is everything to gain and nothing to lose in adding the turbine. It is not at all unlikely that we shall see large new composite plants built presently, although there is enough work on the older ones to keep the turbine builders busy for a long time to come."

New Safety Third-Rail System.

A system which the inventors claim to be a final and effective solution of the third-rail problem has been patented by the Kozesnik Safety Electric Third-Rail Company of this City. The third-rail is mounte between the two main rails and comprises box and contact members made in sections. The contact members are constructed of a non-magnetic metal; the box members are made of a suitable material, and the third-rail sections are separated by block insulators. Each rail section is supported upon sleepers of insulated material which rest upon ties or other foundations in the roadbed, the same as the live third rail. Within the rail sections are a series of vertically movable armatures and contact members which are actuated by the movements of the armatures. Means are provided for electrically connecting the contact members to the conductor bar and returning them, together with the armatures, to their normal position. All exposed parts of the third rail are out of the circuit and are only energized when a magnetic contact shoe rests on them; and by placing the rails in the middle of the car tracks it is claimed that all source of danger is eliminated. An important feature claimed is the possibility of very high voltage which would result in a large saving of copper and a considerable saving in sub-stations, while as there is no loss of current, on account of dampness, the rails always being out of circuit except on contact, the cost of maintenance is reduced. The cost of installation is claimed to be no more than the covered live rail and it is also claimed that good contact is possible between shoe and rail even when the latter is covered with snow or sleet, because of the large surface that is covered by the shoe, and the magnetic action, which has a tendency to increase the friction.

Bell Company and Western Union.

Formal announcement is made this week of the acquisition by the American Telephone and Telegraph Company (the Bell Company) of sufficient stock in the Western Union Telegraph Company to give it control of the latter organization. This great deal has long been pending and the rumours that it had been actually accomplished were crystalized this week by a public statement made by Mr. George J. Gould, Chairman of the Executive Committee of the Western Union, who said: "It is a fact that we have sold a large part of our holdings in the Western Union Telegraph Company to the telephone company. I believe this will inure to the benefit of both the public and the Western Union stockholders, as the business of both companies can be handled so that they form a complement to one another, thus giving to the fullest extent prompt and satisfactory service." The report is current that the Mackay companies controlling the Postal Telegraph Company will ultimately be included in the plan of reorganization, but no confirmation of this could be obtained in New York. In order to make the absorption complete, the incorporation of a new $1,000,000,000 company, it is said, will be necessary to include the $592,475,400 of the bonds and stock of the American Telephone Company, and the outstanding $165,000,000 of the bonds and stocks of the Western Union. The acquiring of the necessary stock and voting rights of the Western Union by the Bell company has been in progress for about six months. The work has been conducted quietly and only a sufficient amount, said to be 51%, was taken over to insure control.

Economy of Administration.

The leading officers of the Bell company regard the step as one of economy solely. They point out that ever since the telephone has been a factor in human life it has had to compete

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with the telegraph. Lines have been paralleled and there has been an immense amount of duplication. The officers of the telephone company believe that the merger will save the Bell company $75,000,000 in new construction while it will also enable the utilization at the same time of wires for both telegraphing and telephoning. The history of the Western Union dates back to before the Civil War, but the Bell company is of comparatively recent origin. Both companies pursued the usual method of absorbing smaller companies. The actual figures issued here to-day are as follows:

	Telephone Company.	Western Union.	Total.
Total assets ..	$680,044,200	$162,316,864	$842,261,064
Capital stock ..	311,837,300	99,817,100	411,654,400
Bonded debt ..	238,680,500	38,845,000	277,325,500
Property account ..	545,045,600	124,086,920	669,132,520
Gross earnings ..	140,016,400	30,541,072	170,557,472
Net earnings ..	45,974,000	7,347,107	53,321,107
Miles of wire ..	8,098,679	1,382,509	9,481,188

The telephone system annually transmits 5,956,800,000 messages, the Western Union 68,053,000. The smaller companies acquired by the Western Union include the New York Telephone Company, $50,000,000; New England Telephone and Telegraph Company, $31,700,000; Bell Telephone of Pennsylvania, $31,150,000; New York and New Jersey Telephone Company, $25,400,000; Southern Bell Telephone Company, $21,400,000; Cumberland Telephone and Telegraph Company, $18,000,000; Chicago Telephone Company, $17,500,000; Western Telephone and Telegraph Company, $16,000,000; Bell Telephone Company of Canada, $12,500,000.

Hard Fight against Electrification.

The Chicago Railway Companies are putting up a hard fight against the City ordinance which proposes to make compulsory the electrification of their systems within the City radius. Some $3,000,000 of the funds of four big unions of railroad employés are to be used in an effort to defeat the ordinance. This action was decided upon by a committee of employés of the forty-two Western systems in session at Chicago this week. In addition to the proposed campaign against the passage of the measure this sum of money will be employed as an active means to combat the efforts of local improvement societies, in influencing public sympathy against the change from steam to electric transportation. A general strike of 65,000 employés of the Chicago railroads may follow the failure of the labour organizations to effect a change in present plans and in the attitude of citizens. Some of the reasons of the committee for its stand against the proposed changes were these:—"More than 60% of firemen and trainmen now employed on the roads would lose their positions; remainder of train and engine men would lose a portion of their earning capacity; excessive danger to life and limb of trainmen by the substitution of electricity for steam in the operation of engines and road equipment; danger to the public; belief that the public is not correctly informed as to alleged benefits to be derived by the substitution of electric driven conveyances; history of operation of Eastern railroads in last two years under electric power not conclusive that public has been helped; fallacy of the theory that smoke-laden atmosphere is deadly to infants."

$16,000,000 for Electric Subway.

An expenditure of nearly $16,000,000 for a new eight-mile subway in Brooklyn is called for in contracts signed this week by the Public Service Commission. Ground will be broken next Saturday and the occasion will be made one of popular celebration. The route of the new subway will be from the Brooklyn end of the new Manhattan suspension bridge along Flatbush and Fourth avenues to 43d Street, Brooklyn, from which terminal extensions are later to be made to Coney Island and to Fort Hamilton. Almost simultaneously it is announced that the Utica Southern has been authorized by the Public Service Commission to build a 27-mile extension of its trolley line from Hamilton to Norwich, passing through the villages of Earlville and Sherberne. For the contruction, the company is authorized to issue $628,000 bonds to be sold at a price to be approved by the commission, and also $400,000 in five per cent. non-cumulative preferred stock.

Long Island Electric.

Contracts totalling close upon $1,000,000 have been given to the Westinghouse Electric and Manufacturing Company by the Long Island Railroad. The order is for 130 motors of 200 h.p. each, the most powerful used for rolling stock, and having twice as much power as the largest type of inter-urban street cars, 52 ft. long, recently ordered by the Pittsburg and other street railway companies. The Long Island order is in connection with the approaching completion of the Pennsylvania Railroad's new New York terminal tunnel. It will be possible to run trains from New Jersey under New York to Long Island. The methods of electric installation will approach those of street car systems, as separate locomotives will not be used, but a passenger car having power will have trailers attached. No date has been announced for the delivery of the motors by the Westinghouse company, but the order will be rushed through as rapidly as possible. A supplementary order is expected to follow.

The Harlem Electrification.

Excellent progress is being made with the electrical equipment of the Harlem division of the New York Central and Hudson River Railroad, from Wakefield to North White Plains. Two new sub-stations are being built, one at Tuckahoe and the other at White Plains, each of which will contain three 1,000 kw. Westinghouse rotary converters and three groups of three single-phase, air-cooled General Electric transformers of 375 kw. capacity each. There are six circuit-breaker houses on the extension containing the third-rail sectionalizing switches. The switches in each house are of the remote control type, and will be operated from the nearest sub-station. The bonding of the track rails has been completed for the entire distance of ten miles for both tracks. Underrunning type protected third-rail has been erected for about half the distance. It is expected that complete electric operation from Grand Central Station to North White Plains will be begun in January, 1910.

Some Hydro-Electric Possibilities.

The enormous opportunities for the utilization of hydro-electric power which exist in the Central West and of which, as yet, little or no advantage has been taken, form the subject of interesting editorial comment in the *Electrical Review and Western Electrician*. In the great territory extending more than 700 miles east and west and more than 800 miles north and south; from Chicago to New Orleans and from Omaha and Kansas City to Cleveland and Cincinnati, including St. Louis, Indianapolis, Columbus, Louisville, Memphis and Galveston, a territory containing tens of millions of people, the prominent hydro-electric plants are very few in number, though hundreds of thousands of horse-power are at hand and readily utilizable. The only noteworthy hydro-electric plants now operating in this territory are that on the Chicago drainage canal at Lockport, and that on the Tennessee River at Hale's Bar, the former designed for an ultimate capacity of 43,000 and the latter for 50,000 h.p. in electric generators, while the sources of energy left untouched can be easily computed to have a potential y of 800,000 to 1,000,000 h.p.

A Typewriter Telegraph.

Two practical telegraph men, Mr. G. C. Cummings, telegraph circuit manager of the Chicago, Burlington and Quincy Railroad, and Mr. J. A. Kick, recently inspector of telegraphs on the same line, have patented an automatic typewriter telegraph system. A wire is electrically connected to a single keyboard typewriter of any standard make at the transmitting end and joined to a similar machine at the receiving end and, on the typewriter being operated in the ordinary manner, the message is reproduced in typewritten characters at the other end of the line, no knowledge of telegraphy being necessary. Alternating currents are used, and by means of various combinations of frequency the selective apparatus picks out the character at the receiving end corresponding to that on the key struck by the operator of the typewriter at the sending end. Sixty combinations can thus be made. The sending instrument is so constructed that it is in electrical step with the receiving end. The characters are transmitted by selecting one of the 60 combinations. By varying the operating voltage, say, from 75 volts to 290 volts, and by the use of a common relay, the electrical impulses select at the receiving end the character corresponding to that desired by the sending operator. The apparatus has been tried on the telegraph circuits of the Chicago, Burlington and Quincy Railroad, and it is believed that it will work on a line 500 miles long without a relay. Automatic repeaters can be used as in ordinary telegraphy. The same electrical energy is required as with the polar duplex. The speed is the speed of the typist—sixty to seventy words a minute.

The Human Battery.

Dr. Andrew McConnell, who is held to be a scientist of some repute in New York, has been raising a storm of criticism in medical circles by laying down in public lectures the theory that the human body is in reality a complicated electrical machine of which the brain is the storage battery and the nerves the wires along which the electrical currents pass. By means of brain-direction he claims that any local trouble in the body can be eliminated, the process being that of mentally concentrating thought upon the affected part and thus "turning upon it the remedial influence of the brain-generated electric current." In proof of his claim that the body is heavily charged with electricity, Dr. McConnell presented a curious instrument of his own invention which acts (at least that is what he says) with the currents of the electrical fluid of the body. The device consists of a thin piece of copper wire about six inches long on one end of which is suspended a steel ball of a quarter of an inch diameter. When the instrument is held in the hand of one person with the ball hanging near the surface of the hand of another, the electrical currents passing between the hands cause the ball to swing in a direction up the arm, later describing circles around a centre in the hand. He asserts that he can hold

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it over an egg and determine by its motion whether the egg contains a rooster or a hen. By the same instrument the sex of an unborn baby may be discovered. By his new science life, he remarks, may be extended from ten to twenty years. Since he has nothing to sell and is not proposing, therefore, to victimize a confiding public ready to believe anything about electricity, the medical fraternity set him down as merely a crank.

Current Items.

J. Ellwood Baird of Buffalo, has been awarded a contract by the Niagara Falls Hydraulic Power and Manufacturing Company, for the building of a conduit from the Shoellkopf Power Plant on the Shoellkopf Power Canal to the proposed new water plant on the Buffalo Road, east of Echota.

The New Haven Railroad has placed orders for telephone and selector apparatus for equipping the Northampton division for telephone train dispatching. This will be the first circuit so equipped on the New Haven road and covers a total of 77 miles with 20 stations.

The annual report of the Commonwealth Edison Company shows that the business of the company is in a highly prosperous condition, the net earnings available for dividends, after paying interest on bonds and debentures and setting aside a depreciation reserve, being $2,386,996, or practically 8% on the capital stock. The net earnings reported a year ago were $1,857,704. The dividends paid during the year were at the rate of 6%, leaving a balance carried to surplus of $586,996.

Dr. Frederick Yeder, has patented a new type of trolley wheel which has a double flange to provide against a tendency of the wheel to jump the wire against which it travels. Under all ordinary circumstances, the central groove will remain in contact with the wire, but should a jar or other cause occasion the wheel to be run in the reverse direction the tendency would be to ride up on tapered walls, thus presenting the side or surfaces of greater diameter to the wire and holding it by the flange from jumping the cable.

The Siemens Bros. Dynamo Works, of London and Stafford, have opened a Canadian office in Toronto, in the Birbeck Building, in charge of A. S. Herbert. Electrical equipment of all descriptions will be imported from the English works of Messrs. Siemens Bros. companies, and branch offices will be established at Montreal and Winnipeg.

Two electric inter-urban railway projects are before the Massachusetts Commission both proposing to build high-speed lines between Boston and important cities lying in the northeast of the state. The projects are those of the Boston and Eastern Electric Railroad Company, and the Boston, Lowell and Lawrence Electric Railroad Company.

A contract has been signed between the city of Brooklyn and the Tidewater Building Company and Thomas E. Bryson for the construction of the fifth section of the Brooklyn Fourth Avenue subway. Work will accordingly be begun immediately on this section, which covers that part of the subway running under Fourth Avenue from Tenth Street to Twenty-seventh Street. The price for the railroad proper is $1,945,640, and for the pipe galleries $251,076. This is the third of six sections.

GERMAN NOTES.

BERLIN.

The first firm of German merchant shipping owners to equip all their vessels with wireless telegraphy is that of Hugo Stinnes, of Mühlheim. This new firm is building a fleet of six steamers of from 2,000 to 7,000 tons, to commence running in December, 1909, with cargoes of coal and ore. They will work the Baltic, the North Sea, the Mediterranean, and South Africa. It is believed that great expense will be saved, as the captains can communicate with the firm through the coast wireless stations instead of telegraphing.

Telephony.

The first telephonic communication between Germany and Italy has just been established. The termini are at Frankfort and Milan respectively, and at present there are no intermediate stations. The line passes over St. Gothard. Munich and Copenhagen were first connected by telephone on October 20. The charge for three minutes conversation is 3 marks, and no one is allowed more than 6 minutes if anybody else is waiting.

New Swiss Electric Tramway.

A new line is to be made from St. Gallen to Walzenhausen, with branches from Kaien to Rehetobel and from Reineck to Heiden and Thal is to be made at a cost of 40,000 guineas. The gauge is one metre, and the steepest incline is 8 in 100. The total length of the new line will be between five and six miles.

Flash Signals in Navigation.

Experiments have been made in the North Sea to establish communication between pilots or land stations and ships at sea by means of flash signals on the Morse code and have been very successful. Electric lights have, therefore, been supplied in large numbers, and a sort of block system for ships closely following each other in dark stormy nights has been established.

Monte Rosa.

The highest telephone in the world is now at the summit of Monte Rosa, about 15,200 ft. above sea level. It belongs to the Regina Margherita Observatory. The other end of the wire is at Alagna (about 4,000 ft. above sea level).

Conductivity of Organic Colloids.

M. F. Bottazzi has devised an apparatus for measuring this conductivity. It consists of a V-shaped tube. In the middle of each branch of the tube is a cock having as much way as the diameter of the tube. The colloid solution is put into the tube up to the level of the cocks, which are at the same level. The cocks are then shut and the rest of each branch is filled with distilled water. Platinum electrodes are then put into the water, one in each branch, carrying a current of from 110 to 120 volts. When the circuit is established the cocks are opened. The current must not exceed $\frac{1}{10,000}$ ampere. After the current has passed for from 12 to 48 hours the cocks are shut and the fluid surrounding the poles is tested. The fluid below the poles can also be tested. Presumably, although nothing is said to this effect in the version of the Atti de l'Academia de Lincei in the Elektrochemische Zeitschrift, the decomposition found to have occurred is taken as the measure of the conductivity. We presume the time is accurately taken.

Thermo Electric Pyrometer.

M. Pecheux describes the calibration of a copper-nickel thermopile by means of a platinum-iridium cell. He finds that the pile gives reliable readings on the galvanometer up to temperatures of 920° C. Between this temperature and zero the E.M.F. varies in three steps, viz. :—

1. From 0 to 235° C., with increasing temperature co-efficient of the E.M.F.
2. From 235 to 390° C., with diminishing temperature co-efficient.
3. From 390 to 920° C., with a renewed increase of the co-efficient.

The E.M.F. of the cell in relation to the temperature t is expressed by the following equations :—

Between 0 and 235° C. $E = 24{\cdot}38\,t + 0\,0{\cdot}0078t^2$
„ 235 „ 390° C. $E = 2124 + 43{\cdot}5\,t - 0{\cdot}035t^2$
„ 390 „ 920° C. $E = 7033 - 2{\cdot}1t + 0{\cdot}023t^2$

Current Notes.

Active preparations are in progress in Dreseen for an International Electricity Exhibition in this city in 1913.—The Elektrizitats A. G. vorm Hermann Poge, of Chemnitz, reports a profit for the recently expired financial year of 906,243 marks, and a 7% dividend will be distributed. The carry over is 17,599 marks. Business is so good that additions have to be made to the factory, and for this and other reasons one million marks is to be added to the capital to bear interest from January 1, 1910. In view of an unusually heavy account for repairs and the new machinery the state of affairs may be described as quite satisfactory.—The Stettiner Elektrizitats Werke A.G. has declared a dividend of 7%, the same as last year.—A scheme has been undertaken by the Etochwerke A.G. of Tyrol for building a power station to obtain 15,000 h.p. from the Schnalserbach. The power is to be divided between two turbine driven sets of machinery for lighting and power purposes.—The annual report of the Berliner Elektricitatswerke is now published. The same dividend is to be paid as for last year, viz., 11%, in spite of political and trade difficulties which have ensued. The eight-hour day movement for one thing has lessened the demand for electric light in workshops, and trade has been bad generally. What has compensated for this sort of thing for the time is the increased sale of Osram and like lamps, which are at present in great demand, and also the extension of electric tramways, which, in spite of the competition of the municipal trams, have reached a consumption of 580,000 kw. hours. The gross profit was 16,711,503 marks, as against 14,662,844 in the year before, and the net profit 8,196.506 marks, as against 7,389,026. The dividend is divided as follows :—4½% on 20 million marks of preference shares, 11% on 31½ millions of ordinary shares, and 4% on 12½ millions of deferred shares. The town of Berlin claims 2,491,072 marks, as against 2,650,639 in the year before, and 109,395 marks, as against 128,883 are carried over. The prospects for the rest of the present year are perfectly satisfactory. Everybody is hard at work, and orders are coming in as fast as they can be filled, or even faster.—The Deutsche Gasgluhlicht A. G. (Auergesellschaft) has issued its report for 1908-9. The net profit is 4,038,199 marks (including a carry over of 510,080), and a 50% dividend (35% last year) will be paid on the ordinary share capital of 6,600,000 marks. The prospects for 1909-10 are supposed to be even better.

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BUSINESS NOTES AND NEWS.

LIGHTING AND GENERAL—Home.

ABERDARE.—Intimation was received at Aberdare that the Local Government Board had sanctioned the borrowing of £17,000 for laying down an electric generating plant for lighting the main streets and for supplying private consumers. It is expected that building operations will be commenced in February next.

AMBLE.—The Council decided to recommend an electric light scheme and to take a ballot of the ratepayers on the question.

BRIDLINGTON.—Sanction to borrow £5,000 for extension of the electricity works was received from the Local Government Board; and the Council decided that in future the works be controlled by a separate committee. It was decided to obtain tenders for a 300 kw. reciprocating engine and dynamo, and alternatively a 300 kw. mixed pressure turbo.

DUNDEE.—The scheme for stair lighting with electricity, automatically controlled from the electric station, submitted to Dundee Town Council by Mr. H. Richardson (Electrical Engineer), was considered by a sub-committee of the Electricity Committee. Explanations were made by Mr. Richardson regarding the scheme, and the Committee, approving of it, agreed to recommend its adoption to the parent Committee. It was stated that the department could introduce the necessary wiring, etc., maintain the equipment, turn on and extinguish the light, and provide the necessary current for an inclusive charge of 8s. per light per annum. It has already been adopted in a number of properties near the station.

EAST LOTHIAN.—The electrical plant with the winding-engine house at the Bankton colliery was considerably damaged by an outbreak of fire.

EDINBURGH.—A scheme in connection with the development of the electric light undertaking of the city was submitted at a meeting of the Electric Lighting Committee of Edinburgh Town Council yesterday. It was contained in a preliminary report by Sir Alexander Kennedy as to the future working of Dewar-place and M'Donald-road stations with special reference to the provision of cooling towers. By substituting a couple of exhaust turbines at Dewar-place for three of the present type, it was estimated the Department could get an increase of 3½ million units per annum without any increase of cost, so far as the coal and water bill was concerend. This, of course, meant the adoption of cooling towers. The former idea was to get the water from the canal, but that project was abandoned, and it was now necessary to provide these cooling towers if there was to be an increased output at Dewar-place station. It was pointed out in the report that cooling towers had been greatly improved of late, both from the point of view of architecture and adaptability. The erection of the new plant at Dewar-place, with the towers, would, it was estimated, cost £45,000. It was agreed to have the report circulated among the members of Council.

GREYSTONES (Ireland).—The new electric lighting system will be in complete working order by January 1 next. Within a fortnight the electric power house, which is being erected by Mr. P. J. Kinlen, contractor, will be handed over to Messrs. William Coates & Sons, who have the contract for the installation of the electric system. The power house consists of a main building, 43 ft. by 22 ft., and an annex, in which will be located the generating plant. This comprises two suction gas engines of 90 h.p. each. One of these engines is capable of generating electric power sufficient to meet the needs of the entire system. The second engine will, therefore, serve as an alternative should occasion arise. A home industry will be benefited by the use of suction gas engines, as Kilkenny anthracite coal is the material employed in working these machines. The public lighting part of the scheme will be immediately begun. The system has the advantage of being wholly an underground installation. The Greystones Electric Light and Power Co., Ltd., are the promoters and owners of the new installation, the resident engineer being Mr. R. F. Fry, of Lynnwood, Greystones. The capital of the company is £3,500.

GRIMSBY.—At a meeting of the Grimsby Corporation Lighting Committee, the Borough Electrical Engineer (Mr. W. A. Vignoles) reported a breakdown on the No. 9 set, entailing damage estimated at £200. The failure of a stud through fatigue of metal, was the cause to which the accident was attributed, and the Committee confirmed the action of the Engineer in immediately replacing the damaged parts. An application for current was received from certain residents at Scartho. The Engineer said the cost of cable-laying would be £450, and the estimated revenue £50 per year. The Committee decided to endeavour to obtain a guarantee from the proposed consumers, and then to decide whether to lay the cable.

HAMPSTEAD.—The Lighting Committee of the Borough Council were authorised, with a view to encouraging occupiers of private houses to use electricity for heating and power purposes, to enter into agreements upon a modified contract system on the basis of £8 5s. per kw. per annum (payable in advance) for the maximum demand required for lighting the house throughout with electric light, together with one penny per unit for all current supplied for whatever purpose it may be required.

PLYMOUTH.—The Corporation Electricity Committee submitted an offer from the contractors to cancel the contract for maintenance of the battery for the Armada-street station, and to enter into a fresh contract for the maintenance of the batteries at both stations for a term of 10 years, at the rate of £280 per annum, being an annual saving of £39 on the existing arrangements. The offer was accepted, subject to the Corporation having the option of terminating the contract at the end of five years. Cable extensions at an estimated cost of £271 for the purpose of supplying current to additional consumers were approved. The Electrical Engineer submitted the monthly return for October. It showed a sale of 238,511 units, and estimated receipts of £2,537 0s. 3d., compared with 209,627 units sold, and £2,182 17s. 8d. received in the corresponding period of last year. The increase of £354 2s. 7d. was made up on the following supplies of current:—Corporation tramways, £58; private lights, £235; private motors, £47; and miscellaneous, £13. At the end of last month the number of consumers was 1,082, as against 966, and the lamp connections were 84,119, against 76,063 last year.

STIRLING.—The Borough Engineer's report for the four weeks ending October 23 shows that 36,595 units were generated at the Electricity Power Station, as compared with 34,858 for the corresponding period of last year. The total number of equivalent 8 c.p. connections is now 26,919, as compared with 24,929 at the corresponding date last year.

ST. PANCRAS.—The London County Council Finance Committee decided in favour of an application by the St. Pancras Borough Council for sanction to the borrowing and for the advance of £5,098 for electric lighting purposes.

TONBRIDGE.—An inquiry into the Council's application to the Local Government Board for sanction to borrow £8,565 for the purposes of sewage disposal works, was held by Mr. A. A. G. Malet. In reply to the inspector, Mr. Plunkett (Borough Electrical Engineer), said he thought that it would pay the Council to take up the cable (for pumping by electric power) and relay it. Mr. Hoadley, Electrical Engineer to the Corporation of Maidstone, gave evidence in support of the proposal, mentioning that the Maidstone plant was working exceedingly well, and that the scheme was very similar to the one suggested for Tonbridge. Electrical energy, in his opinion, was superior to suction gas. At Maidstone they charged a penny per unit, but there were reasons why they should do so. He had known suction gas plants which had been shut down on account of the trouble they had given. The charge of a penny per unit did not involve any loss—on the contrary it gave a very big profit to the electricity undertaking. In reply to Dr. Andrews, Mr. Hoadley said a suction gas plant he knew of in Worcester was shut down on purely a question of reliability. The plant at Maidstone had now been going very satisfactory for five months. It was proposed to lay down only one cable at Tonbridge; but personally he would rather see two cables, each carrying two-thirds of the maximum load.

WALSALL.—An application has been made by the Town Council for sanction to borrow the sum of £35,000 for purposes of the electricity undertaking and for approval of the use of a further portion of the site of the Wolverhampton-street Gasworks for the purposes of the undertaking. Mr. H. R. Hooper, an Inspector of the Local Government Board, is to hold an inquiry into the matter.

WATFORD.—The Electrical Engineer's report suggesting that an application should be made for a loan of £7,500 to cover the expenses of mains, services, etc., within the next three years, was passed by the Urban Council.

WOLVERHAMPTON.—Major J. Stewart, R.E., conducted a Local Government Board enquiry into an application by the Corporation for sanction to borrow £10,000 for the purposes of electric lighting. Mr. C. E. Shawfield (Borough Engineer) stated that the Corporation's charges for electricity for motive power were the lowest in the country, and the cost of production compared favourably with other towns. The profit per unit was one-twelfth of a penny. The Inspector considered this to be a small profit, and said it would not admit of a reduction in price without putting the Corporation on the wrong side of the ledger. Mr. Shawfield replied that if the Corporation electrical undertaking were run as a company and, assuming that the shares were Ordinary shares, they would, after setting aside a sufficient sum for depreciation, be able to pay a dividend of 6%. There

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were very few electrical companies as sound as the Corporation's undertaking. With the present population the Corporation ought to secure ten times as many customers as they had at present. The Inspector agreed to the application being increased from £10,000 to £15,000, which, it was mentioned, would carry the committee over a period of two and a half years.

LIGHTING AND GENERAL—Overseas.

CANADA.—In a message to the *Times* an Ottawa correspondent, telegraphing on the 28th ult., states that an accident in the power house of the Winnipeg Electric Co. has deprived that city of practically all motive power, and will necessitate the shutting down of all mills, factories, and elevators except those worked by steam.

CALCUTTA.—The number of units delivered by the Calcutta Electric Supply Corporation, Ltd., to consumers during the four weeks ended October 29, 1909, were 686,302, compared with 530,50 units in the corresponding period of last year.

ONTARIO.—Mr. Edward B. Merrill, consulting engineer, of Toronto, reported to the Galt Council, fixing the value of the electric lighting plant which the Galt Gas Co. has offered to sell to the Corporation as a distributing plant in connection with the hydro-electric power scheme. Mr. Merrill finds that the value of the plant proper is $63,000, according to the original cost, with deductions for depreciation, $44,000, and, so far as it would be directly available for hydro-electric power purposes, $35,000. The report was referred to the Light Committee.

SPITZBERGEN.—The Trondhjem-American Spitzbergen Co. propose to erect in Spitzbergen electrical power works both for lighting and also for cutting coal.

SYDNEY.—The City Council resolved to cable to Messrs. Preece & Cardew, the Council's consulting engineers, London, asking what they would consider the most satisfactory kind of metallic filament lamp, taking into account the Council's pressure, and the price per hundred at which they could be delivered in Sydney, and then to invite tenders locally. Mr. Forbes Mackay said that it would be advisable to hold a considerable stock of these lamps, for renewing lamps used in street lighting, for replacing carbon filament lamps in premises belonging to the council, and for use in connection with the scheme for external lighting of premises by contract. It would be more economical, he said, to have them bought in England than to buy them through Sydney agents. The progress in the development of these lamps had been so rapid in the last 12 months that his knowledge of them was not up to date. He recommended that 3,400 lamps be ordered, at an estimated cost of £1,100.

TORONTO.—The legal firm of Messrs. Blake, Lash & Cassels, Toronto, have, says the *Standard of Empire*, secured letters of incorporation for the Electric Steel Co. of Canada (Ltd.), an enterprise promoted by Pittsburg steel men, who propose to establish an electric smelting plant at Welland, in the Niagara Peninsula. Work on the initial building, the billet mill, will begin in ten days. One thousand horse-power for the operation of the mill have been contracted for with the Falls Power Co. The daily output will be 1,000 tons, which will require 2,000 tons of ore daily.

TURKEY.—A Constantinople correspondent reports that, subject to the approval of the Ministry of Finance, the commission appointed to examine proposals for the construction and working of a telephone system in Constantinople has awarded the concession to Mr. Laws Webb, representing a combination composed of the National Telephone Co., the Western Electric Co. of Chicago, the British Insulated and Helsby Cables (Ltd.), and the French Thomson-Houston Co.

VICTORIA.—The Electrical Association of Victoria met at the Prahran destructor, and prior to holding the usual meeting, were conducted over the works by the manager, Mr. Calder, C.E., who also explained to members the various processes through which the rubbish passes from the time it is shovelled into a furnace, until after having been practically filtered through a series of flues, the noxious gases are all destroyed, and the rubbish is extracted in the form of "clinker," for which, Mr. Calder stated, there was a great demand; in fact, it was now greater than they could supply. Last year £160 worth was sold, the price obtained being 4s. per yard. From every ton of refuse burned at the destructor, 40 Board of Trade units are generated, and as from 24 to 26 tons of refuse per day are treated, about 6,000 units per week are obtained. These figures are almost up to the British standard, and are, therefore, regarded as very satisfactory. The rubbish burned at the Prahran destructor contains about 40% moisture, which is much more than English rubbish contains, perhaps owing to greater use of vegetables in Australia. A test consignment of 10 tons of the tin obtained at the destructor is now being sent to the London Electron Co., London, which is advancing 40s. per ton. The cost of consignment is about £1 per ton. The recommendation recently made to the Warrnambool Town Council to expend about £5,000 in enlarging the existing gas and coke works, has not met with universal favour amongst the business people, and the directors of the local woollen mill company have decided to advise the council that the money would be far better applied in purchasing an electric lighting plant.

TRACTION—Home.

LONDON.—The total traffic receipts from April 1 to November 20, 1909, on the County Council tramways, were £1,152,090 from lines worked by electric traction, and £90,779 from lines worked by horse traction. The receipts for the corresponding period in 1908 under the same heads were £997,253 and £190,851 respectively.

LONDON.—The London County Council tramways in High-street, Camden Town, Chalk Farm-road, Ferdinand-street, and Malden-crescent; and in Kentish Town-road, Fortess-road, and Junction-road; the additional curves at St. George's Church, Borough; and the tramways from Nile-street, Woolwich, to Beresford-square, the electrification of which has been completed, were inspected on behalf of the Board of Trade.

TRACTION—Overseas.

AUSTRALIA.—The first set of rails in connection with the Prahran-Malvern (Victoria) electric railway have been laid.

SPAIN.—A concession has been granted to the Compañía General de Tranvías Electricos de Valencia for the construction and working of an electric tramway in that town from Mayor del Grao-street to the end of the West Quay.

COMPANIES' MEETINGS AND REPORTS.

SMITHFIELD MARKETS ELECTRIC SUPPLY.

The Smithfield Markets Electrical Supply Co. announces that the directors have been successful in obtaining an extension of the contract with the City Corporation until December 25, 1972, a period co-terminous with the date of expiration of the lease of the company's premises in Charterhouse-street, subject to certain conditions as to purchase of the undertaking in 1932 or 1952. The matter will be further dealt with in the report for the current year.

PUEBLA TRAMWAY LIGHT AND POWER.

The Puebla Tramway Light and Power Co. notifies that it is advised by cable from Mexico City that a formal petition has been presented on its behalf to the Government for leave to extend its electric transmission lines for light and power into Mexico City and the Federal district. This step has been rendered necessary by the approaching development of the Tuxpango Fall (the property of the company), which, whilst supplying the power required by the growing needs of Puebla City, will, at the same time, leave available some 25,000 h.p. for Mexico City and the surrounding district. The Puebla Co. is contemplating creating specially secured Debentures to provide the necessary funds.

ADELAIDE ELECTRIC SUPPLY CO., LTD.

The report of the directors, to be presented at the fifth annual general meeting of the Adelaide Electric Supply Co., Ltd., to be held at Finsbury-pavement House, London, E.C., on the 6th inst., states that, with the sanction of the preference and ordinary shareholders, the unissued balance of 3,000 preference shares were issued during the year at a premium, the bulk of the Shares having again been allotted to local applicants in Adelaide. The premiums received on the issue, amounting, less brokerage, etc., to £993 6s. 9d., have been applied in reduction of Suspense Account. The Profit and Loss Account shows a credit balance for the year (ended August 31 last) of £24,260 3s. 8d. After payment of the dividend on the Preference shares for the half-year ended February 28, 1909, there remains, including the amount carried forward from the previous year, an available balance of £20,830 17s. 3d., which the directors recommend should be applied as follows: To dividend on 30,000 6% Preference shares for the half-year ended August 31, 1909, paid on September 1, 1909, £4,500; dividend at the rate of 6% per annum on 26,065 Ordinary shares for the year ended August 31, 1909, £7,814 19s. 9d.; to extinguish Suspense Account, £1,506 13s. 3d.; transferred to Depreciation Account, £1,000; transferred to Dividend Equalisation Account, £5,000; and balance carried forward, £1,009 4s. 3d. During the year, a further sum of £40,156 was expended on Capital Account in the provision of additional land, buildings, plant and mains. The Company's mains have now been carried into the majority of the extensive residential and manufacturing districts surrounding the City of Adelaide. The directors are glad to say that this policy of energetic development of areas promising a reasonable demand for electric light and power is being fully justified by results. The temporary supply of power to the Adelaide Municipal Tramways Trust was commenced in March last, and is being maintained satisfactorily. The directors recommend that a portion of the profits during the continuance of this supply be transferred to a Dividend Equalisation Account.

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COMPANIES REGISTERED.

DE MARTIS ELECTRIC STORAGE SYNDICATE, LTD.—Registered November 11. Capital £25,000, in £1 shares. Objects: To acquire patents relating to, and turn to account, any invention capable of being used in the manufacture of electrical accumulators; to adopt an agreement with H. de Martis, and to carry on the business of manufacturers of and dealers in motor-cars, electric vehicles, airships and aeroplanes of all kinds, etc. Private company. Registered office, 61, Gracechurch-street, E.C.

DERWENT VALLEY ELECTRIC POWER CO., LTD.—Registered November 20, by Minet, Pering, Smith & Co., 7, St. Helen's-place. E.C. Capital, £2,000, in £1 shares. Objects: To carry on the business of an electric power supply company in all its branches. Registered without articles of association. The first directors are: N. P. W. Brady and A. S. Chetwood.

CONTRACTS OPEN.

HOME.

LLWYNYPIA.—Cambrian Collieries, Ltd., Glamorgan Coal Co., Ltd., and Naval Colliery Co., Ltd.,—Half-yearly tenders for electrical accessories and fittings, and other stores. December 10.

OVERSEAS.

AUSTRALIA.—Deputy Postmaster-General, Melbourne.—Supply and delivery of a branching multiple magneto switchboard at the Post Office, Canterbury, Victoria. March 16, 1910.

BELGIUM.—At the Town Hall of Waremme. For a concession to light the town with electricity. January 30, 1910.

HOBART (Tasmania).—Postmaster-General.—Telegraph and telephone material, etc. Part. as above. December 20.

LIEGE.—Electric lighting at Jupille. December 31.

LUCKNOW.—Municipal Board.—Tenders invited for a concession for the supply of electric energy, coal or oil gas, for house and street lighting, and other domestic or manufacturing purposes. December 31.

MELBOURNE.—Postmaster-General.—To supply coin attachments (for coins of different values) for telephones. Spec. No. 184. 370 50 c.p. metallic filament lamps, with bayonet cap fittings, for 110 volts A.C.; 630 25 c.p. ditto; 160 16 c.p. Linolite carbon filament lamps, 110 volts A.C.; 1,000 16 c.p. T.H. screw socket carbon filament lamps, 110 volts A.C.; and 100 32 c.p. metallic filament lamps, with bayonet cap fittings, 200 volts A.C. December 7.

MELBOURNE.—Railway Commissioners.—One single-phase turbo-alternator, etc. December 17.

SAMARKAND.—Municipality.—Electric tramways, March 14, 1910.

SPAIN.—Llanes Municipal Authorities.—Supply of electric light. Concession for ten years. Local representation necessary. December 9.

SPAIN.—Tabernas Municipality, Almeria.—Supply of electric light for public purposes to that town. The concession will be for a term of 10 years. December 10. Registro de la Direccion General de Correos y Telegraphos, Madrid.—For the working of the urban telephonic system of Gijon. The concession is to be for a term of 15 years. A deposit of 3,000 pesetas (about £110) will be required with each tender, to be increased to 9,000 pesetas (about £330) by the successful tenderer. December 15. Municipality, Ginzo de Limia.—Installation and working of a public electric lighting system for the town. The concession is for 25 years. December 15.

SYDNEY.—Postmaster-General.—Switchboard apparatus for subscribers' premises. Particulars of all Australian contracts, 72, Victoria-street, Westminster, S.W. January 10, 1910.

TURKEY.—Broussa Municipality.—For a concession for the installation of electric light and power, and for the construction of an electric tramway. December 13.

SOME CONTRACTS.

In view of the controversy that has been raging in Sydney as to the type of turbines to instal for the extensions, it is of interest to note that the final selection has fallen on Willans & Robinson turbines and on Dick Kerr alternators. Two units of 4,000 kw., each running at 750 r.p.m., are to be installed. The prices originally submitted, but which included a 400 kw. unit in addition to the two 4,000 kw. units, were as follows:—Willans & Robinson turbines, and Dick Kerr alternators (accepted), £44,547; British Thomson-Houston turbines, £32,354; British Westinghouse turbines, £34,007; Oerlikon turbines, £35,887; Willans & Robinson turbines, £40,690; Escher Wyss turbines, £42,175.

TENDERS ACCEPTED.

CANADA.—Contracts for general work and the equipment of a new power plant at Bracebridge, Ontario, were awarded as follows: Construction of general works of the hydro-electric development of Wilson's Falls, Muskoka River, Canadian Contracts, Ltd., Toronto, $19,341; hydraulic machinery, Messrs. John Kennedy & Sons, $8,100; electrical machinery, Canadian General Electric Co., $6,724.

HEYWOOD.—The contract for electric lighting of the post office was obtained by the Rochdale Electric Co.

HULL.—The tender of Messrs. A. Bannister & Co. for the supply of coal was accepted by the Corporation Electric Lighting Committee, the price being 8s. 3d. per ton. This, it was pointed out, was an increase on last year's figure, which was 8s. 1d. per ton. Mr. Lofthouse said it that meant a difference of something like £300 a year.

LONDON.—The following orders have been issued by the Metropolitan Asylums Board: Messrs. Evershed and Vignoles, electric testing set for head office, £30 12s.; Messrs. W. J. Fryer & Co., alterations to electric lights, south-eastern ambulance station, £22 15s.; United Electric Car Co., fittings and appliances for ambulance, tramcars, etc., £42 16s.

LONDON.—The Fire Brigade Committee of the London County Council selected the tenders of Messrs. G. E. Taylor & Co. (£208 15s.) and Messrs. John Barker & Co., Ltd. (£139 13s.) to execute the wiring and supply the fittings for electric lighting installations at the Waterloo-road and Camberwell New-road fire-stations respectively.

OTTAWA.—The contract for the ten circuit repeater switchboard and storage battery was awarded to the Northern Electric and Manufacturing Co. of Montreal, for $8,497.

WATFORD.—The Urban Council selected the tender of Messrs. Siemens Bros., Ltd., for the supply of meters for the year. Their quotation was the lowest submitted.

CATALOGUES AND LISTS.

The new season's catalogue of the British Prometheus Co., Ltd., dealing with convectors and radiators, is very attractively prepared and well merits perusal. Special attention may be drawn to the new Adams' designs in convectors and the company's Bead Screen Radiators. The screens have been introduced to increase the convecting properties of radiators on which they are fixed, and thereby make them more effective for room heating. In practise the firm employ two forms of curtains, the single screen and the double screen. These screens introduce a welcome touch of colour that may be easily arranged to harmonise with the general colour scheme of any apartment.

The British Westinghouse Electric and Manufacturing Co., Ltd., have just completed a line of control apparatus for Squirrel-cage Induction Motors. Illustrated leaflets covering the whole line have been published by the company. Auto-starters, often called starting compensators, are for starting against full load and above, whereas the other types are mostly for light loads. The actual conditions are specified in each leaflet. The great point in the construction is that the apparatus is fire-proof, and an important feature is the metal and mica constructions. All switch-blades and contacts are clamped on to mica-insulated steel shafts. The leaflets describe the apparatus in detail.

Mr. Geo. Ellison, Birmingham, has issued an illustrated list of iron clad switches and fuses. The "Mill" type switches in watertight cast-iron cases are high grade in every respect. They have a very quick and long break, and are especially suitable for mills, factories, and dusty and damp situations where rough handling is usual. The "Mill" type combined switches and fuses, consisting of a switch with long and very quick break (capable of opening the circuit under full load), with jaw contact and tubular fuses, have many advantages over the arrangements where the fuse tubes serve also as switch blades.

We have received from the Simplex Conduits, Ltd., a full bound copy of the eleventh annual edition of their catalogue. The volume consists of nearly 400 pages, 1,500 illustrations, and close on 15,000 prices.

The Sun Electrical Co., Ltd., have in the press a new catalogue illustrating a large number of new and artistic patterns of their radiators, together with other heating and cooking devices.

We have received from Messrs. Spagnoletti, Ltd., London, a nicely illustrated pamphlet entitled "Therol Topics," together with a charmingly designed calendar for 1910, showing the merits of the "Therol" electric water heater, which was recently described in our columns.

Of handy size, convenient for the pocket, a new list dealing with motors, dynamos, arc lamps, switchgear, meters, and other electrical apparatus, is being issued by the Union Electric Co., Ltd. The pages number 64 and are profusely illustrated.

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PERSONAL.

Mr. Allan Smith, who has been engaged with the Urban Electric Supply Co. at Stamford for some time, was presented with a clock in leather case by Mr. J. Surtees on behalf of the Stamford staff, upon leaving to take an appointment at Newcastle-on-Tyne.

Mr. H. L. Randolph, Local Manager of the Silvertown Co., has returned to the River Plate after a holiday in England.

Mr. James Beaton, of the Methil Dock electric light department, Fife, has accepted an appointment on the North Nigerian Railway.

Mr. W. Yorath Lewis is opening offices at 49, Queen Victoria-street, London, E.C., and at New York as an advisory engineer.

Mr. E. J. Tett has been appointed manager of the new power plant at Lacombe, Alta, Canada.

His many friends in England and Australia will hear with regret that Mr. Ernest Kilburn Scott, consulting electrical engineer and lecturer at the Northampton Institute, of Vale House, Burnt Ash-lane, Bromley, one of our valued contributors, met with a somewhat serious accident in London on Monday evening. Crossing the road in the Strand, Mr. Scott was knocked down by a passing taxicab. He was taken to King's College Hospital, where he was detained suffering from a dislocated shoulder and general shock.

We are advised that Mr. Frank Sydney Paterson has resigned his position upon the board of the firm of Messrs. Johnson & Phillips, Ltd., cable makers and engineers, Charlton, S.O., Kent.

OBITUARY.

Mr. Oswald Haes, the well-known electrical engineer, of the firm of Haes & Eggers, Sydney, died suddenly while on a business visit to Melbourne. Mr. Haes arrived in Australia in 1891, to act as representative of the Brush Electrical Engineering Co. and held this position until some two years ago. Mr. Haes was a member of the Institute of Electrical Engineers, London, and a founder of the Electrical Association of N.S.W.

DIARY.

FRIDAY, DECEMBER 3.

THE INSTITUTION OF MECHANICAL ENGINEERS (London).—At 8 p.m., discussion will be resumed on Mr. Herbert A. Humphrey's paper on "An Internal-Combustion Pump, and Other Applications of a new Principle."

INSTITUTION OF CIVIL ENGINEERS (Students' Section).—At 8 p.m., at Great George-street, Westminster, London, "The Design of Generating Stations," by Geo. Ingram, Stud.Inst.C.E. Col. R. E. B. Crompton, C.B., R.E., M.Inst.C.E., will preside.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.—At 8 p.m., at Faraday House, Southampton-row, London, W.C., Smoking Concert and "At Home." Dr. Alexander Russell, M.A., D.Sc., M.I.E.E., the new Principal of Faraday House, will take the chair at the concert.

SATURDAY, DECEMBER 4.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION.—At the Criterion Restaurant, Piccadilly-circus, London, annual dinner, Mr. H. D. Richmond in the chair.

TUESDAY, DECEMBER 7.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Students' Section).—At 7.30 p.m., at the Municipal School of Technology. "The Electrical Equipment of Cranes," by A. L. Hawes. Mr. J. S. Peck, M.Sc., M.I.E.E., will preside.

ROYAL INSTITUTION.—At 5 p.m., at Albemarle-street, Piccadilly, London, W., general meeting.

THURSDAY, DECEMBER 9.

THE INSTITUTION OF ELECTRICAL ENGINEERS (Dublin Section).—"The Tierney-Malone Electric Point Shifting Device, as used on the Dublin and other tramway lines," by Mr. J. P. Tierney.

SATURDAY, DECEMBER 11.

ELECTRICAL FOOTBALL LEAGUE.—At Brook Green Works, Hammersmith, by permission of the directors of Robertson Electric Lamps, Ltd., second annual concert and distribution of trophies, etc.

TUESDAY, DECEMBER 14.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.—At 2.30, at Balfour House, Finsbury-pavement, London, E.C.; meeting of the Committee.

INSTITUTION OF ELECTRICAL ENGINEERS' Manchester Section.—At the University of Manchester, "Notes on Methods and Practice in the German Electrical Industry," by L. J. Lepine and A. R. Stelling, students.

AERO EXHIBITION IN LONDON.

A second Aero and Motor Boat Exhibition will be held at Olympia, Kensington, in March next. This will also be organised by the Society of Motor Manufacturers and Traders. The exhibition will be an international one, and, as such, all inventions not fully patented will be protected by a Board of Trade licence.

BELFAST TRAMWAY SCHEME.

ESTIMATED OUTLAY OF NEARLY £450,000.

A comprehensive scheme of tramway extension and construction, involving an outlay of nearly £450,000, has been submitted before the Belfast Corporation Tramways and Electricity Committee by Mr. Andrew Nance (General Manager of the Tramways). He set out in detail the following lines which, in his opinion, are entitled to the careful attention of the Corporation:—

Donegall-road, from Shaftesbury-square to the Falls-road line—1⅜ miles. Total estimated cost is—Construction, £22,000; equipment, £8,900; machinery, £2,270; total, £33,170.

Shaftesbury-square to Ormeau-road, *viâ* Botanic-avenue, University-avenue to Ormeau-road line—¾ mile. Estimated cost—Construction, £12,000; equipment, £4,875; machinery, £1,240; total, £18,115. If this extension is made, Mr. Nance recommends doing away with the Ormeau-avenue line.

Stranmillis-road, continuation of line to a point opposite the first lock—¾ mile. Estimated cost—Construction, £6,000; equipment, £2,450; machinery, £620; total, £9,070.

Ligoniel—Continuation of line to Mill-avenue—¾ mile. Estimated cost—Construction, £6,000; equipment, £2,450; machinery, £620; altering road level, £450; total, £9,520.

M'Art's Fort—New roadway and tramway, ascending the mountain side. Length, 3½ miles. Estimated cost—Construction, £56,400; equipment, £20,000; machinery, £5,150; road making, £29,700; total, £111,550.

Castlereagh-road. From Mountpottinger-corner to city boundary—1 7-16 mile. Estimated cost—Construction, £23,000; equipment, £9,300; machinery, £2,389; total, £34,680.

Bloomfield. From Woodstock-road along Beersbridge-road, Bloomfield-road, terminating at the junction with North-road—1 1-16 mile. Estimated cost—Construction, £17,000; equipment, £6,900; machinery, £1,760; total, £25,660.

Old Lodge-road and Oldpark-road, from Peter's-hill to Crumlin-road, thence along Oldpark-road to Cliftonville line. Estimated cost—Construction, £25,000; equipment, £10,150; machinery, £2,250; total, £37,700.

Holywood. With reference to this line, Mr. Nance suggests that the Corporation should be the sole authority, and that Parliament should be asked to authorise the purchase outright by the Corporation of all the powers granted to the promoters of the Holywood Tramways Bill; that the price to be paid to the promoters for the whole of their interest should be the exact amount paid out by each of them, with 5% per annum interest added thereto; that the tramway should then be at once constructed by the Corporation and worked in connection with the rest of the Belfast system. Estimated cost—Payment to promoters, £5,000: construction, £52,000; equipment, £22,750; machinery, £5,750; total, £86,000.

Glengormley. Mr. Nance suggests either (*a*) the absolute purchase of the Cavehill Co., or (*b*) its being handed over to the city for a long term—say, fifty years—at a fixed annual rent. He recommends the Council to seek compulsory powers in the Bill, which will have to be promoted to authorise the other extensions as proposed to purchase the Cavehill and Whitewell undertaking out and out at a price to be fixed by an arbitrator to be appointed by the Board of Trade.

The report will be considered by the Council.

PUBLICATIONS.

"Electricity in the Service of Man: A Popular and Practical Treatise on the Application of Electricity to Modern Life." By R. Mullineux Walmsley, D.Sc., F.R.S.E. London: Cassell & Co. Part I. Price sixpence.

Messrs. Cassell have done well to re-issue this useful book in an enlarged and thoroughly revised form. Each chapter has undergone careful overhauling so as to bring the information up to date. Part I., before us, gives a brief introduction, in which the early history of the subject is treated succinctly but with sufficient comprehensiveness. This is followed by a chapter on the principles of magnetism, and one on electrostatics. The part is admirably illustrated. It may be mentioned that upwards of 1,600 illustrations, many of them quite new, will be comprised in 27 monthly parts, which will constitute the two volumes. Dr. Walmsley is so well known as a successful teacher, that this revival of a book so thoroughly appreciated is likely to meet with a big success.

CHANGE OF PROPRIETORSHIP.

We understand that the business of the Bell Telephone & Electric Co., Westminster, has been acquired by Messrs. Frederick Hodgson & Co., of 24, Queen Victoria-street, E.C., and will in future be carried on under that name.

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SOUTH LONDON ELEVATED ELECTRIC.

The Brighton Railway Co.'s South London "elevated electric" line was inaugurated on Wednesday, the 1st inst. The line extends from Victoria to London Bridge, *viâ* Battersea Park, Wandsworth-road, Clapham-road, East Brixton, Denmark Hill, Peckham Rye, Queen's-road, Old Kent-road, and South Bermondsey, and is just under nine miles in length. Inside Victoria station seven lines are equipped with overhead construction, giving access to five platforms, and in London Bridge station five platforms are similarly fitted. The time taken by the steam trains from Victoria to London Bridge is 36 min.; the electric trains reduce this to 24 min.

The acceleration of the new electric trains on the South London line is superior to anything that can be realised in practice with steam. Thus the maximum speed of 30 to 35 miles an hour is reached respectively in some 30 to 35 sec., whereas with steam, in order to reach the same speed, at least three times this amount of time is required. The average distance on the South London line between stations is, in round figures, 4,600 ft. The line has a great many curves and gradients and, notwithstanding this, the small average distance between stations, and the average speed of electric trains, not including stops, is just over 25 miles an hour, whilst if stops are included the average speed is 22 miles an hour. It will be seen what an improvement electric service renders possible when it is understood that the average speed of the existing steam trains, including stops, is now only about 14 miles an hour.

The overhead conductors convey the current to the trains at a pressure of 6,600 volts, the construction of the overhead line, however, is of such a nature, and the precautions taken are so devised, that it is impossible for any person, in any way, to come in contact with the current at this pressure. The electrical equipment of the car is so arranged, that the mere fact of wishing to inspect any of the high tension apparatus causes the whole of this to be connected to earth, and thus made safe before it becomes accessible.

The high tension current is only to be got at in the high tension chamber, which is of steel, in the motor-man's compartments.

The currents, such as lighting and control, are procured through a small transformer which is located in the high tension compartment at a pressure of only 300 volts. Experience has shown that the risks of fire due to short circuits are much smaller in the case of a system of high tension alternating currents than where continuous currents are in use. The reason for this is that it is the amount of current used and not the energy which creates fire risks; thus, in consequence of the very high pressure used, the current required by one of the South London electric trains, to start it, is only in the neighbourhood of 160 amps., while in the case of a continuous current train, as generally used in this country, this current would be in the neighbourhood of 2,000 amps. The circuit breakers in the sub-stations and switch cabins, through which current passes which feeds the trains, are necessarily set to supply current for several trains—say from four to five trains; under these circumstances short circuit, in the case of continuous current, might cause a current of anything up to 10,000 amps. to flow, without interrupting the feeding circuit or circuit breakers operating and cutting off the current.

In the case of the alternating current system as installed on the Brighton line, when the current reaches 800 amps. the circuit breakers would certainly work and cut off the current. Under the normal construction of electric rolling stock, such currents would not be sufficient to cause serious fire; whereas, in the case of continuous current, 10,000 amps. might be sufficient to cause a very serious conflagration.

Special care has been taken in the feeding arrangement by the use of boosting transformers to so arrange matters as to provide that the current will practically entirely return through special feeders supplied for this purpose, and not to return to the rails and earth, thus avoiding any possible trouble due to electrolysis, or cause any disturbances in existing telephone, telegraph and signal circuits. Experiments made up-to-date clearly demonstrate that the success of this experiment has been realised.

The erection of the overhead work has been carried out under exceptionally difficult circumstances, and the design of the construction was equally difficult, as supports for the constructions had to be erected in such positions as not to interfere with any of the existing tracks, or to inconvenience the service.

The number of tracks to be equipped in both termini are considerable, and, notwithstanding all these difficulties, the whole of the overhead construction was designed and erected without in any way interfering with the existing heavy steam traffic. The construction has been considered by all engineers who have seen it, to be the most up-to-date ever adopted.

The repair shops are situated at Peckham Rye, and every tool is found there which may be necessary to maintain the electrical equipment, and to secure proper maintenance of the rolling stock.

Electric capstans and travelling cranes operated by single phase motors are installed, and one of them is fitted with a specially arranged device, by which a motor coach can be lifted off the truck and another complete motor truck substituted for it, the time for doing this, from the beginning of the operation until the train is ready to go out, not exceeding 40 min.

Telephonic communication exists between this repair shop and all the electrical cabins which have been installed along the South London line, as well as with all the signal cabins, and by this means it is anticipated that in the case of any failure of any portion of the system, it will be possible to rapidly communicate with the electrical department at Peckham Rye, and take the necessary steps to immediately put right any defect which may have been found, with a minimum delay to the traffic.

The use of the single-phase alternating system enables considerable extensions to be carried out without the necessity of building sub-stations and cutting down an extensive feeding system, and there would be no difficulty, if it were found advisable, to extend it to Brighton or even further.

The current for operating the present service is purchased in bulk from the London Electric Supply Corporation, and is delivered to the Brighton Co. at Queen's-road by a duplicate system of mains, at which place it is measured and paid for. The London Electric Supply Corporation have supplied four large generating units at their power station at Deptford, one of which is capable of delivering the total requirements to the railway, and it will thus be seen that ample reserve has been provided for the railway's requirements.

The Board of Trade, after making a careful inspection, passed the line for public service. This is the first time such a system has been submitted to the Board of Trade for their approval, and reflects credit on all concerned in the electrification. The take-over tests on all the trains have given very satisfactory results and in every single case the tests have shown results which have been superior to the guarantees, already a stringent kind, in the contract. Thus, the energy consumption per ton mile was some 15% better than the guarantees, and the same applies to the acceleration of the train. Test runs took place between Battersea Park and Peckham Rye, the average distance between stations on this portion of the line being 4,000 ft., with an average speed of just under 22 miles an hour including stops, and 25 miles an hour excluding stops; the average consumption of electrical energy per ton mile, taken for a very large number of runs, was under 72 w.h. per ton mile.

Experiments have shown that the acceleration obtainable with the single-phase system adopted by the Brighton Railway is quite as good as anything that can be realised with continuous current; thus, on the level, a three car train with its normal equipment can easily attain a speed of 25 miles an hour in 20 sec., an acceleration which is quite as good as anything that can normally be done by continuous current. The characteristic of single-phase motor furthermore allows this higher rate of acceleration to be obtained in such a way that it is lowest at starting and rises as the speed of the train increases. The rolling stock adopted is of the side door type which will enable passengers to have the privacy which at present exists, and which will also enable carriages to be quickly emptied and filled.

The illumination of the coach is particularly effective and consists of four 10 c.p. lamps in groups of two for each compartment, each group being contained in a holophane globe; this globe, in consequence of special prisms ground on it, causes the light to be evenly distributed throughout the compartment and realises a brilliant form of lighting without producing a blinding effect on the occupants of the carriage. It is believed that it is the first time this form of light has been adopted by a railway.

Special care has been devoted to testing all materials used in connection with the overhead line; each individual insulator has been tested electrically at ten times its working pressure and also submitted to mechanical tests of considerably more than ten times the stress to which they will ever be subjected to in practice. All the trains are handsomely upholstered, and at night are brilliantly lighted.

ELECTRICAL DRIVING OF TEXTILE FACTORIES.

We have received the following letter, signed by Messrs H. Ellis, H. A. Jones, R. Pohl, T. Roles, C. W. Salt, W. B. Woodhouse, from Bradford:—

"As members of the Special Committee of the Bradford Engineering Society, appointed to consider the Electrical Driving of Textile Factories, we desire to protest against the recently published document described as a Report of the Committee. Several portions of this document have been published without our knowledge or approval, and without an opportunity being given to the committee as a whole to discuss it. It does not represent the views of the Committee, and is in many respects misleading. The impression that this document gives, viz., of being the outcome of careful enquiries and exhaustive tests, is erroneous—it represents the results of preliminary discussion among the members of the Committee, and of two tests which were by no means exhaustive. We therefore desire to dis-associate ourselves from it."

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PATENTS.

The Control of Electrically Operated Clutches.

695.—1909. M. GREEN, Coventry. This invention is particularly useful in connection with clutches through which power to or from an electric motor or generator is transmitted. It is also particularly adapted for use on electric propelled vehicles which may be those of the mixed or auto-mixed type. Fig. 1 represents an elevation of a controlled clutch and Fig. 2 a part sectional elevation at right angles to Fig. 1. The clutch *a* is operated from a battery *b*, one end of which is earth connected, through carbon contacts, *c*, *d*, held in split sockets *e* and *i* and leads *f* and *g*, one end of the clutch also being earthed. If desired the carbon contacts may be bridged by a resistance *h*. The socket *i* and its carbon block *d* are substantially fixed in position. The socket *e*, carrying the block *c*, is connected with a solenoid core *j* in an insulated tube *k* around which passes a coil *m* carrying the main current of, for example, the electro motor. The solenoid core is adapted to be pressed downwards by an adjustable spring *n*, which is under compression and to be raised when the current flows in its normal direction through the coil *m*, the adjustment of the spring being such that when an overload current of sufficient depth passes the contact between *c* and *d* will be broken and controlled clutching or declutching ensue according as to whether the resistance *h* is used or not. In order to vary the periodicity of the core, when vibrating an iron plug *o* is screwed into the top of the insulating tube *k* so that by its adjustment the required variation of periodicity is obtained. In the form illustrated when the circuit between *c* and *d* breaks the resistance *h*, which when used is in the form of a lamp, takes the whole of the clutch circuit current, but if desired, as has been mentioned above, no such resistance need be used, the break between the blocks acting entirely to break the clutch circuit. The effect of altering the air gap between the core or armature *j* and the keeper *o* is to increase or decrease the difference between the lifting current and the holding current. For instance, if no keeper at all be employed, the armature can be set to lift at, say, 300 amps., the clutch starts to slip, and directly this occurs the main current decreases and the armature drops. This happens so rapidly that the armature takes up a kind of vibration, which is not the effect required. By adding a keeper, the current has to drop considerably before the armature falls, and this is often desirable, as, for example, in certain cases it gives the motor time to speed up.

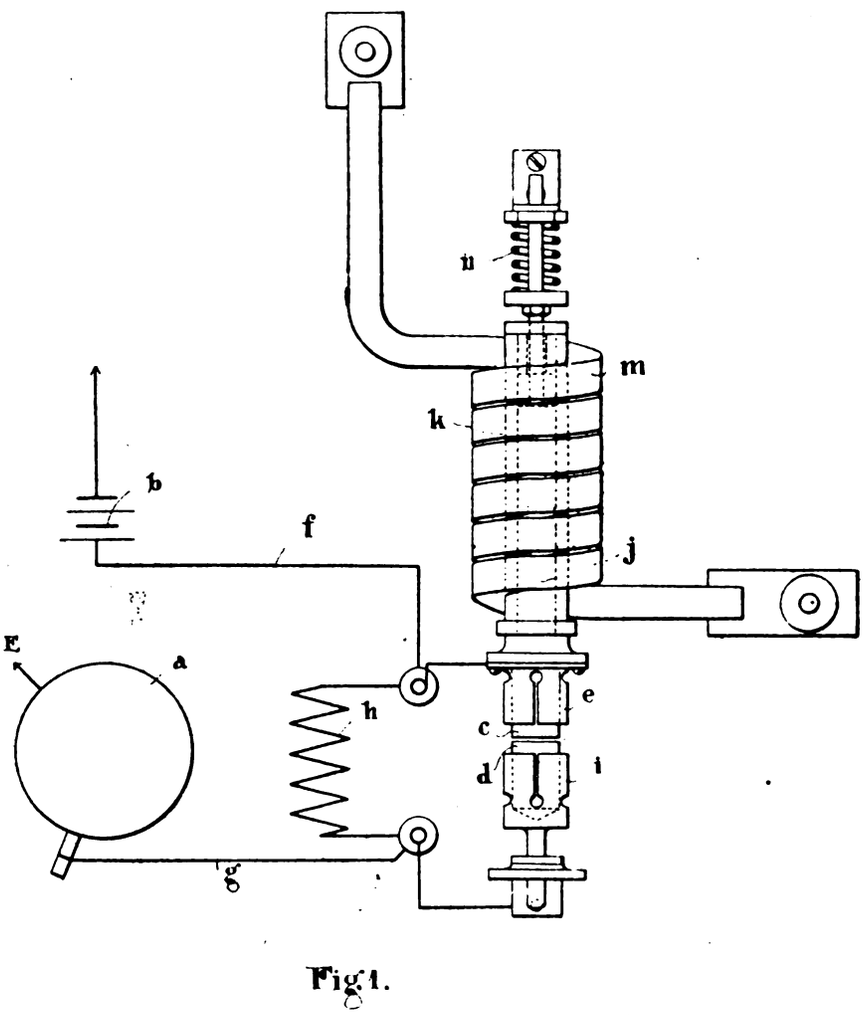

Fig 1.

Electric Indicators.

5040.—1909. A. WHALLEY, Liverpool. This is an improvement in the indicating movement of indicators or annunciators, and particularly in connection with those which have a pivoted revolving indicating part. Fig. 1 is a section of an indicator in which *a* is a coil having a core with a pole piece of the same diameter as the core, or enlarged as shown at *b* with the magnetic return *c* attached to a front plate *d*, the latter having an orifice to receive a drum or rotating part. Fig. 2 is an elevation of the indicator in which *a* is the coil, *e* the magnetic return, *d* the plate, and *f*, *g*, part of the pivoted rotating part. Fig. 3 is an enlarged section of the drum or rotating part of the lines A, B, Fig. 5 is an enlarged elevation of the same part. Fig. 4 is a horizontal view of the drum or rotating part, *f*, *g*, showing two horns, *n* and *o*, which rest against the magnetic return where *i r* is affixed to the front plate and so keeps the rotating part in the normal position. The drum shown in Figs. 3 and 5, in which *f* is a curved piece of iron formed partly in an arc of a circle and partly parallel to the front plate carrying the indicators, is the main point of the invention. The iron extends to the point marked *p* and towards the opposite end is tapered and has the two horns *n* and *o* at right angles to the line A, B, as shown in Fig. 4. The iron has also extensions *k* bent in towards the centre so as to form bearings for the pivots. A part *g* of non-magnetic material forms also an arc of a circle, and with a shorter part parallel to the plane of the front plates, joins the magnetic part at the point *p*. This also has side or wing pieces *j* bent so as to unite with *k* and form bearings for the pivots. The curved part *f* is not a true arc, having its centre at the bearing *q*, but the distance from the point *r* to the centre *q* is very slightly less than from the point *f* to *q*, so that when suspended in position as shown in Fig. 1, it is slightly further away from the pole piece than when the drum is revolved and the point *f* comes opposite the pole piece. The flat section *e*, which is in the same plane as the front of the fixing plate, is formed of ebonite or other suitable material caused firmly to adhere to the metal surfaces so that, as shown in Figs. 1 and 2, the surface of the plate *d* and of the indicator are in the same plane,

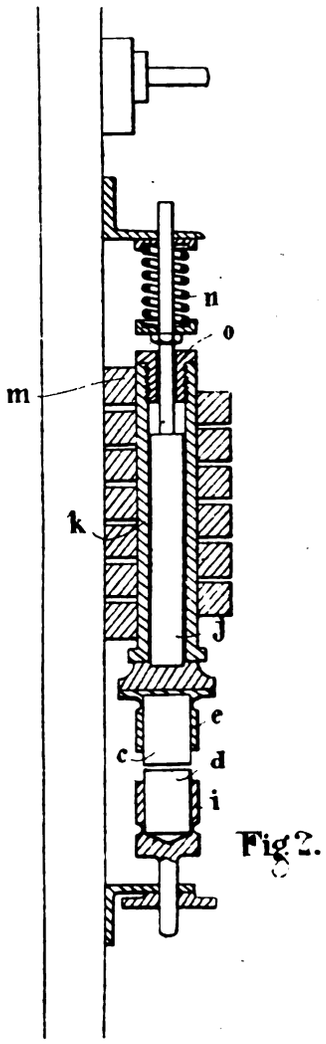

Fig 2.

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and therefore there are no protruding parts to interfere with the efficient cleaning of the face of the board or to be injured by such action. When current is passed through the coil *a*, Fig. 1, the drum is rotated as the section of iron *f* lies in the magnetic field, and the mass of iron is smaller towards the point *r* and increases in mass towards *f*. The drum rotates until the flattened surface *e* is approximately

FIG 1

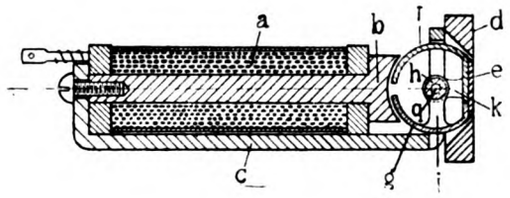


FIG 2

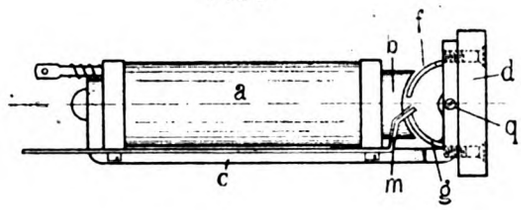
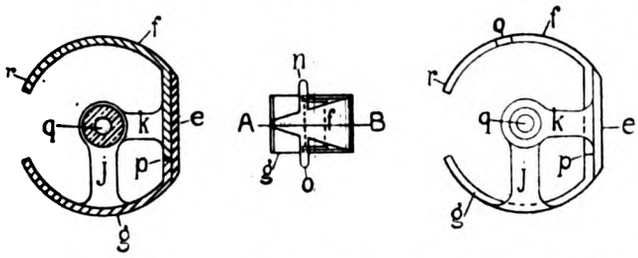


FIG 3 FIG 4 FIG 5



at right angles to its normal position, and a curved segment of *g* is then exposed at the aperature, and slightly protrudes beyond the face of the plate *d* as a calling signal. When current is removed from the coil the rotating part returns to the normal position by gravity as the parts *j* and *g* are heavier than the upper parts.

Electric Batteries.

22236.—1908. L. V. Basset, Enghien. This is an improvement in batteries in which two active liquids circulate through distinct and adjacent compartments separated by porous partitions. In such batteries the active agents are soluble in the electrolyte and the products of their transformations are soluble. A third liquid is introduced into the battery, and while this has no action on the other two liquids circulating in the adjacent compartments at the same time adapted to dissolve the deposits, which from time to time may arise from the interaction of the first two active liquids in the porous partition.

Overhead Conductor Gear for Electric Vehicles.

22413.—1908. British Insulated & Helsby Cables, Ltd., & J. W. Astley, Prescot. This is an improvement in the crossings and frogs of the overhead gear of electric railways. The parts of the frogs and crossings to which the overhead conductor wires are fastened are separate from the base, and they are connected by having projecting threaded studs on their outer edge. These pass through holes in the base and are secured at the back by nuts. The bars are narrow, and at one side extend down on to the wire, while at the other side there is a clamp which is secured to the permanent side by screws. This clamps the wire and holds it. In addition to this there may be a notch in the wire and a corresponding projecting part on the bar. The sides of the wire and the bars are parallel, so that the wheel of the trolley pole cannot foul anything and does not have to run over any uneven or projecting parts.

Ceiling Roses.

27729.—1908. F. G. Bazell, Coventry. The object is to provide a simple construction of ceiling rose of the type in which the main wires may be tapped without cutting them. This is particularly useful and can be adapted for employment in conjunction with a system of wiring carried on insulators or cleats, but is also useful when fitting up temporary lights. Fig. 1 is a central vertical section of a preferred form of ceiling rose. Fig. 2 is a plan of the body and Fig. 3 is an inverted plan of the body. The body A is of porcelain and the terminals B B^2 project through the body as shown at B^3, having binding screws on both sides. Those B on the top are for the main wires C, which, when bared of insulation as shown at C^2, may be clipped by the terminal B. At the opposite side of the body A, the terminals B^2 are formed to receive the branch wires D as usual, suitable cord grips G being provided. These are diametrically opposite one another, connected by a circular web H with holes for the passage of the branch wires. The body A is screwed to receive the usual cover plate F, which may also be of porcelain, and to it is attached the base E which is grooved as at E^2 for the passage of the

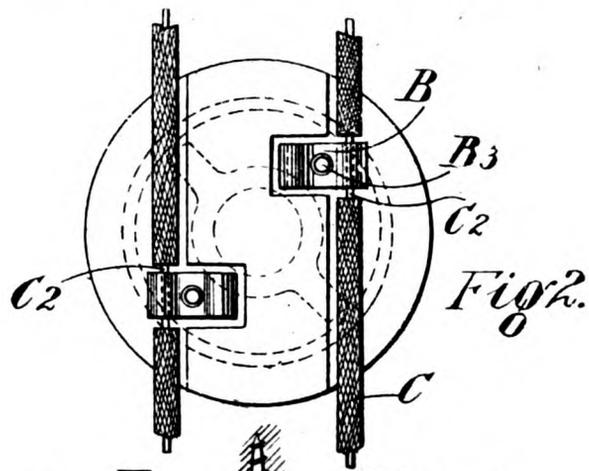


Fig 2.

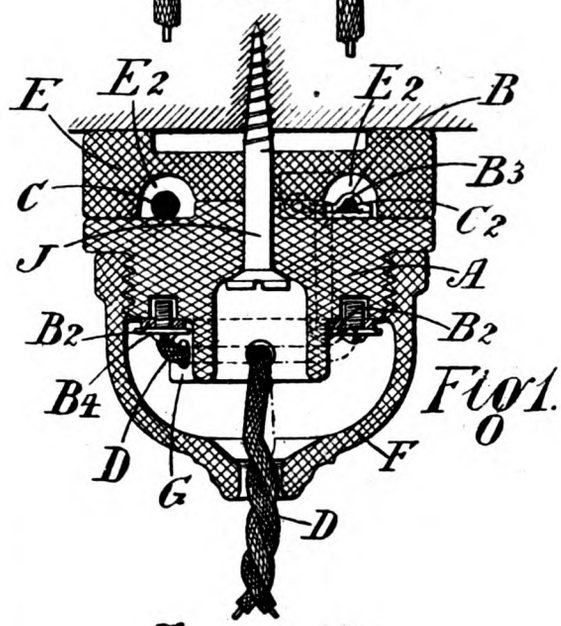


Fig 1.

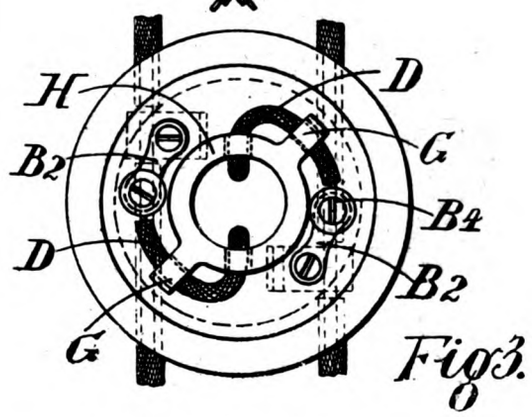


Fig 3.

main wires C, a single screw J passing through the body and base connecting the two and fixing the whole to the ceiling or roof, no wood base or patrass being thus required. It will be seen that the terminals in the construction illustrated, take the form of a stem B^3 which may be a screw engaging a clip portion B, which clips the wires, and a terminal plate at the end B^2. This terminal plate carries a binding screw B^4 which holds the branch wire D. Obviously, any other form of terminal may be employed. For instance, the screws B^3 may pass through the body as shown, and carry a simple nut or terminal at each end. The clip B illustrated forms a convenient terminal for use with an endless wire as it can easily be clipped on to the wire.

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COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last prices. £
British Insulated and Helsby Cables, Ord. 1-100,000	5	7-7½
—— 6 p.c. Cum. Pref., 1-100,000	5	6½-6¾
—— 4½ p.c. Mortgage Debentures	100	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100	89-94
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 1-200,000 and 275,001-475,000	3	¾-⅞
—— 4 p.c. Mortgage Debenture Stock	100	48-52
Callender's Cable, Debentures	100	105-107
—— Ordinary	5	10-10¼
—— 5 p.c. Pref.	5	5¼-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1	⅞-1
Dick, Kerr, and Co., Ordinary, 1,260,000	1	1-1⅛
—— 6 p.c. Cum. Pref., 1-305,000	1	1-1⅛
—— 4½p.c. Debenture Stock.	100	100-103
Edison and Swan United, "A" Shares, 1-99,261	3	⅞-1
—— "A" Shares, 01-017,139	5	1-1⅛
—— 4 p.c. Deb. Stock, Red.	100	66-71
—— 5 p.c. 2nd Debentures	100	81-84
Electric Construction, Nos. 1 to 112,100	2	¾-⅞
—— 7 p.c. Cumulative Pref.	2	1⅛-1⅜
—— 4 p.c. Perp. 1st Mort. Deb.	100	62-67
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100	68½-74½
General Electric Company (1900) 5 p.c. Cum. Pref.	10	8-8½
—— 4 p.c. 1st Mort. Deb. Stock	100	83-87
W. T. Henley's Telegraph Works, Ordinary	5	12-12½
—— 4½ p.c. Preference	5	5½-5⅝
—— 4½ p.c. Debentures	100	106-108
National Electric Construction Co., 1-170,000	1	⅞-1
Telegraph Construction and Maintenance	12	34½-36
—— 4 p.c. Bonds	100	101-103

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Bournemouth and Poole, Ordinary	10	9½-10
Brompton and Kensington, Ordinary	5	6¾-7¼
—— 7 p.c. Preference	5	6¾-7¼
Canadian General Electric Co., Common Shares	$100	114-119
—— 7 p.c. Cum. Pref. Stock	$100	116-119
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100	96-99 xd
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5	3¾ 4¼
—— 4½ p.c. Cum.. Pref., 1-80,000	5	4¼-4⅜
—— 4 p.c. Debenture Stock, Red.	100	98-101
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5	3¾-4¼
City of London, Ordinary	10	9⅞ 10¾
—— 6 p.c. Cumulative Pref.	10	11¾-12⅜
—— 5 p.c. Debenture Stock	100	121-124
—— 4½ p.c. 2nd Deb. Stk. Red.	100	100-103
County of Durham Electrical Power Distribution Co., Ordinary, 1-50,000	5	1¾-2
—— 5 p.c. Preference, 1-50,000	5	2¾-3⅛
County of London Elec. Supply, Ordinary	10	7¼-8
—— 6 p.c. Cum. Pref.	10	10¾-11¼
—— 4½ p.c. Debentures Prov. Certs. All pd., Rd.	100	105-108
—— 4½ p.c. 2nd Debentures, Red	100	98-101
Edmundson's Electricity Corporation, Ord., 1-80,000	5	¼-5/16
—— 6 p.c. Cum. Pref.	5	¼-⅜
—— 4½ p.c. First Mort. Deb.	100	57-60
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100	91-94
Kalgoorlie Electric Power and Lighting, 6 p.c. Non. Cum. Pref., 1-150,000	1	⅝-¾
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000.	5	7-7½
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100	95-98
London Electric Ordinary	3	1⅞-2
—— 6 p.c. Pref.	5	4¾-5¼
—— 4 p.c. 1st Mortgage Debenture Stock, Red.	100	92-95
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	50 55
Metropolitan Ordinary, 100,001-300,000	5	3¾-4¼
—— 4½ p.c. First Mortgage Debenture Stock	100	106-109
—— 4½ p.c. Cum. Pref.	5	4¾-5
—— 3½ p.c. Mortgage Debenture, Red.	100	83½-86½
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,050 ($500) M 1-4,400 ($1,000)	—	80½-82¼%
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb. Red	—	98-100
Newcastle-upon-Tyne Electric Supply, Ord., 1-50,000 and 57,010 to 137,500	5	4-4¼
—— do. 50,001 to 57,009	5	4-4¼
—— do., 5 p.c. Pref., 1-137,500 Non. Cum.	5	4¾-5¼
Notting Hill Electric Lighting	10	12¼-13¼
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	6-6½
—— 4 p.c. Debenture Stock	100	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1	1⅛-1⅜
—— 6 p.c. Non-Cum. Pref., 1-100,000	1	1⅛-1⅜
—— 5 p.c. Debenture Stock, Red.	100	103-106
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5	5¼-5⅜
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5	6¾-6⅞
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	—	105¼-107½%
Smithfield Markets Electric Supply, Ord., 1-12,000	5	¾-1⅛
South London, Ordinary	4	2¾-3
South Metropolitan Electric Light and Power Ord.	1	5/16-9/16
—— 7 p.c. Cum. Pref.	1	1 1/16-1 3/16
—— 4½ p.c. 1st Mort. Deb.	100	100-103
St. James's and Pall Mall, Ordinary, 101-20,080 and 40,081 to 60,100	5	8¼-9
—— 7 p.c. Pref. Non. Cum.	5	7-7¼
—— 3½ p.c. Deb.	100	84-88
Urban Electric Supply Co., Ordinary	5	⅝-¾
—— 5 p.c. Cumulative Preference, 50,001-100,000	5	1⅛-1⅜
—— 4½ p.c. First Mort. Debenture Stock, Red.	100	77½-78½
Westminster, Ordinary	5	8⅛- 8⅜
—— 4½ p.c. Cum. Pref., 110,101-191,379	5	4⅞-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 5 p.c. Cum. 1st Pref., 1-640,000	5	4 15/16-4 17/32
—— Debenture Stock, Red	100	90½-92
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1	⅜-½
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1	⅜-½
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	87-90
British Columbia Electric Railway Co., Ord. Def.	100	143-148
—— Ord. Pref.	100	121-125
—— 5 p.c. Cum. Perpetual Pref. Stock	100	106-109
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	102-104
—— 4½ p.c. Vancouver Power Deb.	100	102-105
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10	¾-1
—— 6 p.c. Cm. Pf., 30,001-60,000	10	2¼-2⅜
—— 5 p.c. Perpetual Debenture Stock	100	84-87
—— 4½ p.c. 2nd Deb. Stock	100	58-62
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100	97-99
Calcutta Tramways, Ord., No. 1 137,610	5	4¼-5
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5	4¾-5
—— 4½ p.c. 1st Deb. Stock, Red.	100	101-104
Cape Electric Tramways, Nos. 1-491,222	1	3/16-7/16
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5	4¾-5¼
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100	96-100
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5¼-5⅝ xd
—— 4 p.c. Deb. Stock, Red. (1985)	100	98-101
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12¾-13¼
London United Trys (1901) 5 p.c. Cum. Pref.	10	2⅝-2¾
—— 4 p.c. 1st Mt. Db. Stock, Red.	100	67-70
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	1/32-3/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1	⅛-⅛
—— 4½ p.c. Deb. Stock, Red.	100	93-96
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100	100½-103½
Provincial Tramways Co., Ordinary, 1-24,912	10	4-4¼
—— 6 p.c. Cum. Pref., 1-10,000	10	10-11
San Paulo Tramway, Light, and Power Co.	$100	153-156
—— 5 p.c. 1st Mort Deb., Red. (1929) 1-12,000	$500	102-104
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1	¾-⅞
—— 4 p.c. Deb. Stock, Red. (1940)	100	69-73
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5	¾-⅞
—— 6 p.c. Cum. Pref., 1-46,261	5	1⅝-2⅛
—— 4½ p.c. 1st Deb. Stock, Red.	100	81-85

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100	61-63
—— 4 p.c. Pref.	100	84-86
—— " " deferred	100	44-46
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	101-103
City and South London, Consolidated Ordinary	100	29½-30½
—— 4 p.c. Debenture Stock	100	100-102
—— 5 p.c. Pref. Stock '91	100	108-110
—— " " " '96	100	104-107
—— " " " '01	100	100-103
—— " " " '03	100	96-100
Underground Electric Railways of London, 5 p.c. Prior Ln. Bds.	—	100-101

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10	3-3½
—— 5 p.c. Debs., Red., within 1-1,609 Red	100	99-102
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000	96-98
Anglo-American Telegraph Co., Ordinary	100	60-62
—— 6 p.c. Preferred Ordinary	100	100-101
—— Deferred Ordinary	100	21¾-22½
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100	87-89
Direct Spanish Telegraph Co., Ordinary	5	3-3½
—— 10 p.c. Cum. Preference	5	8-8½
—— 4½ p.c. Debs., 1-600	50	100½-102½
Direct United States Cable Co.	20	13-13½
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 p.c. Mort. Debs., within 1-8,000 (1913)	25	99-101
—— 4 p.c. Reg, Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	—	—
Eastern Extension, Australasia and China, 1-300,000	10	11¾-12¼
—— 4 p.c. Mort. Deb. Stock, Perp.	100	102-104
Eastern Telegraph Co., Ordinary Stock	100	129-132
—— 3½ p.c. Preference Stock	100	84½-86½
—— 4 p.c. Mortgage Debenture Stock	100	102-104
Great Northern Telegraph Co. (of Copenhagen)	10	29½-30½
Marconi's Wireless Telegraph Co., Nos. 1-394,190	1	⅝-¾
National Telephone, Preferred	100	107-108½
—— Deferred Stock	100	120½-122½
—— 6 p.c. Cum. First Pref.	10	10¾-11
—— 6 p.c. Cum. Second Pref.	10	10½-10¾
—— 5 p.c. Non. Cum. Third Pref.	5	5¼-5⅜
—— 3½ p.c. Deb. Stock, Red.	100	98-100
—— 4 p.c. Deb. Stock, Red.	100	100-102
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100	100-102
West Coast of America, 1-30,000 and 53,001-53,008	2½	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	100-102
West India and Panama Telegraph Co., Ordinary	10	⅛-¼
—— 6 p.c. Cum. 1st Preference	10	8¼-9¼ xd
—— 6 p.c. Cum. 2nd Preference	10	8-9
—— 5 p.c. Debs., Red., 1-800	100	102-104
Western Telegraph Co., 1-207,930	10	13¼-13½
—— 4 p.c. Debenture Stock, Red.	100	103-105

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NOTES.

LONDON TRAFFIC.

Quite recently we gave publicity to a scheme for a Greater London Railway, a kind of electric belt, sweeping round the Metropolis from Woolwich to North Woolwich. That was a grandiose idea, but by no means impracticable, though we may have to wait some time before its realisation. Meanwhile a less ambitious but very useful electric railway project has been brought so far to a head that a Bill for the construction of the railway has been deposited for consideration by next Parliament. This plan is to link up the Metropolitan District Railway at Wimbledon with the station of the London and Brighton Railway at Sutton. It would pass through Merton, Morden, Carshalton and Cheam, providing a much-needed means of intercommunication, and placing these places in more direct touch with the centre of London through Wimbledon. The need of such electric facilities for transit is well illustrated by this case, for although Wimbledon and Sutton are only five miles apart, it now takes 28 minutes by express and 72 minutes by slow train to travel between the two, while the contemplated electric railway will perform the journey in 12 minutes. The cost of the project is estimated at a quarter of a million. This is, of course, only a small link in our traffic web. Another, equally fragmentary but far more costly, project is discussed in our leader columns.

ELECTRICITY AND TRANSPORT.

An excellent opportunity presents itself for anyone having original ideas as to the application of electricity as a means for facilitating traffic. The Dorset Field Club are, under the Cecil Medal Trust, asking for a reasoned paper on "Electricity as a Motive Power for the Purposes of (a) Aviation, (b) Navigation, (c) Motor Traction on Land, in view of Recent Developments." The prize consists of the Cecil solid silver medal and an additional prize of £5 value. It is an entrancing subject, both for review and for anticipatory speculation. The club rules are sufficiently liberal, as the competitors may be between the ages of 18 and 30, and either Dorset born or resident within the county borders for a brief twelvemonths. The competition should bring forth some interesting essays. By the way, full particulars as to conditions can be obtained from the club's assistant secretary, Mr. H. Ponney, of our contemporary, *The Dorset County Chronicle*, Dorchester.

THE PRESS AND "WIRELESS."

As mentioned in our last issue, the Wireless Telegraphy Act, 1904, was given a new lease of life by being included in the Expiring Laws Continuance Act, which has been passed by both Houses. In the House of Lords, however, it was mentioned that newspaper proprietors are most anxious that next Session the Bill should come up separately. Lord Denman said that in view of the Radio-Telegraphy Convention and the acquisition of the Marconi stations by the Government, it might be necessary to alter the Act, and in that case a comprehensive measure might be introduced.

TASMANIAN HYDRO-ELECTRICITY.

In the course of a most interesting lecture before the Royal Colonial Institute, the Agent-General for Tasmania mentioned the subject of hydro-electric power generation in the colony. He said that the State Legislation is now considering a Bill by which a company sought permission to utilise the waters of a river into which three great mountain lakes drained, for the purposes of generating electricity, this electricity is to be used for the treatment of complex ores and other purposes. The outflow of these three lakes alone will give an available force of 82,000 h.p. But there are many other splendid untapped sources of power, ample to generate sufficient electricity to light every town in the island, to electrify mines, provide power for railways and endless factories. So far only the city of Launceston is lit by hydro-generated electricity, and there are a few other small plants at work. But the field for development is immense, and is, therefore, worthy of the special attention of British electrical engineers, manufacturers and others.

"ELECTRON."

Electron is the name of the newest alloy which is being tested in Germany. It is a magnesium alloy of a white colour, having a specific gravity between 1·75 and 2, a tensile strength of 35 kilos to the square milimetre (when wrought), or 18 kilos to the square milimetre (when cast). It can be cast and wrought, and will take a high polish. While likely to be of considerable use owing to its combined hardness and lightness, it is said to possess the drawback of being easily oxidised.

"ELECTRIC HOUSE."

Mr. G. P. Fox, secretary of the South Metropolitan Electric Light and Power Co., Ltd., writes to say that "Electric House," Catford, is proving a big success. He adds, and this is a point to be noted, that "the fact that this demonstration of what can be accomplished by the aid of electricity is not on the old lines of a 'Model Show House,' but is a home in full swing, seems to have great weight with the hundreds of people who during the short time which has elapsed since its opening, have paid visits to the place, coming from far and near." It is certainly an excellent idea, boldly carried out.

LUBRICATION OF ENGINES.

Lecturing on the Willans high-speed engine before the Derby Society of Engineers, Mr. C. Crockford, resident electrical engineer, Midland Railway, Derby, gave high praise to these engines. Referring to lubrication, he said he preferred the splash to the forced system. He advocated the use of mineral oil with water, for if in proper proportions and properly emulsified, it was a splendid lubricant, reaching the parts requiring lubrication, and leaving a considerable film of oil on all surfaces for protection when the engine was standing, an essential point. Mr. Crockford made the interesting announcement that Messrs. Willans and Robinson are experimenting with a double-acting engine with forced lubrication. It will occupy less space than the single-acting engine of the same power, and run at about two-thirds the speed.

BOARD OF TRADE COMMERCIAL INTELLIGENCE.

It is clear, from the official report just issued, that British manufacturers are beginning to recognise the usefulness of the Board of Trade Commercial Intelligence Department. For instance, while the written enquiries were only 1,220 and the personal enquiries only 394 in 1901, they rose respectively to 6,764 and 4,503 in 1908, while for the first half of this year they amounted respectively to 3,789 and 2,490. An excellent move was made when local correspondents were appointed abroad and in

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our Colonies, yet again when the Trade Commissioners were appointed. Naturally, much information is gathered which it does not behove the interests of our national industry to publish broadcast, and this kind of semi-private intelligence was long sent only to Chambers of Commerce. The natural outcome of this was the institution of a register of firms desiring information to be sent to them. The firms so registered now number over 1,400. The Department is also having a beneficial influence on our Consular Service. Altogether, if it only receives the support of the commercial community, the Department will prove an invaluable auxiliary in the matter of business getting.

ELECTRICAL PROPULSION OF SHIPS.

A correspondent points out that Admiral Oram gave the steam consumption of the *Indomitable* as 12·03 lbs. per shaft h.p.h. at full power, certainly an improvement on those steam consumptions which have been published as representing the steam consumption of the *Dreadnought*. He, however, left out the most interesting points, namely, What was the propeller speed, and what was, therefore, the propulsive efficiency for the shaft h.p. so produced? We have here the key to the whole question. With electrical transmission of power for ship propulsion there is no reason why the revolutions of the propellers should not be reduced at full power to, say, 200 r.p.m.; therefore, taking it that the propulsive efficiency of the *Indomitable*, with its propellers running at 300 r.p.m., at full power, is equal to 40%, and that the total shaft h.p. was 43,000, if the propellers were only run at 200 r.p.m., then the propulsive efficiency of the propellers for the h.p. supplied to them would be about 48%. Thus for the same amount of thrust produced (because that is what really pushes the boat along), the h.p. on the shafts would be only 35,800. This would mean a saving in the h.p. required for the same vessel speed and displacement of no less than 7,200 shaft h.p., quite apart from the saving in steam that can be got from running the steam turbines under the high speed conditions brought about by electrical power generation and transmission, especially when superheat is applied. Now, this is an inherent feature in this method of ship driving, because of the small high-speed turbine that will be used, which is impossible, or would become a very dangerous practice, with the large diameter direct-coupled steam turbines at present utilised on our most valuable pieces of national property, *i.e.*, the battle-ship and the cruiser.

ELECTRIC PROPULSION OF SHIPS.

By E. KILBURN SCOTT.

Vice-Admiral Oram's presidential address to the Junior Institution of Engineers, part of which we printed in our issue of November 19, has come at an opportune time. The engineering world was put on the *qui vive* regarding the possibilities of electric propulsion of ships by Mr. Durtnall's papers before the Institution of Marine Engineers, and also before a gathering of naval engineers at Chatham, and the correspondence, etc., arising out of it, also Mr. Mavor's paper in Scotland; and two other papers are now to hand dealing with the same subject.

The first was read a few weeks ago in America by W. L. R. Emmett, chief turbine engineer of the General Electric Co., of U.S.A., and the title is, "The Application of Electricity to Propulsion of Naval Vessels," and the second is a paper by Mr. Mavor before the Institute of Civil Engineers. In his paper Mr. Emmet says: "Although steam turbines were used commercially in Europe long before they were introduced here on any scale America has set the pace in this great development. It is not unnatural, therefore, that we should be in a position to take the first great step towards the driving of ships by electricity."

We must give American engineers full credit for usually carrying out that which they say they will do, and whilst not quite agreeing with the remark that America has set the pace, yet they evidently mean to try and do so in electric propulsion.

It will certainly not be to the credit of our naval authorities if this experiment, so full of great possibilities, should first be made abroad. There certainly must be one or two warships about ready for the superannuated list which could have their reciprocating engines taken out and replaced by steam turbines and electric machinery.

We are quite ready to believe that the engineering staff at the Admiralty Office are a little puzzled as to the rival claims of the two best known systems, namely, the Durtnall and the Mavor, and also that electric power on such a large scale, and especially because it is by three-phase alternating current that is proposed shall be used. But all the essential principles of what is proposed has long been common knowledge to electrical engineers, and would soon become so to naval engineers if only the Admiralty gave their staff the necessary opportunities. In his recent address, Vice-Admiral Oram, C.B., judicated that in his opinion at least the case of electric propulsion had not yet been proved. His concluding paragraph, however, is to the effect that the good work done by electrical engineers on board warships is well known, and he would welcome their co-operation as regards the main engines.

Quite so, then why not advise the Admiralty to equip two existing boats with the Durtnall and the Mavor systems without delay. They would be better than new boats because all the tests and data for the existing engines could be compared with the new data under electric propulsion conditions. We would have thought that there has been quite enough figures published regarding what electric power can do, but as the Vice-Admiral wants more, we are glad to supply him.

In Mr. Emmett's paper comparison is made between steam turbine propellors direct and driving through electric motors. He assumes 8½ lbs. of water evaporated per lb. of coal, and arrives at the following figures:—

	Lbs. of coal available.	Water consumption	Shaft. h.p.	Distance in knots at 12 knot speed.
Parsons' turbine direct	5,550,000	25·6	4,700	4,700
Steam turbine and electric motors ..	6,080,000	17·8	4,400	7,900

Some figures given by Mr. Mavor are also remarkable; for example, he goes closely into the quantities for a cargo boat requiring 770 shaft h.p.:

	Cost.	Weights. Machinery.	Tons. Fuel.	Approximate Length taken up in ship from stern post.
Boilers, engines, condenser	£6,150	186	260	42 ft.
Gas, electric, with producer	£9,789	129	100	48 ft.

He also brings the following interest points:

(A). The single electric equipment, while unable to drive the ship faster than 18 knots per hour, can maintain this speed against a head-wind, because a slowing down of the ship does not slow down the turbine and does not reduce the efficiency of turbines or propellers. If there is a margin of boiler power the turbines can be forced against the extra strain, and the propellers will not cavitate.

(B). In the case of this equipment, again, it is to be noted that full power is instantly available for reversing while the main generators continue running at full speed in a uniform direction. The importance of this feature in handling a large ship is a strong argument in favour of electric propulsion.

It cannot be too strongly emphasised that the electric propulsion of ships enables a low propellor speed to be used by which a greater propulsion efficiency is to be obtained, whilst, at the same time, the prime movers can run at any speed. For the same draft and vessel speed less power will be required, and this will react right through to the boiler. Of course, at lower speeds the diameter of shaft is larger, but the shaft is shorter when driven by electric motors. Electric propulsion also enables superheat to be employed in the steam turbine, for a quick speed turbine has a smaller mass of metal which is not materially affected by superheat. The slow running turbines suitable for driving propellers direct have large diameters, and superheat cannot, therefore, be used. The use of superheat means great economy in boilers, fuel and fuel space. One of the advantages of electric driving propellers is that the energy of any number of prime movers can be concentrated on one or more motors and, therefore, propellers.

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For example, a river or cross-channel boat having light draft and high-vessel speed, requires a multiplicity of propellers, as this gives a maximum propulsion. A tramp boat having greater draft works best with single or twin propellers of large diameter and blade area, and being well submerged there is no chance of air being drawn under to cause cavitation and slip.

It frequently happens that a tramp steamer arrives at a coaling station when either the prices asked or the quantity in stock prevents the captain from taking coal on board. With an ordinary marine engine the method then adopted is to reduce the boiler pressure and link up the engine so as to get about half-speed with minimum fuel consumption.

The power taken to drive a vessel through the water at full speed is some four or five times what it is at half vessel speed, because of skin friction, wave actions and windage. Half-vessel speeds are easily attained with ordinary marine engines by the above-mentioned method of linking, and they can get to another coaling station with little over half the fuel burnt, although it takes double the time. It pays to do this sometimes, and this condition must be met before owners will look into the subject. We understand that the Durtnall system provides for it.

To halve the speed of a steam turbine means great inefficiency; for example, on the *Lusitania*, the fuel consumption at full speed of 25·4 knots (without auxiliaries) was 12·77 lbs. of steam per shaft h.p. Whereas, at 15·77 knots the steam consumption jumped to 21·23 lbs., or an increase of steam consumption per shaft h.p. developed of 65% for a drop in the vessel speed of 38%.

With internal combustion engines it is difficult to run at any but full speed, because of the high compression required.

In the Durtnall system, if there were, say, twin or triple screws and three-turbine sets, then, when it was necessary to economise fuel under the above circumstances, this may be attained by shutting down two out of the three turbines generator sets, the remaining one generating current at half the frequency and supplying current to the two motors on the propeller shafts, and causing them to run at half-speed; in fact, five efficient speeds may be given to the motors if desired, with constant turbine speed.

This paper has no brief for any particular system of electric propulsion, but thinks the Admiralty should give both systems now before the public a trial at as early a date as possible. We make a lot of fuss about the English being the first to get to the pole, but surely it is of vastly more importance that we should continue to lead the nations in naval matters. Undoubtedly electric propulsion has come to stay, and if our Admiralty do not get to business, we shall see navies abroad adopting it first.

SINGLE PHASE ELECTRIC TRACTION.*

By T. A COLLETT.

The advantages presented by a system employing alternating current throughout are obvious to one who has studied this subject. The chief arguments in favour of single-phase working are that only one overhead conductor is necessary, and as pressures of over 3,000 volts are attained, the inferiority of the three-phase system, in which at least two overhead conductors at different potentials are required, becomes more pronounced. This and the fact that the three-phase induction motor has not a large range of speed over which economical operation can be obtained, constitute the chief advantages of single-phase working over three-phase working. The two chief types of single-phase traction motor are :—

(1) The series compensated motor with or without auxiliary poles.

(2) The compensated repulsion motor.

The series compensated motor is the simpler, and is also an excellent d.c. motor. It has a high power factor, and as no magnetizing transformer is necessary, it is, as a rule, lighter than a repulsion motor of the same rated output. If it be fitted with commutation poles, the efficiency may be somewhat higher, with a greater range of sparkless operation. The repulsion motor is distinguished by the method of excitation which results in a higher power factor with a larger air gap. It may also be wound for considerably higher voltages than the series motor; in fact, it might be wound for the line voltage since the stator would be the only part of the motor subject to the h.t. current. It is inadvisable, however, to put h.t. current on such a piece of apparatus as the stator of a railway motor; and if this proposal were adopted, motor control would be less easy and efficient than if it were done on the main transformer.

Control. Motor control is effected by varying the terminal voltage, and since alternating currents are being employed throughout this may be done much more economically than in the case of d.c. equipments. Two methods are in use :—

(1) Tapping the winding of the main transformer at various points.

(2) Use of the Induction Regulator.

The first method is the simpler and more used, being usually employed in connection with a series of controlling contactors. The disadvantages of the induction regulator are that it has a rather high self-induction, and usually requires a motor to move it.

Transmission. E.H.T. current may be transmitted from the power house to transformer sub-stations, which feed the various sections of the line; or, in the case of smaller undertakings, the h.t. current may be put straight on the line. In planning the arrangement of feeders, it must be remembered that the voltage drop between different parts of the circuit will depend more upon the inductance than the resistance of the circuit.

Generation. With a fluctuating load, the difficulty is to keep the trolley voltage constant. The line drop and regulation of the generators is largely dependent on the power factor of the whole circuit; this is a further reason for keeping the frequency low. The practice is sometimes adopted of generating two or three phase and using the different phases on different sections of the line, as single-phase alternators are usually larger and heavier than polyphase machines of the same rated output.

* Abstract of paper read before Northampton Institute Engineering Society, Northampton Institute, London, Nov. 26, 1909. Dr. C. V. Drysdale, M.I.E.E., presiding.

STUDENTS AT CHELTENHAM ELECTRIC WORKS.

The students of the engineering course, and a few from certain other classes, visited the Cheltenham Electric Light Works and Ash Destructor. At the works the party was met by the Borough Electrical Engineer, Mr. W. J. Bache, M.I.E.E., who first of all extended a very hearty welcome to the visitors, and then outlined the nature of working of the electrical plant and special points of interest to be noticed upon making the round of the Works. The students then formed into two parties. The ash destructor was the first subject of study. Here is burnt up in large furnaces all the refuse collected from the town. It was astonishing how well this refuse burnt and what an extremely high temperature the flue-gases attained. The " clinker " or residue of the refuse after burning is made into slabs for paving purposes. The boiler-house, with its water-tube boilers and condensing plant was next inspected, and the apparatus for softening the hard local water before it is run into the boilers was pointed out. From the boiler-house the parties proceeded into the electricity generating room. The arrangement of the plant is well systematised, and gives a very neat aspect to the room. The vertical steam engines and dynamos were the first machines inspected, and then the very modern steam turbines that make 2,000 r.p.m. So great is the speed that, except for the ground vibration in their neighbourhood and the warmed air that is driven out, one would scarcely believe at first sight that any motion was going on. The switchboard is compact, and has the advantage of having no space behind. There is a separate switchboard for the current taken off for running the trams, and when there is a particularly heavy load the fact is readily apparent on the indicating dials. A very ingenious balance for measuring currents for checking purposes that was invented by Lord Kelvin completed the tour of the works. On behalf of those present Mr. L. Richardson, Director of the Technical Schools, thanked Mr. Bache most cordially for his kindness in giving up his time to showing them round the efficient works under his charge, and in reply Mr. Bache said that he would always be only too pleased to do anything he could to facilitate the Technical School students' studies.

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ILLUMINATING ENGINEERING UP-TO-DATE.*

By PROFESSOR S. P. THOMPSON, D.Sc., F.R.S.

Many persons now realise the immense stride made in the introduction of the Auer (Welsbach) mantle for incandescent gas; very many fewer people realise the significance of the corresponding step forward that has been begun by the introduction of the metallic filament glow lamp. We are on both sides in the very middle of an immense evolution in the art of illumination.

But while the means of illumination have thus been developing with amazing strides during a single generation, and the organised systems of distribution, by municipal and urban and rural authorities, and by private corporations, have ramified throughout the community and brought supplies of gas and of electricity—shall I also say of oil?—to our doors, there has been another and very different development going on. I refer to the growth of that branch of the science of optics which deals with the measurement of luminous values. Photometry has been growing into an exact science by the explanation of its laws and the improvement of the instruments of measurement.

We have still to find agreement on the standard of illumination. Here in England, and in the United States, we have already grown accustomed to describe amounts of illumination of surfaces in terms of a British unit—the "candle foot"—not perhaps a very happy term—one that we would readily exchange for a better—meaning thereby the intensity of the illumination at a surface situated at the distance of one foot from a light of one "candle." The source being assumed here to be concentrated at a point, the law of inverse squares holds good. Therefore, as all illuminating engineers know, the illumination due to any point-source is calculated by dividing the number of "candles" of the source by the square of the number of feet that express the distance from the source to the place where its light falls. Since then 1 metre is equal to 3·281 ft. and the square of 3·281 is 10·765, it follows that, if we wish to express distances in terms of the metre, and the illumination in "*candle-metres*," 1 candle-metre will be only $\frac{1}{10{\cdot}765}$ of 0·09289 of a candle-foot. Or, putting it approximately, it takes a light of about 11 candles at the distance of 1 metre to produce an illumination equal to that produced by 1 candle at the distance of 1 ft. Equal illuminations are produced (*a*) by 1 candle 1 ft. away; (*b*) by a 16-candle glow lamp 4 ft. away; (*c*) by a 64-candle Welsbach mantle gas light, 8 ft. away; (*d*) by a 144-candle Nernst lamp 12 ft. away; (*e*) by a 1,000-candle arc lamp 31½ ft. away. We are here dealing with the quantity of the illumination, not with its quality, that is to say, its colour.

Our Continental friends have tried to procure the adoption of the word "*lux*" to denote what here is called a "candle-metre," *i.e.*, the illumination afforded by 1 candle at a distance of 1 metre. Unfortunately they have mixed up the definition of the "lux" with that of the unit of light, so that already the term is ambiguously used; hence, for the present, I avoid it, though I am quite prepared to adopt it if the ambiguity is removed by international agreement.

Adopting, then, for present purposes, the candle-foot as the unit of illumination, one may readily state certain facts with definiteness. All competent authorities are agreed that at night, for the purpose of reading, an illumination is required not less than 1 candle-foot: some authorities saying 1½ candle-foot. The facts appear to be that reading is impossible with an illumination of $\frac{1}{10}$ candle-foot; difficult and fatiguing with one of $\frac{1}{5}$ candle-foot; comfortable with from 1½ to 3 or 4 candle-foot. But that if the illumination exceeds 6 or 8 candle-foot, the glare of the page is again fatiguing and dazzling. The page should neither be under-illuminated, nor over-illuminated. Something depends, it is true, on the size of the print.

No one can have worked at the photometry of modern lamps, or of the illumination of surfaces lit by lamps, without becoming conscious how much misunderstanding there is of the elementary laws of illumination. There is Lambert's cosine law—admirable and simple—if only it were not in so many cases vitiated by the presence of organised—that is, specular—reflection. There is that everlasting law of inverse squares, itself a universal geometrical law of action radiating from a point, so fatally and absolutely misleading if applied to any other case than that of action from a point.

One of the things that I think our Society might well undertake would be the formation of technical Committees charged with the duty of preparing reports on different branches of our subject. One such subject, on which more information is badly needed, is the specific brightness of surfaces of different kinds when subjected to a standard illumination. For instance, let the question be put: How much light is reflected, per square inch, when illuminated with an intensity of 1 candle-foot, from such materials as oak panelling, whitewash, brown paper, or the surface of a red brick wall? Here in this theatre the walls are tinted of a dark Pompeian red or maroon, which reflects but little light. The extra annual expense on lighting that might be saved had a lighter tint been used is surely worth considering.

Now that we have a standard of illumination and simple portable instruments that will measure it, there can be no excuse for inaction or ignorance in applying that knowledge to securing proper illumination for public and private buildings.

Let me begin with school buildings. They are the most important, for whatever bad results flow from bad lighting of churches, factories, or railway stations, those which result from the bad illumination of schools are far more to be deplored—they imperil the eyesight of the next generation. All ophthalmic surgeons agree that the cause which thus forces the children into increasing shortsightedness is protracted pouring over books under an insufficient illumination. All educational authorities ought henceforth to insist on rational requirements as to lighting. Hitherto they have had nothing definite to specify: now that illumination photometers are available, they ought to require a minimum of 1½ candle-foot at the worst-lighted seat in the schoolroom; and not depend on purely architectural rules about heights of windows or areas of window-space.

Hitherto little attention has been paid by either local or central authorities to conditions affecting the lighting of factories and workshops. When we think of the wholly miserable conditions as to lighting under which many workers have to do their daily toil—the tailor stitching by the light of a single flaring gas bat's-wing burner—we may wonder that so little has been done. If I am correctly informed, the Home Office has laid down no rules about the illumination in factories, beyond the general requirement that the lighting must be "adequate." It rests with the inspector to say what he considers "adequate"; and until he is provided with an illumination photometer to take with him into different parts of the factory to measure the illumination there, or until some definite knowledge exists as to the proper amount required for the different trades and occupations, or for different machines and tools, the term "adequate" is almost meaningless. The Home Office has its regulations as to temperature and degree of moisture required or permissible in the different classes of factories and workshops. Then why not also similar regulations as to the proper amount of illumination? Surely the eyesight of the workers is as well worth protecting from injury as their lungs and their limbs. So far as I am aware, Holland is the only country in which legislation has fixed a statutory amount of illumination in factories, the figure there being from 10 to 15 candle-metre; equivalent, therefore, broadly to the value of 0·9 to 1·35 candle-foot.

DISCUSSION.

Reckless Illumination.

Sir Boverton Redwood: We had now various systems of brilliant illumination, which he feared were too often recklessly employed without due consideration for the functions proper illumination should discharge. New methods of lighting, new and brighter illuminants were springing up; yet the eye, by the aid of which their light was perceived, was still the same.

Problem for Solution.

Mr. A. P. Trotter: There were engineers and architects and scientific photometrists who were lamentably ignorant on the

* President's address at inauguration of Illuminating Engineering Society, London, Nov. 18.

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physical problem of proper and efficient illumination, but he hoped that not only our authorities but other people would help towards the elucidation of the many problems in illumination by influencing one factor which, because of its limited capacity, was of great importance, namely, the eye—the public eye.

FUTURE OF THE SOCIETY.

Mr. W. Mordey (Past President of the Institution of Electrical Engineers): The Illuminating Engineering Society could not have had a better President nor one with wider interests. In addition to being a Past-President of the Institution of Electrical Engineers, he had been the founder of the Optical Society, and President of the Physical and Röntgen Societies. The President was equally distinguished in the arts, music, and languages. He felt, therefore, that the future of the Illuminating Engineering Society was in good hands.

NO TRACE OF SCEPTICISM.

Prof. Walmsley (Principal of the Northampton Institute): He had now no trace of scepticism as to the necessity for this society and as to the useful career which lay before it, if it were only carried out in the spirit and with the zeal which is adumbrated in this address.

PHYSIOLOGICAL QUESTIONS.

Dr. J. S. Haldane: The President had reminded them that the questions of illumination were to a large extent physiological questions.

A DISCUSSION ON "GLARE."

The *President* then announced that the next meeting of the Society would take place at the Royal Society of Arts, at 8 o'clock, on Tuesday, January 11, when a discussion on "Glare: Some of its Effects and Causes," would be opened by Dr. J. H. Parsons.

ELECTROANALYTICAL DETERMINATION OF LEAD AS PEROXIDE*

By HENRY J. S. SAND, Ph.D., D.Sc.

The electroanalytical determination of lead as peroxide has hitherto been rendered somewhat uncertain by the fact that when dried at temperatures at which it may be considered to be free from the risk of decomposition, it is always found to retain a small amount of water, and the corrections which various investigators state should be made for this vary very considerably. It has, therefore, been proposed by Treadwell to ignite the peroxide at a dull red heat, and thus convert it into oxide. This suggestion can, however, be carried out conveniently only when a dish is employed as the anode. Where gauze electrodes are made use of, it has been found practically impossible to effect the conversion in a gas flame without at the same time obtaining some lead as metal, owing to the reducing action of the flame.

The theoretical factor for the calculation of lead from peroxide is 0·866, and the experimentally found factors which various investigators have put forward vary between 0·853 to 0·857 according to Hollard and Bertiaux, and 0·8634 to 0·8643 according to R. O. Smith, and also according to Arthur Fischer and Vossen. The results thus differ from the theoretical value according to the investigator, by amounts varying between 0·15 and 1·5 %. The slight variations found by the same investigator refer to different amounts of lead. The temperatures for drying are given variously by the different investigators as 200° and 200° to 230°, but it may be considered certain that the discrepancies are not due, in the main, to difference of temperature.

The following experiments were carried out primarily with the view to elucidate the behaviour of a lead peroxide deposit on drying, and incidentally further to study the effect of varying conditions on its nature generally.

The circumstances controlling the coherence of the peroxide have been found very similar to those which govern the coherence of metal deposits. The higher the temperature and the smaller the current density, the more coherent is the precipitate. When employing the conditions which are most favourable to the quality of the deposit it is, however, necessary to avoid too large an amount of nitric acid in the electrolyte, and it is specially important to remove any oxides of nitrogen which may be present by evaporating the electrolyte to dryness before a determination. Even small quantities of these oxides will render the exhaustion of the electrolyte at high temperatures impossible. The temperature was always kept slightly below the boiling-point, a maximum of about 97° never being exceeded, as the current appears to produce lower oxides of nitrogen from the nitric acid at 100°.

Large quantities of ammonium nitrate appear to render the precipitate of peroxide loose. It is not improbable that, under suitable conditions, alkali plumbates, and even the plumbates of heavy metals, may sometimes be formed as intermediate products.

Colloids appear to have a similar effect on the deposits of lead peroxide as on those of metals. When obtained from a solution in which a small amount of stannic acid in the colloidal state is present, the precipitate of lead peroxide is always much more coherent than it would otherwise be. Small amounts of the colloid are precipitated with the peroxide. This fact should also be borne in mind when a solution is to be electrolysed in which colloidal metal oxides may be produced by the hydrolysis of salts.

In almost all the experiments to be described, the electrolyte contained only nitric acid beside the lead salt. In two or three a small amount of nitric acid and a very large amount of copper nitrate were, however, added in conformity with a suggestion by Hollard and Bertiaux. The method was, however, not proceeded with further, as it suffers from the fact that the electrolyte cannot be conveniently tested for freedom from lead, and besides, the results were found two or three tenths of a per cent. higher than with the strongly acid electrolyte free from copper.

The electrodes employed were those previously described. The outer electrode was always the anode. The gauze covers a surface of about 50 to 55 sq. cm. It consists of about 14 wires per linear centimetre of approximately 0·2 mm. diameter, and the total surface available for the peroxide is probably somewhat less than 90 sq. cm. The volume of the liquid was about 85 c.c. The exhausted electrolyte was always tested for absence of lead by neutralising a sample with ammonia and adding hydrogen sulphide, and the cathode was also examined for freedom from lead.

In a former paper the author gave some results for the determination of lead as peroxide. The theoretical factor was employed, and both positive and negative deviations were obtained, the former seldom exceeding 0·3 %. The details of the method of drying, which were at that time not given, may here be stated. An oven improvised from a 1½-litre Jema beaker, protected at the bottom by asbestos paper, was employed, which was covered by a cork lid, and a current of air was drawn through by means of a water-pump.

In the course of the present investigation it was soon found that at a temperature of about 200° a lead peroxide deposit is capable of absorbing moisture in a damp atmosphere, and only parts with this exceedingly slowly when heated in carefully dried air. The apparatus employed for heating in a moist atmosphere consisted of a sheet-iron can of about 25 cm. height and 11 cm. width, which was closed at the top by a cork. The latter was provided with an opening designed to hold a smaller cork, to which the electrode was suspended by a wire. Some water was evaporated at the foot of the can, which contained sufficient openings to allow the steam to escape, but was devoid of any arrangement to produce circulation of the atmosphere. The distance of the electrode from the bottom of the can was about 10 cm. In the experiments the electrode was always removed from the can while hot, so that there might be no possibility for drops of water to condense on it on cooling.

For those experiments in which the electrode was to be heated in dried air, a copper cylinder of about 25 cm. height and 5 cm. diameter was employed. The bottom was brazed on, and the top was closed hermetically by a cork. An altogether unexpected difficulty was experienced in obtaining a flawless cork of the necessary diameter cut at right angles to the grain, which would fit gas-tight. This difficulty was only overcome by obtaining a cork cut from a composite piece, consisting of three parts glued together. The cork held two glass tubes by means of which air previously dried in a tower containing caustic potash and calcium chloride could be caused to circulate with the aid of a water pump.

In one experiment the electrode, with about 0·37 gram of lead peroxide, was heated to 200° in the moist atmosphere for 25 minutes, whereupon it gained 1·1 mg. in weight.

*Paper read before the Faraday Society, London, November 30.

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On further heating in the dried air for 50 minutes at 180°, it lost 0·5 mg., and on again heating in the dry air for over an hour, it lost 0·3 mg. After this it increased in the moist air at 200° in 15 minutes by 2mg., in another 20 minutes under the same conditions by 1·3 mg., then again in 25 minutes by 1·5 mg., then in 20 minutes by 0·4 mg., and in another 20 minutes by 0·8 mg., making a total increase of 6 mg., *i.e.*, of about 1·7%. After this the increase on further heating was inappreciable. The heavy deposit thus obtained only parted with its water exceedingly slowly when heated in the carefully dried atmosphere. In 20 minutes it lost 0·8 mg. at about 210°, and even at much higher temperatures the decrease was very slow, thus the loss in an hour at 230° to 240° was only 0·6 mg., and at about 280° in an hour and a half it was 1·4 mg.

These experiments show that in drying the peroxide it is specially important not to allow it to absorb water from a moist atmosphere at a high temperature. They furnish a quite sufficient and satisfactory explanation why different investigators should have obtained different results when special precautions were not taken to remove the moisture from the atmosphere of the drying oven. At a minimum temperature of about 230° it appeared that even in a damp atmosphere no appreciable increase took place, but attention must here be drawn to the impossibility to heat an object of 5 or 6 cm. height uniformly in an ordinary drying oven. A difference of 20° to 30° must always be allowed for between the hottest and the coldest parts of the object. Drying at a maximum temperature of 300° was also tried, but it appears that the peroxide is not absolutely stable at these high temperatures and that a continual decrease in weight takes place. The author believes that it may be taken as certain that when lead-peroxide is in contact with air, there is no true equilibrium which would condition the existence of a definite temperature of decomposition, *i.e.*, a temperature at which the decomposition tension of the peroxide would be equal to the partial pressure of the oxygen contained in the atmosphere. We are, on the contrary, here no doubt dealing with a so-called false equilibrium for which it would be exceedingly difficult to state definite conditions of stability.

All these circumstances will always tend to make the drying of the peroxide at high temperatures a somewhat uncertain operation. The best conditions are no doubt to take the deposit quickly up to a temperature of about 230° in a current of dried air. The factor which was found at a temperature of 200° in dried air varied between 0·863 and 0·865.

A much more simple and probably also more certain method to obtain satisfactory results was afterwards discovered in adopting the identical procedure always made use of for metals, viz., to dip the electrode first into a jar containing alcohol, then into another containing ether, and then to dry it rapidly over a Bunsen burner. The electric current itself is made use of to keep the deposit free from water by electric endosmose. The conditions for securing a satisfactory result are a high temperature of the electrolyte and a high current density. A special experiment showed that a lead peroxide precipitate does not absorb water so rapidly that an increase of weight need be feared during the operations of disconnecting. The electrode with a dried weighed precipitate of 0·4600 gram lead peroxide was dipped into water and dried with alcohol and ether. The operations were repeated, and in both cases no change of weight was observed. It was likewise shown that no error need be feared if the ether should burn for an instant after accidental ignition during the process of drying. A measured quantity of solution containing 0·3172 gram of lead was taken for each experiment, the amount of nitric acid was 10 c.c. per 85 c.c. solution. Small currents were taken at the low temperatures in order to obtain a coherent deposit and to avoid the precipitation of lead on the cathode.

In all the experiments, except Nos. 7 and 8, metallic lead was started from and the solution was quite free from oxides of nitrogen as already explained. The amount of nitric acid present was always 10 c.c. and the volume of the solution 85 c.c. The results may be summarised as follows:—For a temperature of about 90° and a current strength of 5 amps. with the electrodes described the factor 0·863 may be taken. For a temperature of 95° to 97° the factor is 0·865. In either case when alloys are analysed in which the percentage of lead is not very high, it will no doubt be sufficiently accurate to employ the theoretical factor 0·866. The amount of peroxide deposited does not appear to have any definite effect on the value of the factor.

LONG DISTANCE TRANSMISSION ON OVERHEAD LINES.*

By PROFESSOR E. W. MARCHANT, D.Sc., Member, and E. A. WATSON, M.Sc., Student.

(*Continued from page 780*).

Advantages of Star: (1) The size of insulator used need only be large enough to withstand the star pressure of the system; (2) the neutral point can be earthed and the pressure between each line and earth definitely equalised.

As a matter of fact, the advantages of the △ system in enabling the transformer to run with two phases only, if one of the lines break down, is not practically important, as it is found with 60,000 volt working that the insulators installed are rarely large enough to withstand the full line pressure, and if one of the phases break down the line is put out of service until repairs are effected. The same thing holds good with regard to the transformers. In spite of this, however, △ connection is much more common than star, and at the Great Western Power Co.'s station, where the change from 60,000 to 110,000 was made on October 1, 1909, the connection was altered at the same time from star to △. No practical difficulty of overheating due to circulating triple frequency current appears to be met with in this arrangement, nor does the variability of the netural point appear to act prejudicially on the working of the system.

It is remarkable that star working is not more frequently used, as it would appear to be a much more satisfactory arrangement from almost every point of view on extra high-tension systems.

Economic Limits of Transmission.

The factors which determine whether a given water-power can be used economically for the supply of electrical energy are: (1) The capital cost of the transmission scheme; (2) the running charge of the station; (3) the cost of producing energy by other means. The last factor is, of course, simply a basis for comparison. If fuel is expensive—as it is on the Pacific Slope—then, obviously, it is economically practicable to use water-powers involving much higher capital expenditure than in a country where coal is very cheap. The capital charges in connection with hydro-electric schemes are by far the most important in determining the cost of generating energy. The running charges are invariably low. In the Ontario Power Co.'s station at Niagara, the whole plant of 50,000 kw. was in charge of three men and two switchboard operators. In some stations the labour required is much greater. For example, at the Electron station, where a wooden flume 10 miles long is used to convey the water of the Puyallup River to the station reservoir, a staff of 50 men was employed in keeping the flume in a proper state of repair. This latter case is, however, quite exceptional, and it is probable that in a very short time all work of this description on hydro-electric stations will be replaced by structures of a more permanent nature. The chief item in the cost of hydro-electric power production is, therefore, the capital charge, and in such a station this is almost invariably higher than for a steam plant. The stations in which one would expect the greatest economy in capital expenditure would be those at Niagara, where the problem of conveying the water to the station only involves the boring of a short tunnel, and where the plant capacity is large. In these stations, however, the cost was given at from £20 to £30 per kilowatt, including the transmission line, though in some cases it was a good deal higher. The higher figure is for the older stations, where a large amount of excavation work had to be done, and where a very expensive type of machine, with a shaft 130 ft. long between turbine and generator, had been installed. The lowest figure for capital expenditure was given for a station with a very small head, in which the natural conditions at the station involved a very small outlay in providing a channel for the water to reach the

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penstock. The cost of this station, including transmission line, was only £15 per kilowatt. Besides the capital charge involved in the station itself, the charge for the transmission line is usually a very serious matter. The Ontario Electric Development Co., for example, sell their energy at Niagara for less than half of what they charge for it at Toronto.

One of the most interesting points about the transmission line is the determination of the most economical voltage at which it should be worked. Kelvin's Law states that the most economical section of conductor for a given transmission is that for which the capital charge on that portion of the capital expenditure, which is proportional to the area of the conductor, shall be equal to the annual cost of wasted energy.

Kelvin's Law is based on the condition that the total charge for transmitting energy along the line shall be a minimum, but a sounder condition to apply to a transmission line is that the ratio of the total cost of transmitting energy to the revenue earned shall be a minimum, and if this condition is applied we find that the cost of wasted energy must be equal to the whole charge for interest and depreciation on the transmission line. If we assume a cost for the station of £30 per kilowatt a load factor of 50%, and interest and depreciation charges 12½%, the cost per B.T.U. will be 0·26d. The total cost per B.T.U. will amount to not more than 0·25d. On a 20,000 kw. transmission, allowing 10% copper drop, the cost of waste energy will correspond with a capital charge of £120,000, if 15% is allowed for interest and depreciation on the line, or a capital charge of £800 per mile. The cost of poles and insulators on a 8,000 volt line will be about £200 per mile, and the balance will pay for a 3-wire line, each conductor of which is 0·30 sq. in. in area. This corresponds fairly closely with the actual section necessary to give a 10% drop, *i.e.*, 0·35 in. of copper. The calculation shows that the use of these voltages is economically sound, and that for transmissions of 200 miles and over pressure of the order of 100,000 volts must be employed.

The second factor which determines the size of the conductor is the working pressure. With the high pressures used (as is shown above), the possibilities of the formation of a corona and the loss of considerable energy by brush discharge is one that requires careful consideration, and it would be impossible to reduce the section of the conductor used for the transmission below that for which such effects are produced. Another factor which might be expected to have some influence on the choice of voltage used for transmission is the cost of insulating the line. The cost of insulation goes up very rapidly when the voltage is greatly increased. The cost of insulators for a line designed to work at 100,000 volts is more than double that for a line designed for 60,000 volts, and it is a matter of simple arithmetic to determine in any particular case what is the most economical voltage for any given transmission scheme. In actual practice the effect of increasing voltage at the cost of insulation is not of great moment, as the cost of insulators is a comparatively small item in the total cost of a pole-line, and the working voltage is settled by the economic considerations detailed above. The common practice is to work the line to give a known percentage drop, and to increase the voltage on the line as the load on it increases until at the full load the pressure on the line is the maximum for which it was designed at a predetermined drop. The usual efficiency of transmission on most of the schemes seems to be about 90%, the copper drop being of the order of 10%, and the total drop due to resistance and inductance about 15%.

Modern Practice (Hydroelectric Plants Only).

The Station Itself.—The design of a hydroelectric power station is affected by local conditions to a much greater extent than if any other form of motive power were employed. Every hydraulic station, in fact, presents a distinct problem of its own, and has far more interest for the engineer than the ordinary power station built in England, which contains so many standard turbo-generator sets, combined with a certain number of equally standard boilers.

The nature of the country, the height of fall available, the nature of rock in the vicinity, and the geographical configuration of the country, all have to be considered in planning out a station and its transmission line. In some favoured cases, such as Niagara and the Snoqualmie Falls, which supply Seattle and the Puget Sound district, an actual waterfall has been found ready to hand, and no flumes or pipe-lines are required, beyond the pipes or tunnels necessary to carry the water from the top of the Falls to the turbines at the foot. This, however, is rather the exception than the rule, and in many cases long lengths of flume, pipe, or tunnel have been necessary; especially is this the case in the western and central districts of America, where actual waterfalls are rare, but rocky canyons containing rushing rivers of frequent occurrence.

The means adopted in this case of leading the water to the turbines from the higher reaches of the river depend entirely on local conditions. In some cases, notably at the Island Bar Station of the Great Western Power Co., the river follows such a winding course that a short tunnel driven through a mountain will tap the stream many miles further along its course. In this particular case a tunnel, 3 miles long, reaches a point on the river 18 miles higher up along its valley, and a head of 420 ft. is secured, which will ultimately be increased to 520 ft. by building a dam and flooding the ravine. At the station at Vancouver also a tunnel 2½ miles has been constructed, which takes water from a neighbouring lake in another valley, and so increases greatly the power available. In many cases, however, this construction is not practicable, and long flumes, ditches, or pipe-lines have been constructed along the sides of the valley. These flumes are generally built of wood, although the use of reinforced concrete is now being considered, as the life of a wooden one only averages about five years, and the flume requires constant watching and patrolling. The flume generally ends in a small storage reservoir sufficient to run the station for a few hours, from which steel pipes lead to the turbines. The storage has to be sufficient to keep the station running while any necessary repairs are made to the flume.

In some cases the flume is replaced by a pipe-line, frequently constructed of wood. An example of this is found at the power station at Ogden Utah, where a wooden pipe, 6 miles long, is employed.

In at least one plant—viz., that of the Central Colorado Power Co., at Shoshone, Colorado—the flume is replaced by a tunnel cut in the rocky wall, which forms the side of the valley.

The choice of prime mover adopted depends very much upon the head of water available. Pelton or Doble wheels are generally used on high heads of 500 ft. and over, and reaction turbines on the lower ones. Pelton or Doble wheels are invariably installed with horizontal shafts, but turbines are used with either, vertical or horizontal ones, although the vertical shaft type is the most favoured at the present time. An interesting example of a low head turbine plant will be seen in the new power station for the City of Winnipeg, where the turbines are in a separate room to the generators, and work entirely drowned in water—the dividing wall being built as a dam, and the shaft passing through a stuffing-box in it. The head of this plant is only 40 ft.

The chief disadvantage of the vertical shaft turbine is the amount of excavation involved in the construction of the wheel-pit, this being especially noticeable in the well-known plants at Niagara, which, with one exception, have their generators situated at the top of the falls, while the turbines are, of course, at the bottom. Out of five large stations at this centre one only—viz., that of the Ontario Power Co.—has its machines at the same level as the turbines. The most striking example of excavation is, however, found at the Snoqualmie Falls, where a chamber, 200 ft. by 40 ft. by 30 ft., at a depth of 260 ft. below the ground, has been cut out of the solid rock, although horizontal shaft turbines have been adopted.

Closely connected with the question of head and type of turbine is that of safety devices, including governing. The problem of satisfactorily governing a large station working under a high head is a very difficult one, and great care must be taken to protect the pipe-line from the effects of water hammer or stress due to the load being suddenly thrown off. There have been cases of stations having their pipe-lines completely wrecked by the sudden closing of a valve at the lower end.

The chief function of the governor in a hydraulic station, as generally installed in the western and central States, is

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to prevent the machines from running away if the whole load is suddenly thrown off. During normal operation it is common practice to keep the machines running at full load, and look after the variations by means of a steam plant installed at some other point on the system.

If governing is done by checking the flow of water, it is necessary to have some form of relief valve or surge pipe installed, a surge pipe being probably the most satisfactory if the head is not too great, but for very large heads this becomes unsatisfactory. A common practice is to use some form of relay valve operated by the water pressure and controlling an oil or hydraulic cylinder which operates the relief valve proper.

The pressure tunnel at the plant of the Great Western Power Co. is protected by a surge pipe at its junction with the steel pipe-line in addition to the usual relief valves at the station itself. That there is need for a protection of this sort was manifest by the frequency with which it discharged and the large volume of water which escaped at each discharge. With high head plants using Pelton or Doble wheels governing is almost invariably obtained by swinging the nozzles so as to partially clear the buckets. These plants are generally placed longitudinally beside a stream, and the nozzles arranged to discharge into it. This method of governing, although obviously very wasteful of water, relieves the pipes from all stress, and on the very high head plants of 1,000 ft. or over is universal.

The general arrangement of the plant of a modern station is fairly well standardised, although not to anything like the extent of an English steam-driven station. General practice in the most recent stations appears to favour generation at about 11,000 volts, with oil-insulated water-cooled transformers of a large capacity raising the pressure to that of the line. Taps are frequently provided for working at less then the full voltage, if desired, and this is often done during the early stages of the plant, before it gets its full load. In some cases the transformer is considered as forming one unit with its generating plant, as in the plant of the Great Western Power Co., where each machine has its own three-phase transformer of 10,000 kw. capacity. In one case—viz., the plant of the Central Colorado Power Co.—the transformers were treated as forming part of the line, a bank of three single-phase transformers being connected thereto without any high-tension switchgear at all, although this, however, is not usually the case, high-tension oil and disconnecting switches being extensively used.

The hydraulic portion of the plant depends naturally very much on local conditions, but where these are similar a standardised design has been adopted. This is especially the case with the vertical shaft pattern, as found in a large number of medium head stations. The oil supply of such a plant is a matter demanding considerable care, as the consequence of a failure of the pressure oil to the footstep bearings of the turbine would be disastrous. The oil supply for this is generally furnished by separate pumps to those which supply the governing mechanism, but provisions made for each supply to draw on the other in case of need. In only one case were direct-coupled exciters found. Separate machines driven by small turbines or Pelton wheels are practically universal. Considerable diversity exists in the design of the switchgear, both cell type and open-pattern arrangement being found, the numbers of each being about equally divided if the Niagara plants are included.

If these are left out, the majority of the stations visited had their high-tension gear and busbars quite exposed, although neighbouring parts were generally separated by brick partitions. Copper or aluminium rods supported on large pin-type insulators were used in all the plants except that of the Central Colorado Co., where the rods were hung from above by means of suspension insulators such as were employed on the line. The line is usually brought into the station through large porcelain bushings, sometimes in the station wall, but in the higher voltage plants placed in the roof, in which case they much resemble a large transformer bushing. Just outside the station are placed the lightning arresters. Inside the station the line goes to a choking coil, usually a plain copper spiral hung in the air, but sometimes an elaborate arrangement with oil insulation; exactly why this latter should be adopted is not clear, as the copper spiral is much cheaper and just as effective for the high frequencies of lightning disturbances. In all cases but one the line was fed through oil and disconnecting switches from the high-tension "bus." The oil switches are either mechanically, electrically, or pneumatically operated, the latter being used on the 110,000-volt plant of the Great Western Power Co., where they appear to be giving satisfaction. The whole of the switch, including the operating cylinder, is alive, and air is supplied through rubber insulating hose. Consequently the switch is extremely compact, and takes up but little space considering the high voltage at which it works.

The disconnecting switches are usually plain knife switches, opened by hand by means of a wooden rod about 8 ft. long. The insulation of this rod is quite sufficient to allow the user to touch live parts with perfect safety, although in the case of the Great Western Power Co. the disconnecting switches, like the oil switches, are pneumatically operated. Instrument transformers are frequently employed on the high-tension side of the staton, although they tend to assume rather formidable proportions. Small electrostatic potential indicators are used on the high-tension conductors to indicate to the operators whether these are alive or not. They consist simply of a pivoted aluminium vane moving in front of a fixed section and acting on a similar principle to an ordinary electroscope. The generators employed in modern stations are all revolving-pole machines of fairly high speed, a 10,000 kw. machine generally running about 300 r.p.m. Their construction is, therefore, intermediate between that of an ordinary slow-speed machine and a high-speed turbo-generator. Salient-pole rotors and natural ventilation seem to be universal. Both three-phase transformers and banks of single-phase units are employed, and practice does not seem to be decided as to which of these is the best. In a small station where there is only one bank of transformers, single-phase units have the advantage that less spare capacity need be carried, while in large stations with a number of banks the provision of a complete bank in the shape of one three-phase transformer is not a serious matter. In the small station, on the other hand, this would involve carrying a spare plant of capacity equal to that installed, while with three single-phase units only one-third of the working capacity would be necessary.

Air-cooled and insulated transformers are used in some of the older stations working at 40,000 volts and under, but not in any of the newer or very high-voltage plants, and they need not be seriously considered. The fire risk from oil insulation does not appear to be great, although it is usual to place each transformer in a separate brick chamber with a steel door that can be closed if required. The insulation of the high-tension leads where they pass through the case of the transformer is a most difficult problem. A terminal for 100,000 volts is quite a large thing, even if condenser-type insulation be adopted. The object of the so-called condenser-type insulation is to obtain a terminal over the surface of the insulation of which the potential gradient shall be nearly as possible uniform. This is done by embedding in the insulating material metal laminæ whose dimensions are so chosen that the capacity between any two laminæ is the same, this giving a number of equal increments of potential from the case of the transformer to the live conductor.

Line Construction.—With the exception of a 33,000-volt line feeding Schenectady, all plants in the States working at less than 65,000 volts appear to use pin insulators, while above this the suspension type is employed.

The construction of the pin insulator depends, of course, upon the voltage for which it is designed, but on 60,000 volts three or four-part insulators are usual. Brown porcelain is very general, but a slate-coloured glaze is now being introduced, which is said to give a very inconspicuous insulator. White glazed porcelain is never used, the reason given by the makers being that it makes too good a target for rifle bullets, although inquiries made at the various power plants showed but little trouble on this score. Glass insulators, practically universal on telephone and 2,300-volt lighting circuits, are not used on the highest voltage lines. They were originally employed at Vancouver on 40,000 volts, but are being replaced by brown porcelain.

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Lack of mechanical strength and liability to cracking by the action of frost seem to be their chief disadvantages. Suspension insulators and steel towers are the latest development in line construction, and are always used for the very high voltages—*i.e.*, 100,000 volts or so. There are two types of suspension insulators in common use, viz., the Locke and the General Electric patterns. These are generally used either four or five in series on a 100,000-volt line, which gives ample insulation even if one insulator should break down. They are hung from the cross-arms, and no provision made against swinging of the conductor except that anchor towers and strain insulators are installed at intervals and, of course, at all bends in the line. With suspension insulators the ordinary triangular arrangement of conductors is not, of course, practicable; generally, if only one line is installed, the three conductors are placed in one horizontal plane. When two lines are run, three conductors can be placed on each side of the tower and suspended form three cross-arms. The towers are generally galvanised steel shipped in sections, which are bolted together at the site. Each section is galvanised completely after construction, so that the risk of corrosion is very slight. It is usual to test insulators to at least 50% above their working pressure before leaving the works. Firms which undertake the manufacture of insulators have installed elaborate testing equipments for this purpose, with which a considerable amount of original work has been carried out.

Although America has been regarded as the home of wooden poles, all the latest and best plants, both at Niagara and in the western and central districts, are now adopting galvanised steel. The advantages of these are fairly obvious, as they are much stronger and more reliable than wood, and also have a longer life. The effect of climate on the formation of a corona on the transmission line has already been noticed. It also has a considerable bearing on the size and type of insulator employed. For example, at the De Sabla station of the Pacific Gas and Electric Co., 11-in. insulators of the type shown in Fig. 25 were used in the interior of the country, while on the same system 14-in. triple petticoat insulators, similar to Fig. 26, were employed near the sea coast owing to the effect of salt sea-fogs, which are frequent in the San Francisco region. Again, in the lines running in the neighbourhood of the Great Alkali desert of America, frequent trouble is caused by dust-storms, which deposit the salt dust on the insulators and cause short circuits. Instances occur every winter of eastern districts being shut down for periods which would be thought excessive in England; but the American public seem to appreciate that it is better to have light 99 days out of 100 than to have no light at all. Certainly with the American system of transmission and distribution, electricity is available in places in which it could never be obtained under our conditions.

Wooden v. Iron Pins for Insulators.—In all the early installations the insulators were mounted on wooden pins, usually of eucalyptus-wood coated in oil or boiled in paraffin. The two difficulties which have arisen in connection with these are: (1) The digesting of the pin-screw due presumably to the formation of nitrogen compounds by brush discharges from the wire; (2) burning of pins due to leakage current. Of these two phenomena the first is by far the most prevalent, particularly on the Pacific Coast, and has led to the practical abandonment of the use of this type of pin in all newer installations. Even in the Salt Lake District at Ogden, where the transmission pressure is only 28,000 volts, the wooden pins are being steadily displaced by iron pins, either with lead screws for screwing into the insulators or by iron pins cemented into the insulators.

Length of Span.—With a wooden pole-line the length of span is usually from 120 to 150 ft., but with a steel tower construction the length of span is increased, on account of the greater strength of the towers, and it is no unusual thing with such a line to have as long a span as 1,200 ft. for the normal line. Where a canyon or strait has to be crossed, spans as long as 3,000 ft. are installed, but in this case steel wire is used instead of aluminium or copper. It might be expected that with such long spans there would be more danger of the wires swinging together in a high wind, but as a matter of fact this difficulty does not seem to be a serious one. The wires oscillate very little when they are deflected by the wind, and swing in unison. The clearances are, of course, much larger than with the lower voltages and shorter spans. The normal clearance on a 60,000-volt line is 6 ft., on a 100,000-volt line 10 ft., and in the latter case, at Island Bar, the three transmission lines are arranged one above the other, so that there is practically no risk of their touching. The sag of a line with a 1,200 ft. span is, of course, much larger than with a shorter span, for a given tension on the line the sag increases in proportion to the square of the distance between the supports, and this necessitates the use of much higher towers. At the Great Western Power Co.'s installation the height of tower was 90 ft., while in Central Colorado, where the number of poles per mile is six, the height of the pole is only 50 ft. The sag allowed may be very large, as much as 30 or 40 ft., at the highest temperatures.

Where the transmission line crosses a railroad or road, the usual practice is to arrange two towers as near together as possible on each side, so that a wire breaking will not be able to reach the ground. A cage such as is common in England is rarely, if ever, seen, and in some parts no special precaution is taken against risk from falling wires.

Line Material.—The two metals chiefly used for an overhead line are aluminium and copper. The relative advantages of these have been much discussed, and although a great many lines have been erected with aluminium as the conducting material, the tendency in the newer stations, at any rate on the Pacific Coast, is to use copper. The advantages of copper are that it has great mechanical strength, and is a material which is easily jointed and soldered; it is not so electro-positive as aluminium, and is, therefore, not so likely to corrode in a foggy atmosphere. On the other hand, aluminium has the advantage of being a lighter metal than copper for the same conductivity, and is a less expensive material to erect. Joints in an aluminium cable are usually made by splicing, no solder being used to give better conductivity. These long splices are often made in the middle of long spans, and appear to be quite satisfactory. The conductor used is, in nearly every case, a stranded one. This is necessary for heavy current transmissions, on account of the great stiffness of a solid conductor. Even when stranded with 7 or 19 wires, the cable is often too stiff for convenient handling, and a hemp cord is inserted. Another reason for the use of the hemp cord is that when a seven-strand cable is erected in the ordinary way, it is usually the centre strand which breaks when the cable is strained. By having the conductors regularly arranged around a central core the stress is more uniformly distributed, and the cable has greater strength for a given cross-section of material than if it were built up in the ordinary way. One disadvantage of aluminium is that it has a higher co-efficient of expansion than copper.

Co-efficient of expansion of copper per °F. ..	0·0000096
,, ,, aluminium ,, ..	0·0000128
,, ,, steel ,, ..	0·0000064

Hence an aluminium line will change in sag more with increase in temperature than one of copper, and when the sag becomes comparable with the height of the tower this is a matter of some importance.

A disadvantage of the larger cross-section of the aluminium line is that the effect of wind pressure on it is more marked than on a copper line, but, on the other hand, the risk of a corona effect and brush discharge with an aluminium line is considerably lessened. The third material which is sometimes used is steel, but this is employed only on long spans, where the question of mechanical strength is of primary importance. Steel can, of course, be worked at a much higher stress than either copper or aluminium, and in spite of tis relatively high resistance, is used on all very long spans of 3,000 ft. or over.

Sub-stations.

(*a*) *Static Transformers.*—The general distribution system in America is so different to that of England that a few words of explanation may be tendered in order to show what special problems are presented in that country. Direct-current distribution as found here is unknown except in one or two of the largest towns, and then only in the central districts. The chief use of direct current is for railway work, and to some extent for elevator service.

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The universal system of distribution is by means of overhead wires strung on wooden poles and working at 2,300 volts; these are carried along all the streets. At intervals a small transformer is bolted on the pole, and steps the pressure down to 110 volts for service to the neighbouring houses. In consequence of this there are a large number of sub-stations which simply contain static transformers for reducing the pressure to the 2,300 volts required for distribution. These stations, in addition to the transformers themselves, contain induction regulators for regulating the voltage on the outgoing side. These are constructed like an ordinary induction motor with a stator connected as a shunt across the lines and a wound rotor which is prevented from rotating, but can be turned through an angle by means of a quadrant gearing with a worm driven by a small motor. The axis of the regulator is placed vertically, and the whole apparatus, except the quadrant and motor, are immersed in oil. Automatic regulation is thus obtained by adding or subtracting the regulation voltage from that of the line.

In some of the sub-stations of the Pacific Gas and Electric Co. regulation was obtained by the use of tapping points on the transformers. A number of turns of the winding equal to 5% of the whole amount were brought out and sub-divided to give steps of about 1% each. A selector switch was arranged to take current off any one, and their connection could also be reversed so as to give a total range of 10%. These regulators were worked by hand, and appeared to give satisfaction. They have the advantage over the induction regulators of not affecting the power factor of the line, though this is not a very serious drawback when the regulation required is only small. In some towns the 60,000-volt current is stepped down to 12,000 volts or so before entering the city. This may be done from a desire to safeguard the citizens, but it is more likely owing to the fact that 60,000-volt transformers can only be built in large sizes, and that 2,300 volts is not sufficient to feed a very large area. Underground cables are used occasionally in the busier districts of the large cities, but are, generally speaking, very uncommon.

(*b*) *Sub-station Converting from Alternating to Direct Current.*—These are chiefly used for railway work, but also for city supply and series arc lighting. The machinery installed presents no special interest, both synchronous and induction motor-generators and rotary converters being found, but the motor converter does not appear to be used. Rotary converters are used on 60 cycles up to quite large sizes, an example being a 2,000 kw. machine installed at Vancouver. This, however, is an exceptional size, and machines for this frequency are not common above 500 kw. Vertical shaft machines are found in some stations, an interesting example being some rotary converters now being built in which the shaft is stationary and the armature spins on it as a pivot. Stations supplying current for series arc lighting are peculiar to the American continent, quite high voltages (up to 10,000 volts) being employed. Rotating machinery is sometimes employed to effect the conversion, but extensive use is also made of mercury vapour rectifiers combined with constant-current transformers. These rectifiers appear to be very successful, having a life of 3,000–4000 hours and being built up to a capacity of 10,000 volts and 30 amperes. Batteries do not appear to be much used except in some of the larger towns; a large one of 8,000 ampere-hour capacity at 250 volts is installed in the sub-station at San Francisco, but in general the amount of attention and maintenance which they require appears to militate against their use more than it would in England. The chief use of the one at San Francisco appears to be to act as a reserve and keep up supply in the event of a breakdown of the transmission line. It is very rarely that separate generating plants are provided for traction and lighting service. One company usually operates the whole, from one system, and this, combined with the large use of power for heating power and elevator service, probably tends to the realisation of a better load factor than obtains on the average English station.

Sub-stations for Changing Frequency.

When low-frequency current has to be distributed for lighting purpose, it is the usual practice to install frequency-changing plant; this consists of motor generator sets, many of them built on vertical shafts. The type of motor may be either synchronous or induction, and the generator is of the ordinary revolving field pattern. These frequency changers are, of course, only used when the frequency of generation is 25 or 30 cycles per second. It is remarkable that very little lighting has been attempted at the lower frequencies. With incandescent lamps, either of the carbon or Nernst pattern, the flicker when the lamps are supplied with current at 25 ~ is imperceptible, and even with metal filament lamps this effect is hardly noticeable. The only lamps with which such a low frequency becomes a matter of importance are arcs; but as, on an alternating current, all arc lamps are notably inefficient as compared with direct-current ones, it hardly seems worth while changing frequency in order to make alteranting lamps effective. In some places sub-stations containing machinery of 35,000–40,000 kw. have been installed to change the frequency of supply from 30 to 60, and to an impartial observer it would seem a far better plan to have spent the money so invested in improving the distributing system.

DISCUSSION.

Best Method of Governing.

Mr. T. L. Miller.—The joints in the pipe line were very important. The best method of governing is by checking the flow where possible. Generators for use with hydro plants ought to be so constructed that when the speed, owing to turbines racing, becomes excessive, no damage was done. Regarding pneumatically operated switches, to ensure reliability a continuous supply of air must be kept in the cylinder for action at any moment, otherwise there might be leakage, and so no force to work switch.

The Overhead System.

Mr. S. L. Pearce.—The power rates in the States were higher than ours. He had considered the question of overhead transmission from the Manchester stations to Gorton and Audenshaw (about three or five miles away), and found that at the best only 20% would be saved over underground cables. But by the time the Board of Trade's requirements were satisfied there was nothing to be gained by the overhead system. Regarding delta *v.* star, he thought the advantage lay with the delta connection, especially for power services. By the use of an artificial star, the cost of the fourth wire could be saved, the distribution being carried out with three wires, and the consumer using the artificial star if required.

English Engineers and Overhead Work.

Mr. Miles Walker.—English engineers were too much afraid of overhead work. They had a horror of shut downs. If the Board of Trade would make reasonable concessions, and if it is really possible to run a 60,000-volt line in duplicate, or even triplicate, year in, year out without a shut down, then he thought overhead transmissions from the coalfields would surely come.

Advantage of Asynchronous Generators.

Dr. Rosenberg.—The only advantage in using asynchronous generators was that it was not necessary to synchronise other machinery before switching in. But in practice no one would switch in large induction motors without first synchronising it with the voltage.

Effect of Local Conditions.

Mr. S. J. Watson (chairman).—The Thury system was not used in America, but the principle of increasing the voltage as the load increased, as they did, was the same. He did not think H.T. transmission would come in England, because local loads were so large. In America 10,000 to 20,000 kw. was carried per line. Here the Board of Trade regulations set the limit at about 1,000 kw.

Causes of Breakdown.

Prof. Marchant (in reply).—The American lines usually had about six poles per mile. The chief causes of breakdown were ice and snow on the lines, and rarely the ice in the rivers. Under certain conditions the capital cost was greater in hydro-electric than in turbine stations. The overhead transmission was very reliable, as results showed. Though the delta connection was very largely used, he thought the star was better. Overhead transmission was largely a question of way leaves, and here we were badly placed, as way leaves were difficult to negotiate at reasonable rates. Copper was more reliable than aluminium for lines. The earth wire screens the line from electro static disturbances, saved the insulation.

A Possible Solution.

Mr. A. E. Watson (in reply).—In the steam experiment mentioned by Prof. Schwartz, he thought there were probably globules of water as well as steam vapour in the jet, and that this might account for the action. The best cement was Portland cement.

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THE

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CONTENTS.

	PAGE
Notes	807
Electric Propulsion of Ships	808
Single Phase Electric Traction	809
Students at Cheltenham Electric Works	809
Illuminating Engineering Up-to-date	810
Electroanalytical Determination of Lead as Peroxide	811
Long Distance Transmission on Overhead Lines	812
Overhead Railways	817
Correspondence	818
Municipal Electricity	818
Electrification of the G.N.R. of America	819
Mining Electrical Equipment	821
Simplex Picture Competition	822
Transfer of Business	822
New Type of Arc Lamps	822
Trade Openings in Sweden	822
Royal Society Lectures	822
"Electrics" Win Competition	822
Technical Problems, with Solutions by Practical Men	823
Reviews	825
Copper Cable Sockets	825
Electric Train Accident	825
Tyneside Notes	826
Midland Notes	826
Lancashire Notes	827
American Notes	827
German Notes	829
Glasgow Electrical Engineers	829
Lighting & General Notes	830
Traction Notes	831
Companies' Meetings and Reports	832
Companies Registered	832
Contracts Open	833
Some Contracts	833
Tenders Accepted	833
Catalogues and Lists	833
Personal	833
Diary	833
Physical Society's Exhibition	834
Educational	834
Patents	835
Companies' Stock & Share List	838

OVERHEAD RAILWAYS.

If we may take Sir Melvill Beachcroft, Chairman of the London County Council, as a prophet, London may soon witness the beginning of yet another system to complicate our already intricate web of traffic arrangements. Speaking at the opening of the Blackfriars subways, Sir Melvill, with a fine appreciation of contrasts, stated that the new move to provide additional traffic facilities would be to build overhead lines. The idea appears to be to construct some form of overhead viaduct from a point north of Blackfriars Bridge to a point north of Farringdon-street; and, again, a viaduct from the Victoria Embankment across the Strand at a point west of the Central Law Courts, these viaducts being continued across the river, over a new bridge to link up the tramways south of the Thames. It is estimated that the combined project would cost £2,000,000. All things being considered, this is probably too modest a computation. It may be asked why we should have an overhead system at all, in view of the fact that so many authorities favour the shallow subway for tram traffic, a modification of which we already have in the short cut from the foot of Waterloo Bridge to Theobald's Road, and another example of which is foreshadowed in connection with the new city bridge project. But Sir Melvill states that underground communication is almost overdone, so far as the busy centres are concerned, owing to the existing underground railways and the difficulties that have to be met as regards sewers, water and other pipes and also foundations. As for the shallow ways, these do not answer the purpose, according to Sir Melvill, who wishes to see some elevated way which would take not only the up and down line of double-decked cars, but ordinary traffic as well. He contends that another advantage of viaducts over subways would be that the new frontage space upon them would be valuable and could be readily let. Evidently we have here something quite different to the ordinary elevated ways such as are known in Berlin or New

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York. It is rather suggestive of a double-decked street. Whether such a device would be successful is doubtful, but what is quite certain is that the ordinary type of elevated rail and tramways alluded to above ought not to be adopted in London. We are only too familiar with the ghastly accidents which have happened again and again both in Berlin and New York on the elevated electric railways, accidents which are peculiarly disastrous both to those travelling in the elevated railways and those using the streets below. Such accidents are difficult to avoid in the type of traffic referred to, and would be particularly so in London, with its extra damp atmosphere and constantly recurring thick fogs. These atmospheric phenomena would not only retard traffic during busy months of the year when aids to traffic are specially wanted, but, in our opinion, condemn the system *in toto*. Indeed, one of the greatest points in favour of electrified "tubes" and subways is that they facilitate locomotion at the worst periods of the year—when rain, ice and fogs render ordinary level traffic more difficult and dangerous than usual. Both in the interests of the general traffic problems and of the electrical industry's contributions to the solution thereof, it is to be hoped that Sir Melvill Beachcroft's suggestion will receive scant encouragement.

CORRESPONDENCE.

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "THE EDITOR, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

LIGHTNING CONDUCTORS.

Sir,—My quotation from Sir Oliver Lodge's "Lightning Conductors" was given perfectly correctly, but I carried it so far only as it was a definite statement of fact relating to the point I raised, viz., that the most abrupt possible bends or changes of direction in a conductor do not increase self-induction.

I do not know whether Mr. Hedges intends us to accept the addition to the quotation as a further extract from Sir Oliver Lodge's letter to him, or whether, by misplacing the inverted commas, he has made it appear that the whole is the context in the book. The correct rendering of the second sentence is: "But so long as a conductor is straight (and a conductor must, of course, be straight), so long will there be some tendency to side flash, however thick it be made," which does not in any way rebut my contention that straightening a conductor does not abolish self-induction, or that, conversely, abrupt bends increase it.

I do not think that Sir Oliver Lodge wrote the words decrying the value of experiments, for his work is based very largely on such, and he has said: "Experiments in a laboratory, and a thorough understanding of what occurs on a small scale, are a very good introduction to the enlightened study of atmospheric electricity, though they are by no means to be regarded as a substitute for that direct study." If he considers that an experiment with a discharge from an influence machine is no criterion as to what would occur in the case of a similar discharge, increased to the extent of a lightning flash, why did he, in a work on lightning conductors, give details of such experiments, including three sets illustrating the inductance-reducing effect of the zig-zag?

If the question to which Sir Oliver Lodge replied was whether he had advocated the fixing of conductors in a zig-zag fashion, his answer is such as I should have expected; but I do not consider it consistent with one as to whether abrupt bends increase self-induction. Mr. Hedges has omitted to inform us what his question was.

I do not think the interposed remark—"a lightning conductor must, of course, be straight"—was intended to be taken literally, but only in its wider sense as the antithesis to the close zig-zagging to and fro that experiment showed to be advantageous in reducing inductance, but which would be impracticable of adoption. Had it been intended in its limited, and strictly literal, sense, it would have been an arbitrary assertion that Sir Oliver Lodge does not justify in any part of this work, that would be impossible to comply with, and that would not be borne out by the recommendations he has made for the application of lightning conductors.

As stated in my letter of October 8, there are reasons why it is not advisable to zig-zag a conductor, woof fashion, across the wall of a building, and I have never advocated such a procedure; but I contend that nothing has been shown, either by theory, experiment, or observation of lightning effects, to suggest that an abrupt bend in a conductor increases inductance, or even that a discharge would spark across a right-angled bend.

Mr. Hedges has taken advantage of a printer's error in my letter of October 22—the substitution of "which" for "what"—to evade my remarks by saying his book was never put forward as the official report of the Committee. But a chapter in it undoubtedly professes to give the report, and it is in this chapter that additions have been made to the official report, over the signatures of the members, and in a way that makes it appear they are the Committee's own words.

Perhaps Mr. Hedges will be good enough to state whether these interpolations were made with the permission and approval of the members of the Committee, or whether they are unauthorised?

I should also like to know whether his addition of the Royal Society to the title of the Lightning Research Committee is intended to add lustre to its report? The official edition states that the Committee was formed by the Councils of the Royal Institution of British Architects and the Surveyors' Institution.

I am, Sir, yours faithfully,

ALFRED HANDS.

91, Leadenhall-street, London, E.C.,
December 7, 1909.

ELECTRICAL DRIVING OF TEXTILE FACTORIES.

Sir,—Referring to the letter on the above subject, which appeared in your issue of the 3rd inst., the Council of the Bradford Engineering Society, after full enquiry, desires to confirm the report as a true and accurate record of the proceedings of the Committee.

The complete report was typed and issued to every member of the Committee several weeks before the meeting at which it was finally adopted, and no portion was, therefore, published without the knowledge of every member, and without full opportunity for discussion.

The Committee decided from the outset not to enter into any discussion undertaken for the purpose of personal or trade advertisement, and it would obviously be useless to take notice of any further communication from gentlemen who so lightly repudiate the statements for which they themselves are responsible.

(Signed) GEORGE CARTER,
Secretary.

Bradford Engineering Society,
Bradford, *December* 7, 1909.

MUNICIPAL ELECTRICITY.

A special meeting of the representatives of the Association of Municipal Electrical Engineers of Greater London and of the London Electricity Companies' Officials Association was held at the Hammersmith Electricity Works on the 2nd. Papers were read by Mr. Seabrooke on The "Telephone" System of Charging, and by Mr. Bell on Electric Heating, with Special Reference to the "Therol" Heater.

The meeting was largely attended by the Municipal and Companies' representatives, and an interesting discussion took place. It is hoped to arrange future meetings of a similar nature.

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ELECTRIFICATION OF THE G.N.R. OF AMERICA.*

BY CARY T. HUTCHINSON.

The first three-phase installation on a trunk line railway in the United States was put into operation early in July of this year at the Cascade Mountain tunnel on the Great Northern Railway, in the State of Washington, about 100 miles east of Seattle.

In general, the plant comprises a hydroelectric generating station, operating under a head of 180 ft., having a capacity of approximately 5,000 kw. in generators at 6,600 volts and 25 cycles; a transmission system, operating at 33,000 volts, delivering energy to a sub-station, where it is transformed to 6,000 volts, at which pressure it is supplied to the overhead conductors and to the locomotive by way of an overhead trolley; on the locomotive the pressure is reduced by three-phase transformers to 500 volts, for the supply of the four three-phase motors with which each locomotive is equipped. The Great Northern Railway crosses the Cascade Mountains through a tunnel 13,873 ft. long; this tunnel is on a tangent, and has a uniform gradient of 1·7%; rising to the tunnel from Leavenworth, on the east, the ruling grade is 2·2%, and 21% of the total distance of 32·4 miles from Leavenworth to the tunnel is on the ruling grade. From Skykomish, on the west to the summit, the ruling grade is 2·2%, and 44% of the distance of 24·8 miles is on the ruling grade.

The plant described herein is designed for use over the entire mountain division, by extending the system of conductors and building additional stations; it was not designed for the operation of the tunnel alone, although even if the problem had been the handling of the traffic through this tunnel and its approaches only, the three-phase system would in all probability have been selected, on account of its greater simplicity and less cost. The choice of the system to be used was under consideration for more than a year; the three-phase system was finally decided on, plans were prepared, bids obtained, and the contract for the four locomotives let on June 22, 1907.

The original problem was to provide equipment to handle a train having a total weight of 2,000 tons, excluding the electric locomotives, over the mountain division from Leavenworth to Skykomish, a distance of 57 miles. The system was to be first tried out at the Cascade Tunnel.

The tractive effort required to accelerate a train having a total weight of 2,500 tons on a 2·2% grade, using 6 lbs. to the ton for train resistance and 10 lbs. to the ton for acceleration, making a total of 60 lbs. to the ton, is 150,000 lbs.; this would require four locomotives of a tractive effort of 37,500 lbs. each. The railway company's engineers limited the weight on a driving axle to 50,000 lbs.; therefore, four driving axles per locomotive are needed, giving a coefficient of adhesion of about 19%. This is a measure of the maximum power required. The locomotive was, therefore, designed to give a continuous tractive effort of approximately 25,000 lbs., and it was expected that four would be used with a train maximum weight. But the locomotive as built greatly exceeds this specification.

The principal data of locomotive are as follows: total weight, 230,000 lbs. all on drivers; two trucks connected by a coupling, each truck having two driving axles; a three-phase motor connected by twin gears to each axle; gear ratio, 4·26; diameter of driving wheels, 60 in.; synchronous speed of motor, 375 rev. per min., giving a speed of 15·7 miles per hour at no load, dropping to 15 miles per hour for a load corresponding to the one-hour rating. The motors are wound for 500 volts, and are completely enclosed and air-cooled; clearance between stator and rotor, $\frac{1}{8}$ in.; trolley pressure, 6,000 volts; each locomotive has two three-phase transformers, reducing the pressure from 6,000 to 500 volts, arranged with taps, so that 625 volts may be used on the motor.

Each locomotive is equipped with four three-phase induction motors, wound for 500 volts at the primary or stator; the motors are completely enclosed, and are cooled by forced air circulation from a large blower. They are suspended from the axles in the standard manner, except that they are geared at both ends of the armature shaft; this was made necessary by the low speed and high torque required, as it was not considered safe to use a single pair of gears. The gear had 81 teeth, the pinion 19 teeth, giving a gear ratio of 4·26. The gears are of specially hardened steel; in order to secure perfect alignment, the two pinions on each shaft were cut simultaneously. At first it was the intention to use some form of spring connection between motor and driving wheel, but this was subsequently abandoned, as it seemed that there would be sufficient flexibility in the armature shaft to take out any small differences between the two sets of gears. As far as can be told at present, this assumption appears to be correct, for there has been no difficulty with the gears and no unequal wear. The gears run with little noise, and the construction seems satisfactory.

The locomotive carries two three-phase air-blast transformers, having a nominal rating of 400 kw. each, transforming from 6,000 volts to 500 volts normally, or to 625 volts by the use of taps. The continuous capacity of the transformer is not as great as that of the motors, although it is fully up to the specification, and it may be that the quantity of air to the transformer will have to be increased when the locomotives are put in continuous service.

Compressed air for the brakes is supplied by two 100 cu. ft. induction motor-driven compressors; the cooling air is supplied by a 9,400 cu. ft. motor-driven blower. The locomotive is equipped with a combined straight and automatic air-brake system.

Control System.—The control system of each motor is separate; the circuits branch from the transformer, and are independent through the resistances. There are 14 contactors in each motor circuit, 56 in all. The pilot control is in duplicate, one switch at each end of the locomotive. There is a clear aisle on each side of the locomotive from end to end, all of the apparatus being assembled in the centre of the cab.

At first I intended to have two running speeds by changing the number of motor poles, but this led to many complications; every effort was made to keep the equipment as simple as possible, and I finally decided to use resistance control in the rotor of the motors and to have a single-speed unit.

Iron grid resistances are provided for each motor; there are 13 steps in the control, but in order to reduce the number of contactors to the lowest possible point an unsymmetrical system is used. A change is made in the resistance of one phase only, in passing from step to step. This arrangement in effect treats the three-phase circuit as a single-phase circuit; on each step of the control the torque is the average of the three values of the torque of the separate circuits. The principal advantage of this is that 56 contactors do the work that would otherwise require 128, thus effecting a great gain in the simplicity of the control apparatus.

Experience with the locomotive in service indicates that the initial torque, which is approximately 20,000 lbs., is somewhat high, and I am now having the control changed so that on the first step two motors only will be thrown in circuit, and on the second step all four motors. This change is readily made by eliminating step 12, which tests have shown to be of little or no value. Fig. 4 shows the speed and tractive effort of the motor on the different control steps, with unbalanced circuits, and on the final step, without resistance.

The energy supply for the locomotive is derived from the Wenatchie River, which flows along the line of the railway for a distance of some 20 miles. The power house is located about 2·5 miles west of Leavenworth. There is a low concrete diverting dam in the river at a point about 12,000 ft. west of the power house, and from this dam a wood-stave pipe of 8·5 ft. interior diameter runs for a distance of 10,908 ft., and continuing this stave-pipe line is a steel pipe line for a distance of 962 ft. The pipe line has substantially the same gradient as the railway line, and gives a static head at low water of 203 ft., and in ordinary water of about 200 ft. The operating head at rated load is 180 ft.

The crest of the diverting dam is 400 ft. long; it has three head gates, a log sluice, and a fishway. The pipe line ends in a surge tank at the corner of the power house, having a total height of 183 ft. above its foundation. The tank proper is 30 ft. in diameter, and with a storage height of 54 ft. above its hemispherical bottom gives a storage capacity of approximately 38,000 cu. ft.

* Abstract of paper presented to the American Institute of Electrical Engineers.

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The pipe line leads directly into the upright pipe of the surge tank, which is 8 ft. in diameter; within the upright pipe is a waste pipe having a diameter of 3 ft. 2 in., extending 7 ft. above the level of the crest of the dam; in the tank the waste pipe is expanded uniformly to a diameter of 7 ft. 6 in., thus affording a circular weir of 23·5 ft. in length.

The power house is designed for three main units and two exciter units. There are now installed in the power house two main units, each turbine rated at 4,000 h.p., directly connected to a three-phase alternating current. The two main units now erected, with the exciter, require approximately 500 cu. ft. of water per second when operating at full load of 8,000 h.p., giving a velocity of flow in the penstock of 8·7 ft. per sec. The extreme low flow of the river at the dam is estimated to be 380 sec. ft. The small pond formed by the dam has a storage capacity equivalent to 8,000 h.p.-hr., for a depth of one foot; it is possible to draw the water in the dam down 3 ft. There are two other power sites in the canyon, each affording a head of 200 ft., available for subsequent developments.

The electric equipment in the power house at present consists of two main generating units, each for a nominal capacity of 2,500 kilovolt-amperes at 375 rev. per min., 6,600 volts and 25 cycles; these machines are designed to have very large overload capacity, and operate at a low flux density.

There are two exciter units, each having a nominal capacity of 125 kw. at 750 rev. per min. These units also have a large overload capacity; they frequently carry 150% overload, on account of the very poor regulation of the water wheels. A third unit, identical with the first two, has been ordered. The power house also contains four transformers for raising the pressure to 33,000 volts, each of a nominal capacity of 833 kw., but guaranteed to operate 100% overload for one hour, with a low rise in temperature. Three of these units are in service, the fourth is kept as a spare. The switchboard apparatus is of the usual type, having panels for the generators and the feeders, and is provided with the usual measuring instruments. One reason leading to the use of the three-phase system was the possibility of regeneration; that is, of returning energy to the system on down grades. With the present installation it is obviously not possible to make any use of the energy so returned, but in order to prove this practically, an automatic rheostat controlled by the speed of generator was installed in the power house; when a train on the down grade reaches a little more than the synchronous speed, the electrodes of the water rheostat are automatically lowered by an amount proportional to the difference between synchronous speed and the speed of the generator; this throws a load on the system, and acts as a brake to the train. The operation of this apparatus is entirely effectual.

The nominal capacity of parts of this equipment, in particular of the transformers, may seem unusual; but it must be remembered that the plant is intended to operate on a load having extreme fluctuations, the entire load being on for, say, 15 minutes and then off for two or three hours, and consequently the transformers can be made small.

This plant has operated satisfactorily with the exception of certain troubles with the water wheels, in particular, the generators have shown ability to hold their rated pressure under extreme variations of speed, due to the effective control of the Tirrill regulators. The generator fields, designed for 125 amperes, have frequently carried 300 to 350 amperes, and the regulators have held the pressure normal, in spite of fluctuations of 35 to 40% in speed.

The transmission line extends from the power house at Leavenworth to the sub-station at Cascade, a length of approximately 30 miles, following the railroad all the way; part of the distance it is on the same side of the river as the railroad and part on the opposite side.

The line carries two circuits each of No. 2 B. and S. gauge stranded hard-drawn copper wire; each circuit is in a vertical plane at one side of the pole, thus permitting the use of short cross-arms; the upper cross-arm was placed some distance below the top of the pole in order to leave room for a ground wire, which has not as yet been installed. The poles are 40 ft. long, placed 6 or 7 ft. in the ground, the tops being 10 in. to 12 in. in diameter; these poles are unusually sturdy, and it was owing to the fact that timber of this kind could be obtained cheaply in the West that this type of construction was adopted. The line is divided into three sections by two out-of-door switches operated by means of a pole deposited with a station agent; each switch is near a station.

In the design of the line, as in all other features of the work, the aim was to secure apparatus and types of construction giving promise of the greatest reliability, in order that there should be as few links as possible in the chain from the power house to the locomotive that would be liable to derangement; for this reason a comparatively low line pressure is used. The telephone line is carried on the same poles; the transmission line is not transposed, but the telephone line is transposed at every fifth pole.

The wires are 24 ft. above top of rail and 5 ft. apart: for single tracks a bracket type of construction is used, and for multiple tracks a cross-catenary type, supported by very heavy wooden poles located about 8 ft. from centre-line of outer tracks, thus leaving unobstructed the space between adjacent tracks. The wires are supported at intervals of 100 ft. Multiple track supports consist, for each phase, of a steady span supported by and insulated from a cross-catenary span, both spans being secured to cross-arms on the poles by means of porcelain petticoat strain insulators; the spans for the two respective phases are 3 ft. apart. The wires of the same phase, for the different tracks, are insulated from each other by means of wood breaks and porcelain link insulators, in series. In the case of brackets, each phase is insulated from ground by means of a wood break in series with a porcelain petticoat strain insulator. Where wires of opposite phases cross at turn-outs, they are insulated from each other by section insulators made of wood and about 5 ft. in length: four insulators are used, each connected at one end to a special 8° crossing pan, and at the other end to one of the four wires converging toward the crossing. Except for one track, whose wires are cut straight through the crossing pans without section insulators, it is necessary to switch the controller to the off position when the trolley wheel passes under the insulators; methods of avoiding this have been considered, and are being tried out. Heavy steel bridges, forming anchorages for the trolley wires, are located in both yards at intervals of 1,000 ft. Lightning protection, though thunder storms are rare, is afforded by arresters connected to the wires at the ends of the tunnel and yards.

Both rails in the tunnel and one rail in the yards are bonded, with cross-bonding at frequent intervals. A single 4 0 exposed bond is used at each joint, having a length of 36 in. in the tunnel, and 36 and 50 in. in the yards.

In my opinion the use of double insulation everywhere is the reason for the almost total freedom from troubles of any kind originating on the overhead structures: two separate pieces of insulation of any given strength are much better than one piece of four times that strength. The only troubles experienced up to the present have been at the section breaks and turn-outs, and have been caused by the trolley wheel leaving the wire. There has been no failure of the wires at any point of the overhead structure nor any breakdown of insulation.

In the tunnel the wires are 17 ft. 4 in. above the top of the rail and 8 ft. apart; the latter spacing enables train-men to operate the hand-brakes, or walk on the tops of freight cars, the construction being such that head-room is not interfered with. Each wire is supported every 50 ft. by means of a 14-in. Detroit clamp attached by swivelled connection to a stud, which is in turn swivelled to the middle point of a turnbuckle. The two eyes of the latter, by means of strand wire, connect each to a link and petticoat strain insulator arranged in series, the two petticoat insulators being secured to the roof of the tunnel by means of two expansion bolts, about 5 ft. 6 in. apart. Anchors and side-braces for the wires in the tunnel are located at intervals of 3,000 ft.

(To be continued).

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

Mining Electrical Equipment.

The electrical equipment of mines has almost developed into a separate science, on account of the very special conditions affecting it, and the need for a combination of practical knowledge of mining requirements and scientific skill in the adaptation of electricity. Foremost among those who have developed this branch of business have been the firm of Ernest Scott & Mountain, Ltd., late of Newcastle-on-Tyne, and now of Gateshead. This firm are pioneers in the electrification of collieries, etc., and have probably installed more machinery of their own make in mines and collieries in the United Kingdom than any other single firm.

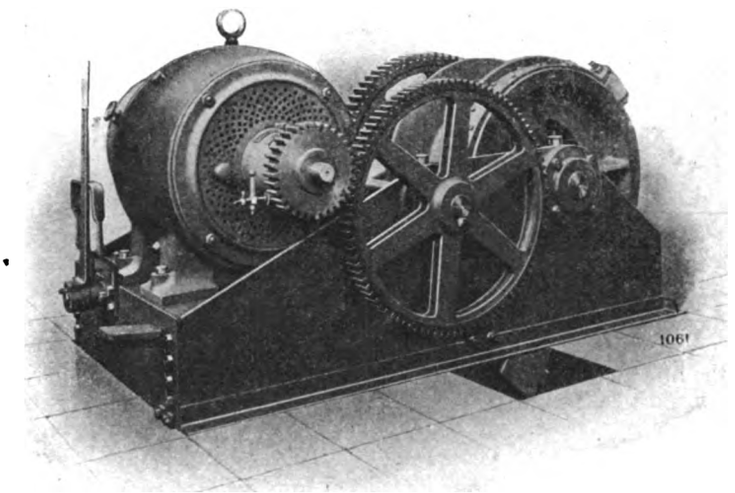

Fig. 1. Portable main rope haulage gear.

Among the most recent instances of their pioneer work may be taken the very large haulage installation at the Loftus Irentonos Mines in Cleveland, Yorkshire. This plant comprises two 3,000 volt three-phase motors, one capable of working up to 600 h.p., and the other up to 400 h.p., each driving a double drum main and tail haulage gear. The exceptional point about this installation is the wonderfully delicate control which enables the machines to be run at any speed from 1 to 15 miles per hour, and the great length of road operated which will eventually be about 2½ miles. We understand that the firm are about to issue a booklet describing this installation, which will be of peculiar interest to practical men engaged in the mining industry.

In connection with electric winding, Messrs. Scott and Mountain, Ltd., have also made quite a name for themselves, and have supplied a considerable number of sets driven by both direct and alternating current motors and controlled by different types of switch gear, comprising tramway controllers, liquid switches, and pump operated tank switches.

The great advantage of electric winding is, of course, chiefly found when the installation of electric plant is in use at some distance from subsidiary shafts, so that electricity is by far the cheapest method of transmitting the power from one point to another.

Messrs. Scott & Mountain, Ltd., realising the great importance of increasing the haulage facilities underground, in view of the recent Eight Hours Act, have arranged for the convenience of their customers, to carry in stock a large range of portable haulage gears and pumps, illustrations of which are given on this page.

The haulage gear is of the simplest construction and can be worked by a lad without special knowledge or training.

The small pumps are of the trunk type, which have been specially designed for unwatering at the face, and are as compact as it is possible to make them, the 50 gallon size only being 40 in. long, 32 in. wide by 30 in. high, complete with a direct coupled electric motor, although the illustration shows the pump arranged for belt drive. These pumps are kept in stock by Scott & Mountain in sizes up to 100 gallons per minute and are suitable for any head up to 200 ft.

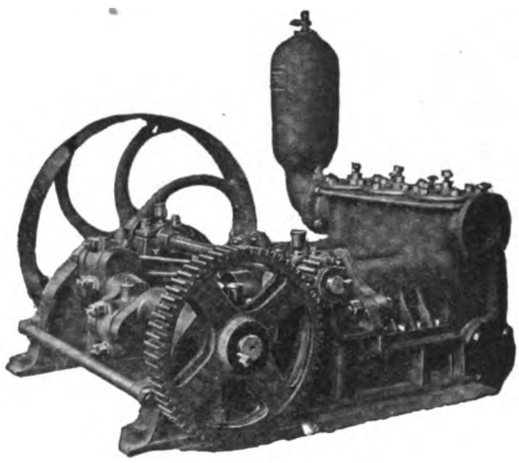

Fig. 3. Enclosed compound engine and A. C. Generator.

A visit to Scott & Mountain's works at Gateshead will

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convince the most hardened doubter of the great advantage to be derived from the application of electricity to mining requirements. At the works can be seen every type of haulage gear in the process of manufacture in sizes from 5 to 500 h.p. Just recently the main shop has been filled with about 30 pumps of various types and sizes, all for one order for abroad.

Messrs. Scott & Mountain, Ltd., with their high speed engines have also made many friends for themselves, both in this country and abroad, the engines being of the enclosed self-lubricating type and made in sizes from 50 to 500 h.p. Some beautiful examples of their work in this direction can be seen at the works, both in course of construction and finished, and the firm are being congratulated on the success which has attended this departure from the manufacture of electrical machinery pure and simple.

Fig. 3 shows one of their three crank enclosed compound engines and alternating current generators of 400 kw. capacity.

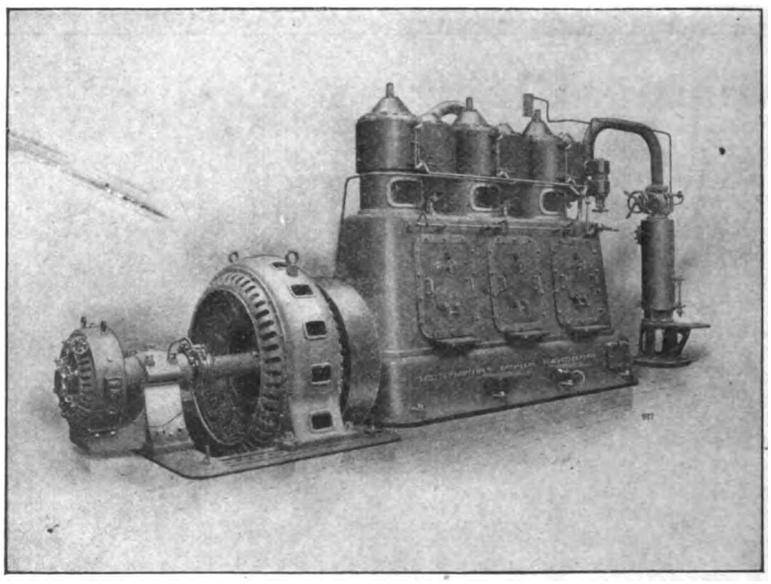

Fig. 2. Portable trunk type pump.

SIMPLEX PICTURE COMPETITION.

Our attention has been drawn by Simplex Conduits, Ltd., to a novel competition which is being inaugurated in the Christmas number of *Installation News*. With the object of popularising their new catalogue and making its contents better known, the company are offering a number of prizes for the solution of a picture puzzle. The task set is to give a name to the fittings of which a portion only will be illustrated on certain pages of *Installation News;* and this, of course, necessitates reference to the firm's new bound catalogue.

TRANSFER OF BUSINESS.

The Electrical Co., Ltd., inform us that the A.E.G. have disposed of their installation and consumers' business to a new company called the A.E.G. Electric Co., Ltd., and that from January 1 the Electrical Co., Ltd., business will again be strictly wholesale, and they will confine themselves to the electrical trade exclusively, dealing only with electrical contractors, electric supply companies and electrical wholesale houses. All other business, including installation business, has been transferred to the A.E.G. Electric Co., Ltd.

NEW OFFICES.

We hear that Messrs. T. H. Brooker & Co., have increased their staff and opened an office at 44, Bedford Row, London, W.C.

NEW TYPE OF FLAME ARC LAMPS.

The Foster Arc Lamp and Engineering Co., Ltd., have secured the Epsom Urban District Council's order for their new "Q" type flame arc lamps. This lamp, which is a radical departure from all existing types of arc flamers, is characterised by its very steady and silent burning, and its remarkable economy in current consumption. The carbon cost per hour is but 0·18d. A great feature of this lamp is the ingenious style of carbons employed. A number of carbons are moulded together side by side, the exact number, of course, depending upon the number of burning hours required of the lamp per trim. By this means the lamp is never extinguished in operation, as with the usual magazine type, to allow new carbons to come into action.

TRADE OPENINGS IN SWEDEN.

The Swedish Chamber of Commerce, 5, Lloyd's-avenue, London, E.C., of which His Majesty the King of Sweden is a patron, has several departments which give facilities to firms wishing to establish Anglo-Swedish trade connections, and also a Credit Information Department, through which the interests of members are safeguarded. Lately a Special Intelligence Branch has been added to the Chamber which circularises to the members particulars *re* trade openings, new markets, etc.

ROYAL SOCIETY LECTURES.

The lecture arrangements at the Royal Institution London, before Easter, include the following:—Mr. W. Duddell, a Christmas course of six illustrated lectures on modern electricity, adapted to a juvenile auditory: 1. First principles; 2. Electrical instruments; 3. Rontgen rays; 4. The generation of electricity; 5. Electric oscillations; 6. Electric lighting; Professor Silvanus P. Thompson, three lectures on illumination, natural and artificial; Professor J. J. Thomson, Professor of Natural Philosophy, R.I., six lectures on electric waves and the electromagnetic theory of light. The Friday evening meetings will commence on January 21.

"ELECTRICS" WIN COMPETITIONS.

In the eleventh annual tournament of the London Private Fire Brigades' Association, concluded on the 27th ult, the Robertson Electric Lamps, Ltd., Fire Brigade won the "Nestle" Challenge Cup for the Championship of the United Kingdom (for the best aggregate times for wet drills by teams of three and five men); the "Marshall" Challenge Cup, for the Championship of the London, Private Fire Brigades' Association (for the best aggregate times for dry drills by one and two men, wet drills by teams of four men, and scaling ladder and hand pump drills by teams of five men each); and the "Dewar" Challenge Shield, for four men wet drill. The winning times constituted a record in any drills of this class.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

Owing to our steadily increasing circulation and the ever widening interest taken in these Technical Problems, it has been found necessary to revise the old regulations.

The new Rules have been framed in order to encourage fresh talent to enter the field; at the same time it is hoped that the progressive lines adopted will meet with the cordial approval and support of our old and valued correspondents.

It is to be noted that these Rules only apply to Questions 1213 and onward. The first replies under the new conditions will appear in our issue of January 7, 1910.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

QUESTIONS.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

WEEKLY PRIZES FOR SOLUTIONS.—For the best solution of any question we offer a cash prize of *seven shillings and sixpence*

For the second best solution (if published) we offer a prize of *five shillings*.

For the third best solution (if published) we offer a prize of *two shillings and sixpence*.

QUARTERLY PRIZES.—No competitor will be awarded more than three third prizes, two second prizes, or one first prize during any one quarter. But, in adjudicating upon the merits of the various solutions, marks will be allotted to the four best solutions to each question, and at the end of each quarter extra prizes will be awarded to those competitors receiving the highest aggregate number of marks.

These prizes will be awarded in kind, the winners being at liberty to choose any book advertised or reviewed in our columns, or any instrument or appliance manufactured by any advertiser in our pages. These quarterly prizes will be of the value of *one guinea*, *half-a-guinea* and *five shillings*. Winners may, if they should so desire, order through us books or appliances of a higher value than their prizes, by forwarding to us the difference in price.

MSS. AND SKETCHES.—All answers to problems must be sent in within fourteen days of the question appearing in our columns. Replies should be concise and ought not to exceed one thousand words in length.

Quarto paper (10 in. by 8 in.) should be used, only one side being used, a margin 1½ in. wide being provided on the left side of each sheet. The number *only* of each question should be written legibly at the top left-hand corner of each solution. The solution should be signed with initials or pseudonym, and the name and full address of the contributor must be appended. Any formula should be set out on a line by itself; all letters and symbols in the text should be clearly written, to make them conspicuous.

Loose sketches should bear the *number* of the question and the author's name and pseudonym, and should be pinned to the MS.

Sketches must be drawn in ink, with good solid lines. Squared paper may be used, but as the faint blue lines are not reproduced by the photographic process, all horizontal or vertical lines to appear must be inked in with heavy, full dotted or chain dotted lines as required. Column width blocks are preferred, so it is well to draw sketches 6½ in. wide, for reduction to one-half.

Copyright of all solutions awarded prizes becomes the property of The Electrical Engineer, Ltd.

Question No. 1208.—Discuss generally the advantages and disadvantages and methods of working of "central battery" systems of telephone circuits.

Answer to Question No. 1208 (*awarded* 10*s*.).—The advantages of the central battery telephone system compared with the magneto or local battery, are many, the chief of which are as follows:

1. The operations necessary for a subscriber to call the exchange are reduced to a minimum, consequently there is less risk of the subscriber misunderstanding the use of the instrument.

2. The sources of energy for speaking and calling are centralized, instead of the separate units each having their own sources of energy.

3. The absence of the local battery and generator in the instrument very considerably reduces the capital charges per instrument.

4. The calling and clearing signals are automatically operated by the subscriber and automatically restored to normal condition by the operator; consequently, the operator's work is reduced per call, and she is therefore able to attend to a greater number of lines, which is also facilitated by the fact that the calling lamps used in central battery work occupy much less space than a magneto indicator.

5. The subscriber's instruments are smaller and lend themselves better to artistic design, and owing to the absence of local batteries there is no risk of spilt acid, etc., spoiling the instrument or its surroundings.

6. The electrical efficiency of the system as a whole is much greater, as there is one large unit in operation all the time, rather than a number of units of energy supply in operation only part of the time.

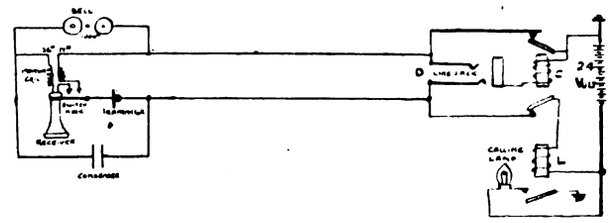

FIG. 1.—THE SUBSCRIBERS LINE CIRCUIT.

7. The time taken in putting one subscriber through to another is considerably lessened owing to the automatic features already mentioned.

The disadvantages of the central battery system are as follows:

1. The exchange apparatus is more complicated, and, therefore, there is a greater risk of faults developing than in a magneto exchange.

2. It is necessary for the exchange officials to have a greater technical knowledge owing to the more complicated circuits and apparatus.

3. The capital outlay on the exchange switchboard and power plant are greater than for an equal size magneto equipment.

4. The insulation of the lines must be kept in good condition, otherwise trouble is caused through leakage of current.

It may be pointed out that for exchanges of a capacity not exceeding about 800 lines, it is usual in many cases to use a switchboard fitted with eyeball or other automatic restoring indicator instead of lamps; by doing so, relays are dispensed with and the apparatus considerably simplified.

As to which system is the best to install in the case of a small exchange will depend largely upon local conditions. Where an electric supply is available for charging the necessary accumulators, and a skilled electrician is at hand to attend to the necessary details involved in the working of a central battery system, this system is much preferable for any exchange of over 25 lines' capacity. The operation of a central battery circuit is as follows:

Fig. 1 shows the connections of an ordinary instrument through to the switchboard. It will be seen that until the subscriber removes the receiver from the switch hook the circuit is broken for a continuous current, but an alternating current can pass round through the condenser and bell and the operator therefore is able to ring up the subscriber's instrument by sending an alternating current along the line.

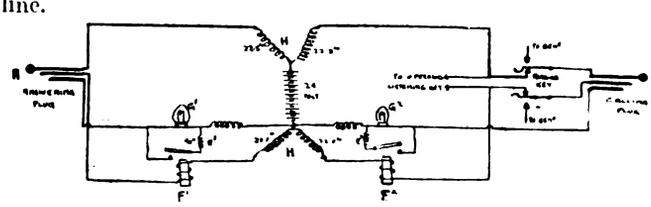

FIG. 2.—THE CORD CIRCUIT.

Upon removing the receiver from the switch hook, the line circuit is made complete for the continuous current which passes through the cut-off relay armature C, through the line relay L to the 24-volt battery; the other side of

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the battery is connected through to the other armature of the cut-off relay and thence to line. The armature of relay L is attracted, causing the calling lamp to light and attracting the operator's attention.

Now, referring to the cord circuit, Fig. 2, when the operator sees the calling lamp alight she inserts her answering plug A into the jack D corresponding to the lighted lamp, the current passes through the 40ᵂ resistance E (the supervisory lamp G^1 being cut out by the current passing through the supervisory relay F^1 over the lines), through the sleeve of the plug and the bush of the jack, and thence through the cut-off relay and back to the battery, the cut-off relay is operated and the calling lamp is extinguished. After obtaining the number required, the operator plugs into the corresponding jack and calls up the wanted subscriber by means of her ringing key. Until he answers, the relay F^2 is not operated, and therefore the supervisory lamp G^2 is lighted. When the subscribers are finished talking they hang up their receivers, which breaks the circuit to the continuous current, the relays F^1 and F^2 are de-energised, and the supervisory lamps G^1 and G^2 are lighted, indicating to the operator that the conversation is completed.

The battery shown in Fig. 1 and Fig. 2 is the same, being shown in this form for convenience in making the diagram clear.

The actual talking circuit is from the instrument through one coil of the repeater, through the battery and other coil of the repeater, through the supervisory relay and back to the instrument.

The repeater is really an induction coil having four equal windings, as shown in Fig. 2. The variations in current set up in the transmitter are superimposed upon the steady direct current flowing, and these variations in passing through the repeating coils react on the corresponding coils to the other instrument, and setting up a fluctuating current in this circuit which causes a variation in potential across the transmitter and 17ᵂ coil of this instrument, and partly through the action of the induction coil and partly through the flow of current to and from the condenser owing to the variation of potential across the transmitter. The receiver receives a fluctuating current corresponding to that originated in the sending transmitter.—P. G. P.

Answer to Question No. 1208 (*awarded* 5*s.*).—It will be best to explain first the method of working in the central battery system of telephony. This will be understood by a careful examination of Fig. 1, which shows a "Central Battery Exchange" switchboard, connected to two subscribers.

The operations are as follows:—When the subscriber A takes his receiver off the hook, the line lamp L_1, placed over his jack, lights up, calling the operator's attention to the fact that a connection is desired. She inserts one of her answering plugs into the jack A, presses the listening key k to the left, and calls for the number required. The number being given, she inserts the calling plug of the same cord circuit into the jack of the subscriber B to be called,

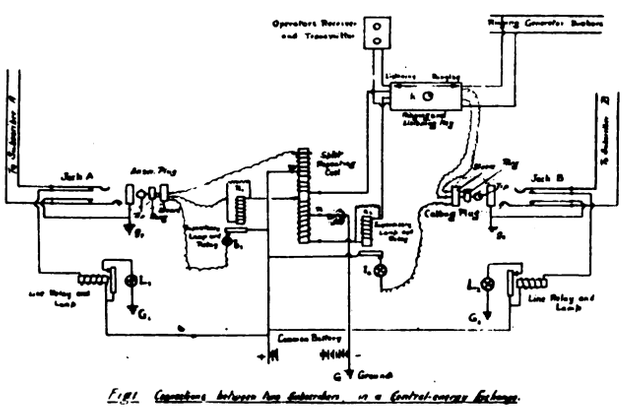

Fig 1. Connections between two Subscribers in a Central-energy Exchange.

and presses the key k to the right, thereby ringing the bell of subscriber B. As soon as the calling plug has been inserted into the jack B, the supervisory lamp l_2 lights up, and remains lighted until the subscriber B takes his receiver off the hook. Now the two subscribers are conversing, and all the switchboard lamps belonging to these subscribers are extinguished; the connection is indicated by the inserted plugs. As soon as one of the subscribers hangs up his receiver the corresponding supervisory lamp lights up; when both supervisory lamps l_1 and l_2 are lighted up, the operator knows that both receipers have been hung up. She pulls out the plugs, and thereby disconnects the subscribers. If for any reason she desires to listen during the conversation, she may do so by pressing her listening key k to the left.

The Electrical Connections.—When subscriber A takes his receiver off the hook, the current from the positive pole of the battery flows through the line relay under the jack A, the line, his apparatus back to the station and to the ground g_1. The circuit is thus completed, since the negative pole of the battery is permanently earthed. The relay attracts its armature and closes the circuit of the line lamp L_1, whereupon the lamp lights up through the ground connection G_1. Inserting the answering plug into the jack A opens the relay circuit through the auxiliary springs shown inside the main contacts, and thus extinguishes the lamp. The plugs used in this system have three contacts, the tip, ring, and sleeve. Through the tip and ring the talking circuit is completed; while the sleeve contact merely connects the supervisory lamp l_1 into the circuit. The supervisory lamp l_1 lights up between the positive pole of the battery and the ground g_1; its circuit is opened (1) by the armature of the supervisory relay shown above the lamp; (2) when the answering plug is not in the jack A. The purpose of this lamp is to indicate to the operator that the subscriber's receiver is on its hook; in other words, that he is not using his telephone. The supervisory relay is inserted in the main talking circuit, and holds the lamp circuit open as long as direct current is flowing through the line A; in other words, as long as the receiver is off its hook. When the lamp lights up, it is extinguished by pulling the answering plug out of the jack.

Connections for a Subscribers' Telephone.—One of the simplest schemes of connections for use on the common battery system is shown in Fig. 1A. The receiver being taken from the hook, the line circuit is closed, and the battery in the exchange supplies the subscriber's transmitter with the current necessary for talking, and at the same time lights the lamp in the exchange.

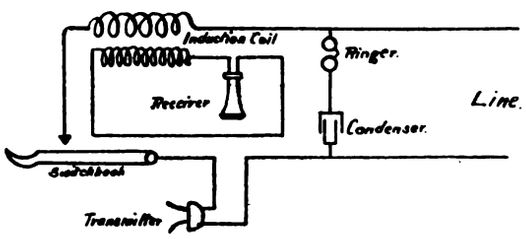

Fig 1A. Connections in a Subscribers telephone.

The incoming alternating currents of high frequency are transmitted to the receiver through the induction coil. The ringer is connected across the line and is protected by a condenser from the passage of direct currents; alternating currents for ringing pass easily through the condenser.

Connections for a Magneto Telephone Set.—In order to show the difference between magneto telephone and central battery connections, the sketch Fig. 2 is given. This system requires a separate battery and magneto for each subscriber. On ringing up the exchange, the subscriber takes his receiver from its hook, and so closes the battery circuit. The battery supplies the direct current for the talking, the high frequency talking currents being transmitted through the induction coil. On finishing the conversation the subscriber replaces the receiver on its hook, and so breaks the battery circuit. The magneto generator, for ringing, is bridged across the line, but its circuit is always open by means of an automatic device, except when the subscriber turns the handle. The magneto, when turned, does not ring a bell or light a lamp in the exchange, but drops a shutter, which displays to view the number of the subscriber to the operator. At the end of the conversation each subscriber has to give a little turn to his magneto. This operates a so-called "clearing out" drop shutter, and indicates to the operator that the subscribers have finished talking.

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Advantages of the Central Battery System of Working.—(a) One battery is required by the whole exchange, which can be conveniently placed, so as to be readily overhauled and kept in order. In the magneto system, a battery has to be placed in each subscriber's box, this necessitating a visit to the subscriber whenever his battery goes wrong. (b) The operation of calling up the switchboard operator is simpler. In this system merely taking the receiver off its hook calls the attention of the operator, while in the magneto system the handle of the magneto has to be turned. On the finish of a conversation, too, the operation of replacing the receiver on its hook is at once made evident to the operator. In the magneto system the handle of the

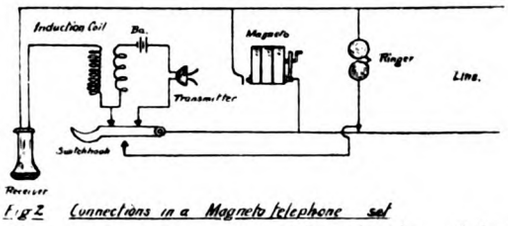

Fig 2 Connections in a Magneto telephone set

magneto has again to be turned. Thus the time of the busy man is not lost in ringing up the operator. (c) Less noise is occasioned at the switchboard. This is self-evident, for in the central battery system a lamp only is lit, while in the magneto system a shutter is dropped.

Disadvantages of the Central Battery System.—(a) Advantage (c) really turns itself to a disadvantage in the case of a lazy operator. A noiseless lamp does not attract the attention of the operator as does a noisy shutter, thus causing a loss of time in getting into connection. (b) This disadvantage is due really to the ignorance of the subscriber. Should he fail to attract the notice of the operator, he waggles his receiver hook up and down as fast as possible. This does no good; it does not keep putting his lamp out, and then relighting it, owing to the time lag in the filament and circuit. This state of affairs is only obtained when he moves his receiver hook up and down by a slow motion. On the other hand, the magneto system gives him an advantage. The more vigorously he turns his magneto handle, the more noise does the shutter at the operating table make, and the quicker does the operator strive to get him into circuit.—S. G. W.

REVIEWS.

"Chats on Electricity, Told in Plain Language for the Non-technical." By Frank Broadbent. London: T. Werner Laurie. 196 pp. Illustrated. 3s. 6d. net.

In a brief prefatory note to a book which deserves wide popularity, Mr. Frank Broadbent, who is well-known as a consulting engineer and as the author of numerous technical volumes, points out that the applications of electricity, both in domestic and industrial life, are now so many and so varied that it is almost impossible to mention any sphere in which it does not play a part, while the strides which electricity has made have been so rapid that it is difficult for anyone not actually engaged in the industry to keep pace with its many developments. His object, therefore, has been to produce a book which expounds in simple language the nature and properties of electricity, and which also explains the operation of some of the apparatus in general use. In both these objects Mr. Broadbent has succeeded admirably. He has opened up to the non-technical reader an extremely fascinating chapter in modern science, and has produced a volume which might well serve as an introduction to the text books on electricity and magnetism. A careful perusal of these "Chats" should be of immense value to the beginner, while in these days of the popularisation of electric lighting, electric heating and cooking, and the widely extended area of the small motor, the layman will find this well-printed and admirably illustrated little book an indispensable companion.

BOOKS RECEIVED.

Electricity. By H. M. Hobart, B.Sc., M.Inst.C.E. London: Constable & Co., Price 6s. net.

Elementary Treatise on Electricity and Magnetism. By G. Carey Foster and Alfred W. Porter. Revised Edition. London: Longmans, Green. Price 10s. 6d. net.

COPPER CABLE SOCKETS.

Small cable sockets can be made very cheaply from sheet copper, as shown in Fig. 1. the wings P P are bent over so as to leave an opening at the top, so that they may be squeezed down tightly on to the cable. The opening also enables the solder to run in freely. The socket may be strengthened for the bolt or stud by bending over the extension R, as shown dotted, and sweating it to the socket.

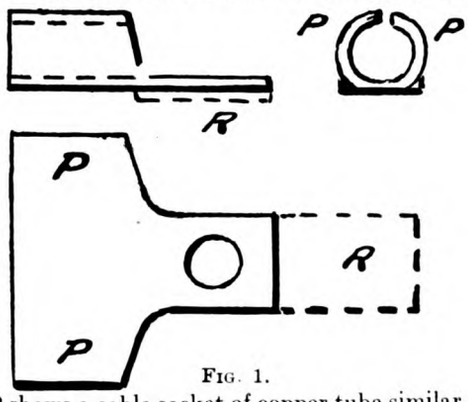

FIG. 1.

Fig. 2 shows a cable socket of copper tube similar to those made by the Broughton Copper Co. It gives double thickness of metal for the bolt. If the hole for the cable is a little too large it is an easy matter to make a saw cut at the top so that the tube can be pinched in to exactly fit, as in the previous example.

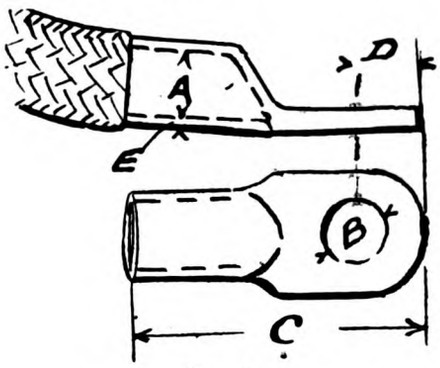

FIG. 2.

Amps.	Usual size of cable.	A	B	C	D	E
25	$\frac{7}{16}$	$\frac{1}{4}$	$\frac{3}{16}$	$1\frac{1}{2}$	$\frac{9}{32}$	$\frac{1}{16}$
50	$\frac{19}{16}$	$\frac{3}{8}$	$\frac{9}{32}$	$1\frac{3}{4}$	$\frac{11}{32}$	$\frac{1}{16}$
100	$\frac{37}{16}$	$\frac{1}{2}$	$\frac{7}{16}$	$2\frac{1}{4}$	$\frac{7}{16}$	$\frac{1}{16}$
150	$\frac{37}{14}$	$\frac{9}{16}$	$\frac{1}{2}$	$2\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{32}$
200	$\frac{61}{16}$	$\frac{5}{8}$	$\frac{9}{16}$	$2\frac{7}{8}$	$\frac{9}{16}$	$\frac{3}{32}$
250	$\frac{61}{14}$	$\frac{3}{4}$	$\frac{5}{8}$	$3\frac{1}{4}$	$\frac{3}{4}$	$\frac{3}{32}$

E. K. S.

ELECTRIC TRAIN ACCIDENT.

The inquest on Nathaniel Calder, a conductor, and Frank Tibbles, a motorman, whose deaths were the result of the accident to an electric train on the District Railway at Ealing-broadway on November 18, was concluded.

It may be recalled that the train ran into the station from the depôt and dashed into the stop-blocks.

Edward Bedell, one of the conductors of the train, said that conductors were supposed to test the emergency brake, but on the morning of the accident he did not do it.

The Coroner (Mr. Kemp): Why not?—Something must have taken it off my mind. The train had started before I had finished my other duties.

Witness added that the train, which was due to leave the depôt at 5.33 a.m., started a minute or two before its time. If it had not done so he would have had time to test the brake.

Answering Major Pringle, representing the Board of Trade, the witness said that it would only take half a minute to test the brake.

In reply to a juror, the witness said that the brakes of the train were tested every morning. This was the first occasion upon which he had not tested them.

William Alexander Agnew, chief mechanical engineer to the District Railway, said that if the company's rules had been observed the accident could not have happened.

The jury returned a verdict of Accidental Death, and expressed the opinion that there was a general slackness in the examination of the brake of the train.

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ELECTRICAL PROGRESS AT HOME & ABROAD

FROM OUR SPECIAL CORRESPONDENTS.

TYNESIDE NOTES.

NEWCASTLE.

In spite of the depression which has been felt on Tyneside within the last year or two owing to the almost complete cessation of shipbuilding, extensions in electrical equipments have been proceeding. This is partly due to the fact that those firms who recognised that the depression was only temporary, and who had the necessary reserve capital available, utilised the period of temporary stagnation in order to increase the efficiency of their works. Another reason is that in some instances the developments of the requirements of shipping have proceeded, particularly in the larger classes of vessels, at such a rate, that additional means have been required to cope with them. An instance of the latter case is to be found at the yards of Messrs. Swan, Hunter & Wigham Richardson, Ltd., where there have been recently installed two heavy cantilever cranes over their largest berths, for the purpose of handling the heavy material required on such work. These cranes have an extension or outreach of 100 ft., and at this distance are able to lift 1½ tons. At shorter radiuses, up to 75 ft., they are able to lift weights of 5 tons, and the cranes are electrically operated from the three-phase supply at 440 volts, 50 periods, from the sub-station on the works, which is supplied by the Newcastle-upon-Tyne Electric Supply Co., Ltd. These, in addition to other instances which have been given in these columns of electrical shipbuilding appliances, indicate that electrical work on Tyneside is proceeding favourably.

Floating Dock for Battleship Repair.

What may be described as the outcome of the recent agitation for increased facilities for docks and harbours which would be able to accommodate a battleship of the largest size now made, or likely to be made, and which might be put out of action, is the order which has been obtained by Messrs. Swan, Hunter & Wigham Richardson, Ltd., for the building of one of two floating docks for the British Government, to have a lifting capacity of 32,000 tons. Its length is to be approximately 700 ft., and its beam 100 ft., and it will, therefore, be able to dock a boat of the *Dreadnought* class. In order to deal with the repair of such a vessel, a very complete electrical installation is to be placed on board the dock for the purpose of operating cranes, capstans, temporary lighting equipments, and the necessary machine tools which the floating dock will contain for repair on site. It is also probable that as various pressures will be required in order to deal with the different voltages on board ship, a motor generator plant will be needed. The placing of an order such as this upon Tyneside indicates the possibility of a considerable amount of electrical activity in the coming year among electrical supply firms.

Electricity in Mines.

Although it will be seen from our last week's notes that colliery engineers appear to be recovering to some extent their confidence in electricity in mines, there is still a certain amount of suspicion among the pitmen. Mr. Burt, M.P., in his latest monthly circular to the Durham Miners' Union, appears to be still unsatisfied as to the position, and does not think that electricity has yet established a claim that it has rendered the mines freer from danger than before its adoption. The efforts of such engineering firms as Messrs. A. Reyrolle & Co., Ltd., and Messrs. J. H. Holmes & Co., are directed to show that, given reliable electrical plant of good design and manufacture, and a suitable system of distribution underground, there is no reason to doubt the safety and reliability of electricity in mines. This was demonstrated at the recent tests which were made at the works of the former firm before the members of the Institute of Mining and Mechanical Engineers, as regards the possibility of explosions in wide flanged switch boxes, and by the exhibition which the latter firm gave to the members of the North of England Institute of Mining and Mechanical Engineers.

Extension of a Tyneside Works.

One pleasant indication of the recently increasing number of orders which have been placed with Tyne shipbuilders is that trades depending to some extent on this activity are resuming full work, and in some instances are laying out increased plant to deal with it. An example of this is to be found in the action of Messrs. Henry Watson & Sons, of High Bridge Works, Walkergate, who, in their operations as coppersmiths and brassfounders, are now completing the electrical equipment of a new foundry. Electricity is here being applied for operating a new rotary sand blast, together with a fan for the cupola blower, and a pug mill; while the premises are lighted both by means of incandescent electric lamps, of which there are a considerable number, together with arc lamps. In the latter portion of the lighting equipment, both flame and enclosed types are being used. The whole of the plant has been supplied by the British Westinghouse Electric & Manufacturing Co., Ltd.

MIDLAND NOTES.

BIRMINGHAM.

At the meeting of the Birmingham Section of the Institution of Electrical Engineers, held at the University, Mr. M. Railing occupied the chair, and a paper was contributed by Mr. F. H. Reakes Lavender, M.Sc., on the subject of "Research on Metallic Filament Lamps," followed by a paper by Messrs. H. W. Handcock and A. H. Dykes on "The Present Aspect of Electric Lighting." The papers were jointly discussed. One suggestion in the first paper a good deal criticised was that a lamp should be discarded when its candle power fell 3% below its original. On this, Mr. Maurice Solomon pointed out that two natural limits determined the life of a lamp in practice. One of these arrived when the lamp broke, and the other when its candle power fell below the efficiency stage. Mr. Milns, of the Birmingham Electrical Supply Department, thought that a good many consumers would be very well pleased if their lamps could be got to burn 1,500 hours. The influence of the new metallic filament lamp led to various lines of discussion. Mr. Handcock had suggested in his paper that more economical burning should enable the central stations to tempt the small consumers by fixed charges, and this became a kind of arena of discussion. Dr. Sumpner thought that this would greatly simplify the method of charging, and the whole system of supply, while returning to the original state of things before meters were introduced. Mr. Lindsay Forbes agreed that the electric light had now passed beyond the stage of luxury, and this speaker, with several others, thought electric practice might be assimilated to that of most water departments. Mr. Milns was able to supplement the facts of the paper with some experiences in the supply of blocks of 72 hours on contract at 6d. a week in summer and 1s. a week in winter. The speaker emphasised the importance of payment in advance to avoid hasty departures and "moonlight" flits by dubious tenants who were apt to take their lamps with them. Mr. Milns was able to report that after paying all charges the revenue on the current worked at about a penny to three halfpence per unit. In this case four 8 c.p. carbon lamps were supplied to each house. An experiment in progress in Birmingham was the service of small houses through prepayment meters, at a charge of 5d. per unit to include meter and service charges. With these the customers are quite satisfied, and the system is considered suitable for artizans' dwellings. Several speakers saw objections to supplies on the contract system, such as the possibilities of fraud in the substitution of larger for smaller lamps. To such objections, Mr. Handcock replied that, after all, the stealing of electricity was felony, and that probably it was easier to steal by tapping on the other side of the meter than by putting a lamp into a holder provided for a smaller one. He held that as soon as the long-hour consumer paid 12s. or more for a light he was entitled to be regarded as a profitable customer. In Harrogate the system was so successful that it was extending with consequent increase of plant. It was clear that in future the electric light undertaking, like the gas department, must look for its profit from the small consumer.

Effect of the Metallic Filament Lamp.

A good deal of information was forthcoming as to the effect of the introduction of the metallic filament lamp. Mr. Milns said the growth in revenue in the City Department represented about a 5% increase in the first year of its introduction, in the next year 10%, in the next 17%, and the present year would probably be about 27%. He found some fault with the marking of the lamps in respect of voltage, which were often erroneous. Among the latest developments in Birmingham and the Black Country is the supply of electric light to public-houses, a fact mentioned by Mr. Fennell in the course of the discussion. The speaker pointed out the obvious attractions of such long-hour consumers, and mentioned that several brewery companies were arranging for the introduction of the light into their largest houses. This speaker considered that the introduction of the electric filament lamp really ought not to cause a scare and lead them to upset the whole system. The general trend of the discussion was that eventually the new lamp would enormously benefit electrical undertakings in the widening of the scope of their services. Apparently, there was some sympathy with a view expressed by the Chairman that a small candle power high voltage electric lamp was very much needed. He understood that certain manufacturers were working on this problem with a good prospect of success.

Construction of a Modern Dynamo.

A very useful lecture was delivered by Mr. E. A. Watson, M.Sc., on December 1, before the Scientific Society of the Birmingham Midland Institute on "The Construction of a Modern Dynamo." The speaker showed a thorough technical knowledge of his subject, describing in considerable detail the various component parts of the dynamo, of which illustrations were given by means of lantern slides. Various parts were on exhibition in the room, and were examined with interest by several of those present.

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LANCASHIRE NOTES.

MANCHESTER.

There has been but little improvement in the state of trade here during the week. The demand for electrical accessories, lamps, fittings, and such material has been greater, but this is thought to be only a temporary revival occasioned by the usual increase in business just before holidays. Although the state of the cotton trade is such that it has been decided to continue on half time, there are yet some signs of the demand for electrical goods increasing early in the New Year. In any case, this improvement is sure to come shortly, for all the local supply authorities are making strenuous efforts to increase their loads. There is no doubt that the metallic filament lamp has been the cause, not only of a large increase in the number of lighting customers, but has also, by its economy, induced many people to try radiators, irons, and, in some cases, small cooking outfits. As a result of the economy of electric heating becoming better known, local suppliers report that they are selling much faster than they can deliver.

Winding Engines.

In view of the interest taken in the application of electric driving to work hitherto mechanically driven, any papers pointing out difficulties encountered in the design, installation, or working of the latter are always valuable to electrical engineers. Such a paper was Mr. G. T. Well's on "Winding Engine Design," read before the Manchester Association of Engineers. He discussed fully the details which have to be settled when getting out a tender for pit head machinery. The difficulties are not so great from a purely mechanical point of view, and a paper design is comparatively easy; but stock patterns and various human influences often make considerable deviation from the original designs necessary, and, consequently, add considerably to the cost of tendering. Among the human influences, he mentioned as of great importance the particular colliery manager's notions on winding engines. Was he a faddist concerning parallel, conical or other type of drum? Did he favour high average speed of winding? Had he any opinions concerning values, valve gears, or other details? These and much other similar information ought to be obtained before commencing to tender, if it is desired to save expense. He thought at present compound engines had the field, though if the low pressure exhaust turbine proved successful, the simple engine would be more largely used in future. He described a safe winding device, which depends simply on the absorption of the kinetic energy by resistance to it at the right moment. The automatic action is got by a governor operated directly by the engine and connected with the depth indicator, so that when the cage reaches a certain point, the brakes are applied independently of the engine man. The device also throttles the exhaust, so that a cushioning action is obtained when nearing bank. It can be adjusted for any speed, and is equally effective for raising coal at 46 ft. per sec., or for men at 23 ft. per sec. The brakes are set by a weight and set by steam pressure as soon as the engine starts running. From the discussion it was obvious that the majority of the engineers seem to think the electrically-driven winder an impossibility. The best answer is to point to the several plants in this country and the many abroad.

Fleetwood Rating Case.

At a special sitting of the Lancashire Quarter Sessions at Preston, Mr. H. W. Worsley-Taylor, K.C., pronounced judgment in the case in which the Blackpool and Fleetwood Tramroad Co. appealed against the Fleetwood Urban District Council's rating that portion of the line within the town at £467 as a "tramway," instead of at one quarter that sum as a "railway." The undertaking was constructed under a private Act of 1896, and consists of a "tramroad" beginning in Blackpool and terminating in Fleetwood, and a "tramway" wholly in the streets of Fleetwood, the two parts being a continuous line. The point in the case was whether a tramway is a railway. Although in 1904 the Tramroad Co. successfully appealed to the House of Lords against the full rating, the District Council, relying on the decision of 1892 in the case of Swansea Improvements Co. and Swansea Urban District Authority, continued to charge the full rate. Both sides in this case agreed that the Swansea decision was binding unless it had been since overruled. The companies say their appeal case and the Wakefield Corporation *v.* Wakefield Light Railway decision had overruled it. In pronouncing judgment, Mr. Taylor said the case was one of great importance, for if it should ultimately be held that this tramway was to be rated at only one quarter of the full rate, the decision must cover the rating of the whole of the tramways in the country, and so disturb the basis on which local authorities and tramway undertakings had proceeded since the Swansea decision in 1892. He thought there was nothing inconsistent between the Wakefield and Swansea decisions, but that the former upheld the latter. The Bench were of opinion that the Swansea decision had not been overruled by the other decisions brought forward, and, therefore, the appellants failed. Notice of appeal was given and a case stated.

AMERICAN NOTES.

NEW YORK.

It is well within the bounds of probability that the not remote future will witness the installation in this city of the electrically-driven moving platform as a passenger transporting agent. As an exhibition feature the moving platform has always attracted attention, and many projects have been mooted to apply this principle to the transportation of passengers. Most of these have been abandoned, because the idea of a moving platform several miles in length was regarded as altogether too large a proposition, apart from the fact that no speed could be obtained with it, consistent with public safety, and, consequently no advantage at all commensurate with the cost. It has remained for Mr. Henry B. Seaman, Chief Engineer of the New York Public Service Commission to demonstrate the practicability of a scheme formulated by the Continuous Transit Securities' Company, which has offered to construct a moving platform under Broadway from Tenth-street to Forty-second-street. The proposition of this company was first put forward nearly 12 months ago, but underwent considerable amendment last June after the Legislature had passed the Rapid Transit Act permitting subway construction by private capital.

Details of the Project.

Mr. Seaman, after pointing out in his report that, owing to the constantly increasing density of population on Manhattan Island, it has long been evident to students of the transportation problem that a contrivance similar to that offered by the Transit Securities Company may eventually be necessary as a means of transportation for the most congested routes of the city, explains that the scheme is that of a platform made up of short units coupled together, forming an endless chain, which is kept in continuous motion. The main platform is provided with seats, and will travel at a speed of 12 m.p.h. Provision is made for the loading and unloading of passengers at will by the introduction of narrow loading platforms moving at differential speeds. Thus, for the continuous train moving at 12 m.p.h. speed there would be three loading platforms moving at 9, 6 and 3 m.p.h. respectively. The passenger steps from a stationary platform to one moving at the 3-mile speed; thence to the 6-mile speed; and then to the 9-mile, and so reaching the ultimate speed of the continuous train. The transition of speed between platforms, each increasing at 3 m.p.h., may be made without inconvenience. The advantages of this arrangement are: (1) Vastly increased capacity, and seats for all passengers; (2) no delay by waiting for trains at stations, as the train is always there and constantly moving; (3) passengers may board or leave the train at any point at will, and instead of placing stations one-third of a mile apart, as on the present subway, they may be placed at every cross street, or, indeed, at any intermediate point, and the construction may take the form of a continuous arcade.

Objections Considered.

It must be admitted that in the way Mr. Seaman puts it the proposition is not without its attractions; but two points will at once occur to the critic—first, that the platforms must always be running at the maximum speed whether with a light or heavy load, and that there must be many points in the day when it would be carrying very few passengers; and, secondly, that it is not everybody who would care to take the risk of boarding a moving platform. As to the first point, calculations based on statistics of the "rush-hour" traffic on existing subway lines show that the difficulty is more apparent than real, and that the advantages more than counterbalance the objections. With regard to the second point, it is admitted that a certain amount of agility would be necessary on the part of the passenger, but it has to be remembered that at each successive stage he is only encountering a speed difference of 3 m.p.h., and that, after all, it is no more risky to step from a platform moving at 9 miles to one moving at 12 miles, than it is to step from a stationary surface to a surface moving at the slow rate of 3 miles an hour. The company claims to be able to carry 125% more passengers than can be carried by trains, and the cost of construction is set at $11,000,000.

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Electro-Automatic Signalling.

A highly successful demonstration of the efficacy of the Electrical Automatic Railroad Safety Signal Company's appliances has been given on the Erie Railroad, and has thoroughly convinced the experts of the perfect practicability of the system. A special train, with a large party of railway signal engineers and other guests of the La Croix Company, was run at full speed, head on, toward a light locomotive approaching from the opposite direction. Both the trains were automatically stopped an ample distance apart. This system adds to the elements of the well-known electric block signal, the blowing of a whistle, burning of a light, and the application of the air brake, all in the cab. In addition to this feature, a telephone in the cab or in the train is available, to be switched on and allow conversation with the station agent or operator while the train is on the line at a block.

New Power Plant Schemes.

In connection with the Salt Lake power scheme, water right has been granted to C. H. Roby for 615 acre ft. of water to be obtained from North Dry Creek. Four dams are to be constructed, and the maximum amount of water to be drawn from the river for storage purposes will be 50 sec. ft. The plant will develop 3,000 h.p.—The Lehigh Coal and Navigation Company is planning to erect a power plant near Tamaqua, Pa., which will rank in size with the hydro-electric plant at Niagara Falls. While a great part of the power will be secured from the river known as James' Run, there will be auxiliary boilers and special grates. These grates are to be especially constructed to burn culm from the nearby mines. It is the promoter's idea to furnish power to Philadelphia, Baltimore, and Washington.—Plans have been prepared by Colonel C. E. Apponyi for the development of a hydro-electric plant upon the Colorado River at the first rapids above the head of high water navigation, about 180 miles above Needles, Col. The point selected for the plant is between Lincoln County, Nevada, and Mojave County, Arizona. Water rights for a strip of 5 miles have been secured, and it is estimated that at least 30,000 h.p. can be generated by the use of four successive turbo-generator units, each working under a 50 ft. head. Energy will be transmitted to Tonopah, Nev., 170 miles away, and to Prescott, Ariz., 160 miles away, and will also be sold to intermediate mining camps.

Electric Railway Notes.

The J. G. White Company of this City has been given by the Albany Southern R.R. a contract for double-tracking its line between Rensselaer and Kinderhook Lake, N.Y., as well as the straightening of curves and the rehabilitation of a large amount of the present track of the company.—The new interurban line, which will be constructed between Galveston and Houston, Tex., will be about 45 miles long, and will be constructed entirely on private right-of-way. The main power house will be located in Texas City, in Galveston Bay, and will include two turbo-generators rated at 100 kw. and 500 kw. The line will be operated at 600 volts direct current, using the overhead trolley system. Four sub-stations will be provided along the line, located about 10 miles apart. The company will operate over the tracks of the local companies in both Galveston and Houston.—The Utica Southern Railway has been authorized by the public service commission to build a 27 mile extension of its trolley line from Hamilton to Norwich, passing through the villages of Earlville and Sherberne. For the necessary funds to carry on the construction, the company is authorized to issue $628,000 bonds to be sold at a price to be approved by the commission, and also $400,000 in 5% non-cumulative Preferred stock.—The East Pittsburg shops of the Westinghouse Electric and Manufacturing Company are beginning work on a very heavy order for railroad motors for the Long Island R.R., which represents almost a million dollars. This calls for 260 motors of 200 h.p. each, which will be used to equip part of the cars on the Long Island system, and is in line with the enormous development work the Pennsylvania R.R. is now doing in anticipation of the completion of the New York terminals and tunnels under the North and East rivers.

The Bell and Western Union Combine.

Mr. Clarence H. Mackay, president of the Mackay companies, has issued a statement in which he says: "We have had nothing to do, either directly or indirectly, with the combination of the American Telephone and Telegraph Company with the Western Union Telegraph Company. We have not wished to join it, and have not been invited to join it. There have been no negotiations whatsoever with us in regard to the matter, and there is every reason why we should not have had anything to do with it. It is true that we own a large block of stock of the American Telegraph and Telephone Company, but that is one of our many investments. We never have had, and have not now any representation on the board of that company. We are not disturbed in any way. We have successfully met hard competition for over 25 years, and have prospered, and are in first-class financial condition—better than ever before."

American Plant in Canada.

It is reported this week from Pittsburg that the Province of Ontario has completed plans for offering great inducements to American manufacturers to locate in Canada. These plans have been outlined through the placing of a contract in Pittsburg for 1,500,000 lbs. of half-inch aluminium wire, to be delivered with the greatest possible speed, the idea being to carry electric current from Niagara Falls throughout Ontario, in order to furnish power to those who will use it, at the lowest possible rate. The Pittsburg officers of the Aluminium Company of America announce the placing of the contract by the hydro-electric commission of Ontario at a cost of $400,000. Wire already contracted for is to be distributed at Toronto, Windsor, Hamilton, Saint Catharines, Welland and Port Dalhousie. The hydro-electric commission, which will have charge of the work, acts as financial agent to the various municipalities, and will regulate the rates for certain minimum amounts of current to be supplied at each point. The different municipalities getting the current will be bonded to pay their share of the cost, and the current to be supplied will be greatly in excess of present demands of those places, so that power may almost be offered free by these towns to American manufacturers.

A Giant Transformer.

Twelve of the largest self-cooling transformers in the world have just been built by the Westinghouse Electric and Manufacturing Company for the Southern Power Company. As the size for which a transformer can be built self-cooling is limited by the amount of heat-radiating capacity for which the case can be designed, the maximum has hitherto been 750 kilovolt-amperes, but those made by the Westinghouse Company are 1,000 k.v.a., 100,000 volt transformers. The case consists simply of a plain boiler-iron case, to the outside of which are welded a number of radiating tubes. These tubes are in the vertical position, and are given a 90° bend at the top and bottom where they enter the case. The mechanical construction is very strong, so that there is practically no chance of ever springing a leak. Because of the ease with which the tubes can be widely separated from one another, the air circulates very freely among them, and the efficiency of the radiating surface is higher than for the corrugated case. The transformer for the Southern Company are 14 ft. 6 in. high and 24 ft. in circumference.

Current Items.

With the co-operation of supply houses and manufacturers throughout the United States, the electrical firms of San Francisco have organized an exhibition on an elaborate scale in that city, which will be open from January 29 to February 5.

The Sunbury, Hazelton & Wilkes-Barre division of the Pennsylvania Railroad has made the rather remarkable discovery that it is impossible to run trains as speedily with the telephone as with the telegraph, and, therefore, the telegraph service will be retained for emergency use.

The earnings of the Bell Companies in the United States during the first nine months of the current year have reached close on $100,000,000, the net earnings being $27,500,000.

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Mr. L. H. Webster, of Belvidere, N.Y., has obtained a patent for what he calls a telephone guard—viz., a wire device to be clamped to a transmitter mouthpiece to receive the lips of the user and thus serve as a gauge for distance, preventing contact with the mouthpiece, yet encouraging close proximity.

Mr. Kobori, M.E., the Japanese electrical engineer, who has been for several weeks in this country, on behalf of the Uji River Electric Company, of Kyoto, has purchased the machinery here for the 40,000 k.w. hydro-electric plant at Uji, 8 miles outside the Japanese capital.

A company with $6,000,000 capital is completing plans for the construction of a large hydro-electric power plant in Central Idaho. A site for a dam and power plant has been located on the Salmon and Snake rivers, about 40 miles south of Grangeville. The plans call for a combination tunnel and dam, which will develop 280,000 h.p. The dam will be 100 ft. high. The tunnel will be built through solid rock, 7½ miles in length, and it is estimated that a fall of 530 ft. will be secured.

GERMAN NOTES.

BERLIN

Some elaborate researches have been made in Germany with reference to the comparative cost of cooking by electricity and by gas. It appears from the average of a very large number of experiments made under varying conditions that if the cost of a kilowatt is more than half as great again as that of a cubic metre of gas (35 cubic ft.) the gas is the cheaper heating agent. Otherwise electrical heating is the more economical. It is claimed that the use for which electrically generated heat is least suitable in the household is for boiling water.

Electric Motors in Breweries.

Since motors have been protected from water by casing them, their use in German breweries has become common, and is rapidly increasing. One of their main functions is to drive the pressure regulator which forces the beer through the filters into the casks in which it is despatched. A very interesting type of these machines is a cog wheel pump coupled direct to the electro-motor. Variations in pressure cause variations in the resistance of the motor circuit, so that the least change is at once checked and the beer travels steadily and without frothing. Another type has horizontal beer cylinders, and pressure is maintained constant by two cylinders fitted with suitable valves and containing air or water under pressure. The power of the motor is best transmitted by friction coupling, as belts are apt to get slack in the moist air of a cellar. The power transferred to the pumps from the motor by friction is transmitted by toothed gearing to the cranks of the pump-cylinders. The motor should be provided with a controlling resistance, which is adjusted daily according to the work expected. Another job which may be advantageously given to the motor is to drive the stirrer in washing the filtering material above alluded to. This requires frequent washing by being stirred up in water kept boiling by a steam coil or by direct steam. Finally, the machines in a bottling warehouse are all advantageously driven by electric motors, especially the filling and labelling machines.

Hamburg Street Railways.

The Hamburg street railways must again be extended, new lines being required for growing suburbs. The suburb of Hamburg-Altona is now to be municipally united with the town of Altona, and a complication has thereby arisen, for the Altona Corporation is trying to get powers to make an electric railway of its own which will be in direct competition with the Hamburg-Strasseneisenbahngesellschaft. The latter company has recently improved its system within Hamburg itself by making a short direct line between the east and north-eastern quarters, which before had no direct communication of this kind. This new line will greatly facilitate communication between those quarters and the harbour, a matter of the highest importance.

Electric Steel.

According to Dr. Neuburger, of Berlin, the manufacture of steel by the aid of electricity is already yielding a product far superior to any that can be got by the older methods. The steel is even better than crucible steel. Besides, electricity not only enables us to produce steel with a given content of carbon direct from the ore, but in some cases does so economically. Dr. Neuburger states that a saving in this way is effected if in the particular locality three electric h.p. are not dearer than one kg. of good coal. Certainly high productive iron ores and sands, which cannot be satisfactorily worked in the blast furnaces, give results with electric working that leave nothing to be desired. Day in America has shown, however, that the advantages of electricity can be used even in the blast furnace itself, and that under suitable conditions pig iron can be made more cheaply in an electric than in an ordinary blast furnace.

The Top Compass.

After years of striving Dr. Anschutz Kaempfe, of Kiel, has succeeded in finding in a spinning top electrically driven a sure substitute for the magnetic needle. Experiments have been made on warships since the spring of 1908, and have shown such a superiority on the part of the top compass over the magnetic compass that it has been adopted for the whole German Navy. The apparatus is on the principle of the gyroscope, and consists of a top weighing about 10 lbs. with the compass card fixed on the top of it; to diminish friction it swims in mercury. It is driven at 21,000 r.p.m. by an electric motor. The power required is about 150 watts. When the top has been in motion for about two hours it has placed itself (its axis, presumably) in the geographical meridian, and thereafter stays there. It is true that deviations therefrom occur, but only with considerable changes in the sojourn in different latitudes, and these deviations are easily estimated beforehand and allowed for. The principal top is put in the middle of the ship and others in different places and regarded by the principal top. The top compass is found perfectly trustworthy in submarines in which the magnetic compass has proved very unsatisfactory.

Radium.

The presence of radiumemanation over the sea in certain places has been proved by experiment on board the *Grosser Kurfurst* during a voyage from Alexandria to Naples on the first two days of April, 1909. Thorium emanation was not detected. It is supposed that the radium emanation had been blown off the land by wind, as the amount of it present in sea water is so excessively minute that it seems very improbable that it would escape from the water into the air.

Current Notes.

The Munich street tramways carried 82,661,718 passengers in 1908, 18,356,614 more than in 1907. The takings were 8,173,279 marks, plus 7,930 marks for carrying letters for the poss office. The expenses totalled 4,980,065 marks, showing a diminution of from 30·89 to 29·67 pfennigs per km. (9 pf. = about 1d.).

The Lech Elektrizitatswerk A. G. of Augsburg made a net profit of 383,028 marks for 1908–9, as against 352,938 for 1907–8, and a dividend of 5% is proposed. 62,807 marks have been passed to reserve, and a third 10,000 volt main has been laid down.

The Neiderschlesiche Elektrizitats und Kleinbahn A.G., made a net profit of 787,272 marks for 1908–9, as against 751,686 for the preceding year. 10,194 marks are carried over. The dividend on the capital of five million marks will be again 6%. The output of the works is applied to power and lighting in the approximate proportion of two to one.

GLASGOW ELECTRICAL ENGINEERS.

At the eighth annual dinner of the Institution of Electrical Engineers, Glasgow local section, Mr. E. G. Todd (Chairman of the section), presided.

Proposing the toast of "The Corporation of Glasgow," Sir J. H. A. Macdonald (Lord Justice-Clerk) remarked that the science of electricity had made more marvellous progress in the last 30 years than some others. But let them have commonsense as well as science. He hoped the insane idea that they were to carry their mails by aeroplanes and airships all over the country and over the sea would not take hold of those who were members of the Institution of Electrical Engineers. (Laughter). If any one suggested that they were to travel from one part of Glasgow to another in an aeroplane driven by wireless telegraphy, he advised his hearers, in the first place, not to take shares in the concern—(laughter)—and, in the second place, not to attempt it. (Laughter.)

Professor Archibald Barr proposed "The Institution of Electrical Engineers," which, he said, now had a membership of 6,000.

Dr. Gisbert Kapp (President of the Institute of Electrical Engineers) replied, and, following up Sir J. H. A. Macdonald's remarks, said electricity was an excellent servant, but a bad mistress. They were told that Britain was backward in the science, but she was not really so. It was a see-saw, one day she was a little behind, the next day a little ahead. It was an interesting race. The horses were not always in the same position, but there was no winning post, for there was no finality in the electrical profession. (Applause.) The latest development of electricity was in connection with agriculture, in the stimulation of plant growth, where an increase of 30% had been realised in some instances.

The Bishop of Glasgow proposed "The Glasgow Section," and the Chairman responded.

GORSEINON ELECTRIC LIGHTING.

The Gorseinon Electric Light Co., Ltd., Glamorgan, intend to apply for a Provisional Order to authorise the Company to generate and supply electricity for all public and private purposes as defined by the Electric Lighting Acts within the whole of the parishes of Gowerton, Llandilo-Talybont, Loughor (Borough) and Penderry in the rural district of Swansea.

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BUSINESS NOTES AND NEWS.

LIGHTING AND GENERAL—Home.

BARNET.—It was reported to Southgate (Barnet) District Council that terms of an agreement for the lighting of the district by the North Metropolitan Electric Power Supply Co. had been arranged. The Council may require the company to sell on payment of the amount of capital expended by them, and, in addition: If the purchase takes place in 14 years, 30% of the capital expenditure; if in 21 years, 22½%; if 28 years, 15%; and if 75 years, 7½% of the capital expended.

BERMONDSEY.—Two explosions, supposed to have been caused by the fusing of underground electric cables, occurred at Jamaica-road, Bermondsey, on Saturday afternoon. Within a short distance is Grange-road, the site of the fatal explosion a year ago, but in this instance the results were not so serious, a fireman receiving slight burns to his face. A resident observed smoke issuing from airholes and an electric standard in the road, and raised the alarm. Soon afterwards a loud report was heard, and the trap of a manhole was forced into the air, but dropped into position again. The thoroughfare was deserted at the time, and the fire brigade were quickly on the scene. As a fireman, named Knight, was moving the lid of another manhole a second explosion occurred, and he was burnt about the face. The flames were eventually suppressed with sand.

BIRMINGHAM.—As a result of an electric cable fusing in Spencer-street on the 1st inst., a number of jewellers and other manufacturers in the immediate neighbourhood were for about an hour and a half inconvenienced by the cutting off of the electric power. About seven o'clock in the morning a police constable noticed that about 8 ft. of the pavement had been forced up to a height of about 2 ft. and smoke was issuing from the crevices between the bricks in dense clouds. The constable immediately communicated with the Electric Supply Department, and a number of workmen were promptly despatched to repair the damage. As soon as the top layer of bricks was removed the smouldering cable burst into flame, which, however, was quickly extinguished, and in order to prevent the damage spreading any further the power was cut off at the section box. The work was pressed forward as quickly as possible, and a temporary service of electricity was supplied to the factories that had been affected.

CAMBERLEY.—The Urban Council confirmed a resolution in favour of applying to the Board of Trade for a provisional order authorising the Council to supply electricity for public and private purposes.

DUBLIN.—A temporary breakdown occurred in the electric lighting system in Dublin. The public arc lamps were extinguished, and many of the principal thoroughfares were plunged into darkness, while private houses and business establishments were also affected. The breakdown was rectified in about 15 min.

HAMPSTEAD.—The Borough Council resolved to contribute £50 to the Association of Electric Supply Undertakings in London for literature to be supplied by the association for distribution to consumers on the subject of the merits of electricity for lighting, heating and power purposes. They further decided that a new sub-station be constructed in Redington-road to cope with the increase in the consumption of electricity in the West Heath District, and that series gear be fixed to sub-stations in England's-lane, Fitzjohn's-avenue, Parliament-hill, High-street, and Heath-drive, to increase the transformer capacity of those sub-stations. The Council further ordered that 95 street gas lamps be converted into incandescent electric lamps in the boundary thoroughfares between Hampstead and Marylebone and adjacent roads, the Marylebone Borough Council being about to similarly convert the lamps on their sides of Boundary-road and Greville-road. It is estimated that the conversion will result in a saving of 4s. 6d. per lamp per annum.—Adopted.

LLANIDLOES.—At a meeting of ratepayers, the report of the Town Council respecting the feared abandonment of the electric light and power scheme for the town was considered. A motion was adopted, expressing in the strongest possible terms approval of the resolution passed by the Council to Mr. David Davies, M.P., and the promoters of the scheme, and their desire for the work to be carried out. Those present pledged themselves to support the scheme, and appealed to Mr. David Davies to regard the influences brought to bear upon him in opposition to the electric scheme as being contrary to the wishes of the townspeople generally.

LONDON.—The Charing Cross, West End and City Electricity Supply Co. propose (under the St. Martin's Order, 1889) to lay mains in John-street and Duke-street, and to construct inspection boxes. The County of London Electric Supply Co. propose (under the County of London, North, Order) to lay low tension mains in Mitchell-street and Central-street, and (under the St. Olive Order, 1895), to lay mains in Queen Elizabeth-street and Lafone-street. The South Metropolitan Electric Co. (under the Mid-London Order) have decided to lay low tension mains in Meard-street; also (under the Blackheath and Greenwich District Order, 1897) high and low tension mains in High-street, Lewisham. The St. Pancras Borough Council intend to lay mains in Brecknock-road and Leighton Groove, Euston-road, King's-road, Wells-street, and Gough-street; and the Westminster Electric Supply Corporation, propose to lay mains in Gloucester-street, Lupus-street, and Rutland-street.

MIDDLESBROUGH.—At a meeting of the Corporation Electric Lighting Committee the Electrical Engineer (Mr. H. M. Taylor) reported that their appeal against the assessment of £2,000 had failed. A communication was received from the Electrical Contractors' Association drawing attention to the clause in the proposed Bill wherein the Corporation were seeking powers to do wiring and other work. The association suggested that they should add the words "through a contractor, but not otherwise." Unless this concession was acceded to, the association would have to oppose the Bill. It was decided to ask the association for a more explicit definition of their requirements. The Engineer reported that the gross profit, exclusive of interest and redemption, upon the consumption for the half-year ended September 30 was £1,925, a decrease of £55 compared with the corresponding period of 1908. They were now purchasing meters out of revenue, and this item had absorbed £210, so that the result of the half-year was better by £155 than last year, the total costs per unit being 1·43d. against 1·46d. per unit last year. With regard to the returns for November, the total estimated revenue was £2,321, against £1,917, an increase of £404, and the profit, exclusive of interest and redemption, was £1,495, being an increase of £369, as compared with the corresponding period of 1908.

NOTTINGHAM.—The agitation to retain at Nottingham the Post Office electrical engineering staff of the North Midland District has been successful. The Postmaster-General (Mr. Sydney Buxton) informed a deputation who waited upon him in London that the whole scheme should be reconsidered, and that, with the exception of the engineering clerical staff, the department would remain as at present. The North Midland District, the Post Office engineering work of which is covered from Nottingham, comprises Sheffield, Derby, Leicester, Lincoln, Doncaster, Grantham and Grimsby. It was proposed (and, in fact, definitely decided on and partly carried into effect) to split this district and to transfer the staff to new centres to be formed at Liverpool, Leeds, Birmingham, and Bristol. One result would have been that £6,000 per annum in wages would have been removed from Nottingham, and the city would have lost some of the importance which, as the centre of such a district, it possesses.

OLDHAM.—To the Corporation Electricity Committee Mr. Newington (Electrical Engineer) reported that the number of arc lamps was 770, incandescent 32,696, an increase of 162 during the fortnight; motors, 529; and 158,733 equivalent of 8-c.p. lamps, an increase of 431.

ROTHERHITHE.—An explosion in an electric main occurred at Mill Pond Bridge, Rotherhithe. The force blew up the covers of three manholes, and a fireman was injured.

STOCKTON.—At the Council meeting the Electricity Committee reported that they had again considered the question of guarantee from consumers for laying in cables, and had decided not to depart from the present rate of charging 20% upon the outlay for a period of five years. They had decided not to extend the cable to Newburn and the Grange Estate, as sufficient customers had not been obtained on the canvass.

SUNDERLAND.—Matters seem now to be improving somewhat with the Sunderland electricity undertaking, which is run by the Corporation and has been particularly hard hit by the trade depression of the past two years in relation to power consumption at the shipyards and works. Ald. Bruce (Chairman of the Committee) states there has been a steady increase in the demand of late. The charge to the Tramways Committee has been reduced to the extent of between £1,300 and £1,400 a year, and there has been tremendous economy among consumers for lighting purposes by the use of metallic filament lamps. The number of these consumers will have to be extended to make up the decrease. Important economies, says the *Newcastle Chronicle*, have been made in the working costs, and prospects are brighter than for some time past.

WALSALL.—Mr. H. R. Hooper, Local Government Board Inspector, held an enquiry into an application of the Walsall Town Council for sanction to borrow £35,000 for the purposes of extending and improving their electricity undertaking. In reply to the Inspector, the Engineer (Mr. Barnard) said he was anxious to get the three-phase system alongside the present works, so as to deal with applications of large power. The

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Inspector pointed out that there was an outstanding debt on the undertaking of £90,000, and they were seeking to secure a further £35,000. He regarded it as a serious thing that for some years the capital charges had gone up steadily. The Inspector also pointed out that last year there was a loss on the undertaking of nearly £900, there was very little reserve fund, and altogether the position was very weak. It was unfortunate for Walsall that it had an obsolete system, but they had no funds whatever to deal with desirable improvements. With regard to the Bloxwich section of the scheme, the Inspector questioned whether the possible increase in consumers would be sufficient to warrant the additional outlay. He suggested that the application might be reduced from £35,000 to £22,000 by leaving out Bloxwich and erecting no new buildings. Mr. Morse (solicitor) opposed the application on behalf of the South Staffordshire Tramway Lessee Co., and submitted that the company for whom he appeared had offered to supply the Corporation more economically than under the proposed scheme, and contended that it would be in the interests of the ratepayers and the Corporation if the offer were accepted.

YORK.—The City Electrical Engineer reported to the Corporation Electricity Committee that the loans sanctioned to cover the estimated capital expenditure during the two years ending March 31, 1910, for mains services, motors, and meters were nearly exhausted, and that it was necessary to apply to the Local Government Board for sanctions to meet the estimated expenditure for a further period of two years. The amount required was £2,475, viz., for mains' services, £1,100; motors, £800; meters, £575. The Committee decided to recommend the Council to apply to the Board for their sanction to borrow the above sums. Eighteen additional applications for electric lighting have recently been made, equivalent to a lamp connection of 625-39 watt lamps.

LIGHTING AND GENERAL—Overseas.

AMSTERDAM.—On the 3rd inst., at the busiest hour of the evening, the electric light in the shopping centre of Amsterdam suddenly went out, owing to a short circuit. Great inconvenience was caused, and for many hours shops and restaurants had to use candles. Further confusion was caused by the telephones also going out of order for a time.

FRANCE.—The Société Eau, Eclairage Electrique et Force Motrice de Brissac, has been formed at Brissac for the installation of electric lighting power works.

INDIA.—The National Gas Engine Co., Ltd., Ashton-under-Lyne, Manchester, have supplied an electric magneto, etc., for the E.I.R. Electrical Department; and the Lancashire Dynamo Co., Ltd., a starting transformer. This latter firm also had an order, we believe, for the supply of eight electric motors for the Jamalpur Locomotive Workshops; and the General Electric Co., Ltd., for the supply of two watthour meters.—The United Provinces Government have granted a loan of Rs. 50,000 to the Mussoorie Municipality for expenditure in connection with the hydro-electric scheme of the station. Electric installations in houses account for Rs. 36,000 of the loan, which is to carry interest at 4% per annum and have a currency of 10 years.—The Punjab Public Works Department has, at the suggestion of the Lieutenant-Governor of the Punjab, been investigating the question of utilising the Leh and Sohan rivers at Ralwalpindi for the purpose of generating power for use in the Station and Cantonments. The preliminary investigation undertaken shows that there is a head capable of producing 400 h.p.—Proceedings are being taken under the Land Acquisition Act for the purchase of a site for the Simla terminal station of the hydro-electric installation now in process of construction for that town.

RIVER PLATE.—The Legislature of the Province of Buenos Aires has created a tax of $1 paper per month on all telephones installed throughout the province. This class of taxation is completely new in the country. Seeing that the Legislators recently raised their own salaries 35%, they have, we presume, found it necessary to impose new taxes, so as to ensure that the necessary funds will be forthcoming at the end of each month to pay their salaries. The director of public lighting has prepared his project for the illumination of the city of Buenos Aires during the Centenary Festivities. 391,000 incandescent lamps of 10 c.p. will be installed in various streets. The lighting will cost $22,000 a night. Altogether the sum of one million dollars will be spent on illuminations.

ROUMANIA.—The municipal authorities of Bucharest have called for tenders for the construction of electric works designed to supply electric energy for the new city tramways and also for electric lighting. The project includes the erection of a sub-station in the centre of the town. The upset price is placed at 1,800,000 frs. (£72,000).

RUSSIA.—A St. Petersburg correspondent reports that the use of electricity in Russia is still somewhat limited. There are only 30 cities possessing an electric tramway system, and of the 80 cities lighted by electricity 40 have their own electrical works, the supplies in the remainder being provided by private enterprise. The following figures show that the electrical undertakings in Russian cities are very remunerative. The net profits of the works of the city of Vilna were 83,851r., or 50%; Wolvgda 18,078r., or 39%; Minsk 14,849r., or 38%; Nicolaieff 34,554r., or 33%; Orenburg 38,064r., or 44%; Poltava 28,642r., or 49%.

SINGAPORE.—Having taken over the business of the Tanjong Pagar Dock Co., at Singapore, the Straits Settlement Government appoint a Board of management. The Board at once set about making improvements, and these included the erection of modern machinery from which will ultimately proceed the electrical energy to drive the workshop machinery, the dock pumping plant at the new works at Keppel Harbour and at the existing works at Tanjong Pagar, to operate cranes and coal-handling plant on the new wharves, and to light the whole of the docks, workshops, godowns, and wharves belonging to the Dock Board. The building is of a very substantial nature, built of brick and steel, and has been erected and equipped departmentally, under the superintendence of Mr. F. R. Marsh, the Board's chief electrical engineer. The buildings are large enough to hold the necessary plant for a further 2,000 b.h.p., the plant at present installed having a total capacity of 1,700 b.h.p.

SOUTH AFRICA.—In the next five years £100,000 will be spent on additions to the Durban electric lighting plant out of the loan which the Corporation will raise for street improvements.

SWITZERLAND.—The Swiss budget for 1910, which includes, for the Department of Telegraphs and Telephones, the following items: An expenditure of 25,000 frs. (£1,000) for printing appliances; 44,400 frs. (£1,776) for Morse colouring apparatus, relays, etc.; 600,000 frs. (£24,000) for telephone stations, comprising bells, commutators, protectors, etc.; 465,000 frs.(£18,600) for commutating apparatus, switchboards, machines, transformers for central and intermediate stations; 239,000 frs. (£9,560) for repairs to telegraph and telephone apparatus; 36,600 frs. (£1,464) for electric measuring and testing instruments; 150,000 frs. (£6,000) for batteries, accumulators, salts, acids, and tape rolls.

TRACTION—Home.

ISLE OF WIGHT.—The working of the railways, says a local correspondent, has long been a contentious subject. The County Council are again taking up the matter, and the Parliamentary and Railway Committees have written to the various public authorities in the island stating that they have had submitted a scheme of electrification and an alternative proposal for the construction of light railways or electric tramways. Representatives of the various authorities are invited to a meeting at Newport on December 13 to confer on the matter.

LONDON.—The Highways Committee of the London County Council report that the reconstruction for electric traction of the undermentioned tramways has now been completed. The lines have been inspected on behalf of the Board of Trade, and the tramways duly opened for public traffic: From the *Britannia*, Camden Town, *viâ* High-street, Camden Town, Chalk-farm-road, Ferdinand-street and Malden-crescent to Malden-road; from Prince of Wales'-road, *viâ* Kentish Town-road, Fortress-road and Junction-road to the *Archway Tavern*, Highgate; Archway-road (between St. John's-road and Flowers Mews); from Nile-street, *viâ* High-street, Woolwich, and Beresford-street to Beresford-square. The first three lines are on the conduit system, and the other tramway on the overhead system. The Board of Trade have also approved of the use of electrical power on the underground conduit system of electric traction on the double-junction curves which have been constructed from Marshalsea-road, into Borough High-street and on the line constructed in Monnery-road between the tramways in Junction-road and the Holloway car-shed to be used for taking cars into the car-shed.

TRACTION—Overseas.

BRISBANE.—The Brisbane Electric Tramways Investment Co., Ltd., announce that the traffic receipts of the Brisbane tramways for the month of November amounted to £16,170, corresponding month last year £14,504, increase £1,666.

BRITISH COLUMBIA.—The length of the new British Columbia Electric Railway line to Chilliwack will be 64½ miles and will be bedded on a good grade. The sub-grade has been completed over two-thirds of the entire road. At the rate of one mile per day the rails, which are 70-pound steel, have been laid to Langley Prairie. No grade on the entire road will be greater than two and five-tenths per cent. The power to operate the line will be supplied by the station at Lake Buntzen, coming over the high tension lines in its full voltage, to be reduced to operating voltage by the five sub-stations located at Chilliwack, Sumas Mountain, Clayburn, Mt. Lehman and Cloverdale. The reduction stations will be reinforced concrete structures and will each represent to the company for the buildings alone an expenditure of $25,000 to $35,000, while the machines therein will be 300 to 600 kw. power. The system will be operated on standard time. The rolling stock will consist of a combination train, including freight cars. These cars will be operated under the multiple unit system and coupled by the A. M. M. type of air and the junction box electrical connection and will run jointly under one motorman, at the same

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time each car propelling itself. The new controller differs from that in use at present by being only about a foot square but having about 3,000 connections with the group switch. For freight transportation the company has purchased three 50-ton motor locomotives.

MONTREAL.—The Canadian Pacific Railway is considering a proposal to prevent smoke nuisance in this city by operating trains within the city limits by electric power.

TORONTO.—Mr. J. W. Moyes, who was appointed to report on tube railways for Toronto, has recommended the establishment of a dual system of underground and surface railways to cost $4,485,000. The underground system would be 3¾ miles long. The outgoing section would be served by surface railways.

COMPANIES' MEETINGS AND REPORTS.

THE ELECTRICAL COMPANY.

The report just issued by the Electrical Co., formerly Schuckert & Co., Nuremberg, shows a net profit of 4,535,953 marks, against 3,866,598 marks the previous year, and it is proposed to pay a dividend of 6% against 5% last year. The capital is 50 million marks.

SIEMENS & HALSKE, BERLIN.

The electrical engineering company Siemens & Halske, Berlin, report a net profit of 11,429,009 marks, against 9,688,263 marks the previous year, and propose paying a dividend of 12% against 11%. The capital now amounts to 63 million marks. The orders now on the books are greater than at the corresponding period last year.

WINNIPEG ELECTRIC RAILWAY.

The statement of the Winnipeg Electric Railway for September shows gross earnings for the month of $218,088, an increase of 24%, while the net earnings increased 21%. For the nine months of the year the gross totals $1,848,897, an increase of 20%, the net gain being the same. Earnings are at the rate of 14% on the common stock.

NORTH METROPOLITAN ELECTRIC POWER.

An extraordinary general meeting of the North Metropolitan Electric Power Supply Co. was held at Kingsway, London, W.C., for the purpose of passing the following resolution: "That of the amount which the company are authorised to borrow a sum not exceeding the nominal amount (inclusive of bonus) of £25,000 be raised by the issue at such price and to such persons as the directors may determine of further mortgages in the like form, and on the like terms and conditions (as nearly as the directors shall think practicable and desirable as, and ranking *pari passu* with, the existing mortgages issued by the company, and on the terms that the amounts secured by such further mortgages may, at the option of the holders thereof, be paid or satisfied by the issue to such holders of debenture stock of the company under the provisions of an indenture dated July 30, 1907, and made between the company, of the one part and the Beaver Trust, Ltd., of the other part, and so as to form part of the further stock as defined in the said indenture and to be subject to, and with the benefit thereof."

Mr. Emile Garcke presided, and formally moved the resolution, which was seconded by Mr. J. Devonshire, and unanimously agreed to.

INDIA RUBBER AND TELEGRAPH WORKS CO.

The directors' report for the year ending September 30, will be presented at the 46th ordinary general meeting of the India Rubber, Gutta Percha and Telegraph Works, Co., Ltd., to be held at the company's offices, Cannon-street, London, E.C., on Tuesday next. The accounts show, after provision for doubtful debts, a net profit of £57,927 5s. 6d. Adding £51,980 7s. 4d. brought forward, and deducting £12,500, the dividend on the ordinary shares paid in June, and £3,333 6s. 8d., the dividend on the preference shares paid in July, there remains a disposable balance of £94,074 6s. 2d., which, after providing for the balance of the dividends for the year, will leave £55,011 16s. 2d. to be carried forward. The directors recommend that the payment of the half-yearly dividend of 5s. per share, or at the rate of 5% per annum, be made to the preference shareholders on January 1 proximo, and they further recommend the distribution of a dividend to the holders of ordinary shares of 15s. per share, free of income tax, amounting to £37,500, making, with the interim dividend paid in June, a total payment of 10% for the year. The general business of the company shows an increase compared with the turnover of last year, which is, however, partly due to the higher scale of prices at which some of the goods have been sold. Taken as a whole, the foreign agencies have not done so well as the board had reason to expect, but the sales of the home agencies have been fairly satisfactory. The prices of some raw materials have attained a very high level, but the advances the directors have been able to make in the selling prices of the goods have sufficiently met the case; some provision, furthermore, has been made to cover a possible fall in selling price of stocks in hand. The board is making a considerable capital expenditure at the French works to meet the expanding motor and bicycle tyre trade on the Continent, and further capital expenditure will, doubtless, be necessary at home. These latter extensions are having the serious consideration of the directors, as a growing business must have facilities provided. The electrical industry continues dull. A certain amount of cable work has fallen to the company's share, and the steamers *Dacia* and *Buccaneer* have had occasional employment. The works at Silvertown and Persan have been maintained in the usual state of efficiency. The board appointed Mr. Matthew Hamilton Gray, Mr. Christian Hamilton Gray and Mr. William Ernest Gray extraordinary directors, as they have been closely identified with the management of the business for several years, and have largely contributed to its success. Mr. Matthew Gray expressed his regret that he was unable to give the close attention he would like, but hoped the board would accept his services in a consulting capacity, and to this the Board agreed.

BRITISH COLUMBIA ELECTRIC RAILWAY.

The report of the British Columbia Electric Railway Co., Ltd., for the year ended June 30 last, states that the gross receipts show an increase of $339,699, or 17%, and the net earnings, including income from investments in subsidiaries, and after charging renewals, show an increase of $48,792, or 5·6% over those of the preceding year. From June 30, the close of the financial year under review, up to October 31 last, there has been a still further increase in gross earnings of $231,961, or 32%, and in net earnings of $98,086, or 28%. From January 1, the company, in pursuance of its long-established policy of allowing the public to share in its prosperity by treating them in the most liberal manner possible, spontaneously reduced its charges for electric light by about 17%. The rates now charged compare favourably with those of the largest cities of Canada. Various reductions in railway fares and charges have also been made during the year. It was anticipated when these reductions were put into force that they would involve considerable diminution of profits, but the increase in the volume of business has more than compensated for the reduced charges, and the above-mentioned satisfactory results are shown for the whole year. The following charges have been made against the revenue account of the year, namely, provision for renewals maintenance (from which £16,674 has been deducted for adjustments and expenditure on renewals during the year), £36,447; bonus to employees, £9,683; amount added to capital amortisation fund, £2,018. The net profit for the year, after making the above deductions, amounts to £163,306, to which must be added balance brought forward of £4,974, together £168,280. The directors have decided to recommend a dividend on the Deferred Ordinary stock at the rate of 8% per annum, making 8% for the year, and to transfer to reserve fund £37,329, carrying forward £7,061. There has been deducted from the reserve fund the sum of £25,267, representing the difference between the net amount realised by, and the par value of, £500,000 of 4½% Debenture stock issued in November, 1908, and there has been added to the reserve fund £10,000, representing the premium on £100,000 5% Preference stock and £100,000 Deferred Ordinary stock issued in June, 1908. After the transfer now recommended by the directors as above, the reserve fund will stand at £160,000. The number of lights in use at June 30, 1909, was 347,026, an increase for the year of 59,402. The number of passengers carried during the year was 25,183,739, an increase for the year of 3,855,559. The company is extending its railway system and general undertaking as the interests of the country and the requirements of the public demand. The new lines of railway may not prove immediately remunerative, and must be expected to increase the ratio of expenses during the next two or three years, but they will undoubtedly in time develop a very valuable business.

COMPANIES' REGISTERED.

MADEIRA ELECTRIC LIGHTING CO. (1909).—November 25. £30,000 (£5). To acquire from the receiver for the debentureholders of the Madeira Electric Lighting Co., Ltd., the concession granted to the said company by the municipal corporation of the City of Funchal, Madeira. To acquire from the said receiver the property and assets of the said company under an agreement dated July 23, 1909. Private. 75, Lombard-street, E.C. (106,123).

WAKELIN BROS., LTD.—Registered November 1. Capital £2,000, in £1 shares. Objects: To adopt an agreement with J. F. Wakelin, trading as Wakelin & Co., and as Wakelin Bros., at 5 and 7, Tottenham-street, Tottenham Court-road, W.C., and to carry on the business of electrical, mechanical and general engineers, smiths, founders, etc. Private company.

CONTRACTS OPEN.

HOME.

BELFAST.—Corporation Tramways and Electricity Department.—One 1,500 kw. continuous current turbo dynamo and condensing plant. January 10.

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LLWYNYPIA.—Cambrian Collieries, Ltd., Glamorgan Coal Co., Ltd., and Naval Colliery Co., Ltd.—half-yearly tenders for electrical accessories and fittings and other stores. December 10.

LONDON.—London County Council.—Overhead electrical equipment for the construction on the four-wire system of electric traction, of the Council's tramways from Woolwich to Eltham. Dec. 14.—Installation of electric lighting at Poplar Divisional Offices, Stafford-road, E. December 15.

STEPNEY.—Corporation Electricity Committee—Coal and ash handling plant.—December 30.

WISHAW.—Burgh Electricity Department.—Supply of 25,000 or 50,000 pairs of 6.35 and 7 m.m. carbons, suitable for 9 amp. oriflame d.c. arc lamps. December 13.

OVERSEAS.

AUSTRALIA.—Deputy Postmaster-General, Melbourne.—Supply and delivery of a branching multiple magneto switchboard at the Post Office, Canterbury, Victoria. March 16, 1910.

BELGIUM.—At the Town Hall of Waremme. For a concession to light the town with electricity. January 30, 1910.

HOBART (Tasmania).—Postmaster-General.—Telegraph and telephone material, etc. Part. as above. December 20.

LIEGE.—Electric lighting at Jupille. December 31.

LITHGOW (New South Wales).—The Commonwealth Government.—Power generating station equipment. Particulars from Commonwealth representative, 72, Victoria-street, Westminster, London, S.W. By Tuesday, January 11 next.

LUCKNOW.—Municipal Board.—Tenders invited for a concession for the supply of electric energy, coal or oil gas, for house and street lighting, and other domestic or manufacturing purposes. December 31.

SAMARKAND.—Municipality.—Electric tramways, March 14, 1910.

SYDNEY.—Postmaster-General.—Switchboard apparatus for subscribers' premises. Particulars of all Australian contracts, 72, Victoria-street, Westminster, S.W. January 10, 1910.

SOME CONTRACTS.

The contract between the Government of the Province of Buenos Aires and Mr. J. F. Tettamenti for the working of an electric tramway in La Plata has been signed. The concession is for 80 years.

The Diesel Engine Co., Ltd., of 179, Queen Victoria-street, London, E.C., have received an order from the Delhi Electric Tramways & Lighting Co., Ltd., for a 240 B.H.P. Diesel engine and continuous-current generator. When the power house at Delhi was first built, Diesel engines came under consideration of the Board, but it was decided to put in steam. The results, however, have shown that the running costs with steam are so high that it has been found necessary to instal Diesel engines to effect an economy in generating costs.

TENDERS ACCEPTED.

LONDON.—The London County Council Stores and Contracts Committee selected the following tenders for acceptance, the amounts, where specified, being the estimated value of the goods to be supplied.—Electric carbons, Wm. Geipel & Co., Vulcan Works, £100; electric insulating materials, British Insulated & Helsby Cables, Ltd., £27; the British Westinghouse Electric & Manufacturing Co., Ltd.; The Edison & Swan United Electric Light Co., Ltd., £92; The General Electric Co., Ltd.; James North Hardy & Son, Manchester, £100; The India Rubber, Gutta Percha & Telegraph Works Co., Ltd., £216; J. G. Ingram & Son; D. Jarowslaw, Tower-hill, London; The Micanite & Insulators Co., Ltd., £60; The Ruberoid Co., Ltd., £45; Geo. Schultz & Co., £49; Whiteley Brothers, Rishworth, near Halifax, £104; F. Wiggins & Sons, London, £50. Electric cables and wires, Hooper's Telegraph & India Rubber Works, Ltd., £600; The Yorkshire Cable Co., Ltd., £40.

CATALOGUES AND LISTS.

We have received from Messrs. Siemens Bros. & Co., Ltd., a copy of their new catalogue, No. 519, "Telephone Switchboards." These switchboards are designed on the most modern principles, and are of the best workmanship and material only. The types listed are suitable for most conditions that obtain in modern private telephone installations, and a range of sizes is provided which covers all requirements, from those of suites of offices to those of small towns. Although the switchboards included in the list will meet all requirements usually arising in practice, yet the firm are always willing to quote for any special apparatus to meet particular conditions. The catalogue is arranged in the form of single sheets held together by fasteners, so that as other sheets are issued from time to time, these may be embodied in their correct places inside the cover.

The Tudor Accumulator Co., Ltd., have prepared an attractive catalogue describing and illustrating their well-known stationery cells.

The Adnil Electric Co., Ltd., are sending out an illustrated list of direct current dynamos and motors, type M. This new type has been developed, parallel to the well-known K and K O machines, to meet the demand for motors and dynamos of moderate weight and price, but which, nevertheless, retain all the important mechanical design, high efficiency, liberal overload capacity, and sparkless running.

PERSONAL.

Mr. Herbert E. Mitchell, for many years chief engineer and manager of the late consulting practice of Messrs. Medhurst & Brewer, Victoria-street, has opened an office at 5, Victoria-street, Wetsminster, where he will continue to practice in consulting engineering work.

Mr. Howard Foulds, Secretary of Faraday House, has been elected a member of the Holborn Borough Council.

Mr. Geo. W. Bunting, consulting and electrical engineer, of 49, Park Avenue, Whitley, has been appointed by Messrs. Feld Bros & Co., Ltd., as their sole representative for Newcastle, Middlesbrough and district.

Among those present at the conference on "Industrial Education and Apprenticeship," held at the Mansion House, London, were Mr. R. K. Gray (of the Institution of Electrical Engineers) and Mr. H. K. Barnes (of the Electrical Winders Society of Great Britain).

DIARY.

FRIDAY, DECEMBER 10.

NORTHAMPTON POLYTECHNIC INSTITUTE.—At 6.30 p.m., at St. John-street, London, annual prize-giving.

SATURDAY, DECEMBER 11.

ELECTRICAL FOOTBALL LEAGUE.—At Brook Green Works, Hammersmith, by permission of the directors of Robertson Electric Lamps, Ltd., second annual concert and distribution of trophies, etc.

NORTHAMPTON POLYTECHNIC INSTITUTE.—At 6.30 p.m., members and students' annual conversazione.

MONDAY, DECEMBER 13.

INSTITUTE OF ELECTRICAL ENGINEERS (Newcastle Local Section).—At 8 p.m., at Armstrong College, Newcastle-on-Tyne, "The Use of Flicker Photometer for Differently Coloured Lights.

INSTITUTION OF MECHANICAL ENGINEERS.—At 8 p.m., "Planning and Equipment of Turbo Generating Stations," by Thomas Walmsley.

TUESDAY, DECEMBER 14.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.—At 2.30, at Balfour House, Finsbury-pavement, London, E.C.; meeting of the Committee.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Section).—At the University of Manchester, "Notes on Methods and Practice in the German Electrical Industry," by L. J. Lepine and A. R. Stelling, students.

WEDNESDAY, DECEMBER 15.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section).—At 7.45 p.m., at 92, Victoria-street, London, S.W., "Electricity Supply on Tap," by Messrs. C. B. Nadand and W. Bernard Thompson.

JUNIOR INSTITUTION OF ENGINEERS.—At 7.30 p.m., at the Royal United Service Institution, Whitehall, "The Design and Maintenance of Cement Works," by Harry Horsburgh, Assoc. M.Inst.C.E.

INSTITUTION OF ELECTRICAL ENGINEERS (Newcastle Local Section).—Annual dinner.

THURSDAY, DECEMBER 16.

INSTITUTION OF ELECTRICAL ENGINEERS.—At 8 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W., "Some Quantitative Measurements in Connection with Radio-telegraphy," by Dr. J. S. Fleming, F.R.S., member, and "Efficiency of Short Spar Methods of Generating Electrical Oscillations," by Dr. W. H. Eccles and A. J. Makower, associate member.

FRIDAY, DECEMBER 17.

INSTITUTION OF MECHANICAL ENGINEERS.—At Storey's Gate, Westminster, London, at 8 p.m., papers by Wm. Mason, and C. A. M. Smith, B.Sc.

SATURDAY, DECEMBER 18.

ELECTRICAL ENGINEERS (London Division).—At the Café Monico, Piccadilly Circus, annual corps' dinner.

THE ELECTRICAL ENGINEERS (London Division). Orders for week ending December 18, 1909: Officer Commanding, Col. R. E. B. Crompton, C.B. Monday, December 13, "A" Co., Technical Drill, 7 to 9.30 p.m.; Tuesday, December 14, "B" Co., Technical Drill, 7 to 9.30 p.m.; Wednesday, December 15, Gymnasium, 6.30 to 9.30 p.m.; Thursday, December 16, "C" Co., Technical Drill, 7 to 9.30 p.m.; Friday, December 17, "D" Co., Technical Drill, 7 to 9.30 p.m.; Saturday, December 18, Corps Dinner, held at the Monico, Piccadilly Circus, at 7.30 for 8 p.m. (Signed) P. H. Campbell, Capt. R.E. Adj. for O.C., E.E., L.D.

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PHYSICAL SOCIETY'S EXHIBITION.

The Physical Society's annual exhibition, which is to be held on Tuesday, the 14th inst., will differ from that of previous years, in that it will be open in both the afternoon (from 3 to 6 p.m.) and in the evening (from 7 to 10 p.m.). Also short discourses will be delivered at 4 and 8 p.m. by Prof. C. V. Boys, F.R.S., on "Soap Bubbles," and at 9 p.m. by Prof. S. P. Thompson, F.R.S., on "Combinations of Mica and Selenite Crystals." The following firms will be exhibiting:—Bausch & Lomb Optical Co.; British Radio-Telegraph and Telephone Co., Ltd.; Cambridge Scientific Instrument Co.; Casella & Co.; A. C. Cossor, Ltd.; H. W. Cox & Co.; G. Cussons, Ltd.; *The Daily Mirror* (pictures by telegraph); J. H. Dallmeyer, Ltd.; Elliott Bros.; Everett, Edgcumbe & Co.; Gallenkamp & Co.; Gambrell Bros.; F. Harrison Glew; J. J. Griffin & Sons; Hicks & Co.; A. Hilger, Ltd.; India Rubber, Gutta Percha & Telegraph Works, Ltd.; Isenthal & Co.; Marconi's Wireless Telegraph Co.; Leslie Miller; Muirhead & Co. Nalder Bros. & Co.; Nalder Bros. & Thompson; Negretti & Zambra; Newton & Co.; R. W. Paul; Pitkin & Co.; The Reason Manufacturing Co.; Ross, Ltd.; Siemens Bros. & Co., Ltd.; Snell & Tinsley; Strange & Graham; Synchronome Co.; Weston Electrical Instrument Co.; Carl Zeiss, Ltd.

From the programme, of which we have received an advance proof, there appears to be many items of considerable interest to both physicists and electrical engineers. We understand that invitations have been given to the Institution of Electrical Engineers, the Faraday Society, the Optical Society, and the Röntgen Society.

Shown by the British Radio-Telegraph & Telephone Co., Ltd., will be a complete receiving station for wireless telegraphy, comprising detector and tuner combined in one piece of apparatus. The detector consists of a laminated cylinder of magnetic material rotating in a diametrically opposed magnetic field. The tuner comprises two variable condensers and inductances. All possible combinations of detector and tuner are accomplished by means of switches, and the tuner has an accuracy of 3% on a 20 to 1 ratio.

The Cambridge Scientific Instrument Co., Ltd., will exhibit a Féry radiation pyrometer. This instrument represents a great improvement over that shown last year. By using a special alloy for one side of the small thermo-couple a largely increased E.M.F. has been obtained. Tbis permits the old suspended coil galvanometer to be by a standard pivoted millivoltmeter such as we use in connection with our ordinary thermo-electric pyrometers. The advantages secured are robustness, a more open scale, independence of accurate levelling, greater convenience, etc. This pyrometer will be shown in use in connection with a Méker furnace. The same firm will also show a Duddell oscillograph (permanent magnet oil-bath pattern). In this latest design, the vibrating loops of phosphor bronze strip are each mounted as a separate unit called a "vibrator." Two of these vibrators are each mounted side by side in an oil-filled bath. This design has the great advantage that so long as the top of the oil-bath is kept screwed down, the instrument is perfectly air and dust tight, and is always ready for use at a moment's notice, since it does not require re-oiling as the older design did. Owing to the use of a permanent magnet instead of an electro-magnet, the instrument can easily be insulated for use on high voltage circuits. The one shown is suitable for use on voltages up to 25,000 above earth. An instrument complete with the necessary resistances and shunts has recently been supplied for use on circuits up to 50,000 volts above earth.

One of the leading features of the stand of Messrs. A. C. Cossor, Ltd., will consist of Phillips' electroscope for comparison of radio-activity. In this instrument, due to Mr. C. E. S. Phillips, the usual gold leaf is replaced by a light aluminium vane suspended by a quartz fibre. The vane is acted upon by inductors on the principle of the usual quadrant electrometer, and it is provided with a small mirror for reading the deflection from a beam of light. A torsion head is provided for adjusting the zero position. In order to electrify the vane without causing mechanical disturbance, the equivalent of a U-tube is provided, containing oil. The latter is connected with one pole of a battery, so as to be at a certain potential, and a bulb is provided at one end of the U-tube. When it is desired to electrify the vane, this bulb is compressed, so that the oil rises in the other end of the tube and comes in contact with a downward prolongation of the vane, thus causing the latter to be electrified.

Dynamometer ammeters and voltmeters will be on view at the stand of Messrs. Everett, Edgcumbe & Co. Ltd. These instruments, like the Everett-Edgcumbe wattmeters, consist of a fixed coil and a pivoted coil attached to a knife-edged pointer moving over a scale provided with mirror to avoid parallax. The two coils are connected either in series or parallel, according to the nature of the instrument. The indications are, within very close limits, the same both for alternating and for direct current, so that these instruments possess the great advantage of being capable of calibration or checking with direct current and subsequent use with alternating current. This is a feature possessed by no other instruments with the exception of the electrostatic voltmeter and the hot wire ammeter, both of which have obvious limitations in other directions. These instruments can, moreover, be made astatic so as to be completely immune from disturbance by stray magnetic fields. They will also exhibit a rotary synchroniser for the paralleling of alternators. This is a new type of synchroniser which, besides other improvements, is distinguished by the absence of sliding contacts. The various windings are all of them fixed, and only the pivoted armature rotates. Another interesting item on this stand will be a portable direct reading lamp photometer. This instrument is intended for the rapid testing of metal filament carbon glow-lamps, and is entirely self-contained in a compact portable case. It is so arranged as to be perfectly direct reading in candle-power, and has a very wide range. It can, moreover, be used in broad daylight.

Mr. F. Harrison Glew will show a radium collector for atmospheric electricity. The radium collector consists of a metallic spiral, coated with insoluble salts of radium; this is suspended from a special weather-proof insulator attached to an elevated rod, balloon or kite. The radium ionises the atmosphere, thus enabling the aerial to acquire the potential of the elevation. The lower end of the aerial is connected to an electroscope which automatically discharges to earth every few seconds, and can be adapted to give time records, or continuous electric chimes may be operated and various experiments shown working.

An electric battery driven clock will be placed on view by the Reason Manufacturing Co., Ltd. This is a new form of electric clock, provided with a special contact mechanism which ensures the clock keeping accurate time without reference to the strength of the battery. With a pair of ordinary good quality dry cells, this clock will keep going satisfactorily for two years, after which it is only necessary to put in a new pair of dry cells to ensure accurate running for a further period of two years. The specimen exhibited is provided with a glass case with ornamental brass fittings, and the mechanism is plainly visible.

EDUCATIONAL.

DAIMLER ENGINEERING SCHOLARSHIPS.

The Daimler Motor Co. (1904), Ltd., have decided to continue their offer of Works Scholarships for 1910. These consist of one Major and four Minor Scholarships. The Major Daimler Engineering Scholarship carries the following advantages:—(a) Instruction in the theory of motor engineering for two years; (b) A systematic course of practical instruction for this period; (c) A salary of £50 per annum for two years, provided that the holder of this Scholarship shall agree to serve the Daimler Motor Co., if the Company so desire, in any capacity they may select, at a salary of not less than £150 per annum, for two years after the expiration of the Scholarship; (d) Payment of the usual pupil's premium, viz., £100. The four Minor Scholarships carry the same advantages, with the exception that payment during the holding of the Scholarship shall be at the rate of £20 per annum. Full particulars of the conditions for gaining these Scholarships may be obtained on application to Professor W. Morgan, B.Sc., Manager, Pupils Department, Daimler Works, Coventry.

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PATENTS.

Electric Railway System.

22227.—1908. W. ROBINSON, Brooklyn, U.S.A. The invention consists in the system of and means for connecting and controlling the operation of the intermediary circuits which serve to operate the control of the other circuits in a section whereby a more effective and reliable control is given to the system.

Electric Arc Lamps.

22454.—1908. S. C. MOUNT & THE BECK FLAME LAMP, LTD., Hayes. Two or more carbons are so arranged that when the current is switched on the respective pairs of carbons are simultaneously separated, but an arc is maintained only between one pair so that thus the pairs of carbons burn successively. When one pair of carbons is consumed an arc between another pair is struck, and so on until all the pairs of carbon have been burnt out.

Controlling the Voltage of Variable Speed Generators.

22500.—1908. W. STANSFIELD & J. J. HATT, Manchester. This improved variable speed generator comprises an armature and a multipolar field having two sets of poles. One set of poles influences one group of armature conductors and the other set of poles influences the remaining group of armature conductors. Pairs of brushes span the two sets of conductors. The first set of poles is excited by field windings, including a winding connected across the second group of conductors. The second set of poles are excited by two opposed windings so connected to the brushes and having such relative cross sectional area that the resulting joint magnetic effect on these poles causes a variation of the voltage of the second windings. This compensates for the variations of voltage in the first conductors due to variation of speed and current, and so maintains a constant potential across the mains.

Supporting Electric Lamp Brackets.

23053.—1908. J. J. RAWLINGS, South Kensington. A junction box made of metal has a front which either forms part of the box or is attached by screws. A grooved slot is formed in the front at an angle of about 45° to the front of the box. This lost receives a tongue. The portion of the tongue which does not engage the slot is bent in various ways to enable the bracket to be readily hung upon the support and easily removed.

Electrical Distribution by Alternating Current Transformers.

23064.—1908. J. S. PECK, Manchester. Means are provided for indicating whether full voltage exists across the main transformer terminals when the short circuiting switch for the auxiliary transformer is open. For this purpose a fuse may be provided to hold up a lever which would otherwise effect the closure of the short circuiting switch. The fuse will be blown and the short circuiting switch permanently closed if the auxiliary transformer becomes short circuited when the short circuiting switch is open.

Portable Electrically Driven Pumps.

23328.—1908. W. A. STEVENS, Maidstone. The pump, which is directly driven by an electric motor, is mounted on a two-wheel carriage designed to act as a trailer to an electric vehicle. The carriage with its pump is detachable, and can be taken by hand to situations inaccessible to ordinary fire engines. Electrical energy is supplied by means of a flexible cable to the pump from the battery or petrol dynamo of the electric vehicle.

Electric Switches.

27213.—1908. G. SWEETSTER, Upper Norwood. A ring fits in the usual casing of the switch. In this ring is fitted a thin metal strip buckled out on one side so that it can be snapped back and forth across its central position. The buckled strip being in connection with one supply wire closes the circuit by coming into contact with a spring connected to the other supply wire. As the buckle can be snapped over from one extreme position to the other a quick make and break is produced.

Portable Electric Lamp Fittings.

3836.—1909. L. A. WILLIAMSON, Pittsfield, U.S.A. This is an improvement in portable electric lamps that have a drum on which the electric lamp is rotatably mounted in a casing so that it can be drawn out and connected to the ordinary stationary electric lamp socket by means of a plug. The improved lamp can also be carried to any part of a room and suspended in position. It is so small and light in weight that it can be carried in a travelling bag, or in the pocket of a garment.

Electric Contact Key.

4270.—1909. M. C. CONNER, Hale. The contact springs are rigidly mounted at one end and cross each other so that when their free ends are separated by the operation of a plunger the parts of the springs near the crossing are brought into contact.

Electric Block Signal Systems.

6289.—1909. H. W. PRICE, Toronto. The rails of the track are divided into blocks. Each block has a supplemental insulation at the piont near the insulations of the track that are opposite each other, but on one rail only. The electric signalling devices are arranged for both single tracks where the travel is in both directions, and double tracks where the travel is in one direction on one track and the opposite direction on the adjacent track.

Electric Car Indicator.

6818.—1909. H. E. FISHER, San Francisco. The indicator plates are suspended between discs and are automatically revolved by a tripping device attached to the trolley pole. This tripping device is actuated by coming into contact with a trip member at certain points on the overhead wire.

Incandescent Filament Lamp.

7092.—1909. W. HEINRICH, Charlottenburg. The binding paste used in the manufacture of the filaments consists of a mixture of 50 parts dry pulverised sulphur and 60 parts dry amorphous phosphorous carefully heated until chemical reaction sets in. Three parts of this mixture are mixed with 15 parts metallic powder. The binding medium is set free when the filaments made thereform are heated in a vacuum.

Electric Glow Lamps.

7913.—1909. F. FARBER, Dortmund. The glass bulb of the lamp is seated on a spiral spring, which presses the bulb against a stop. When the glass breaks the spring moves the lamp upward and brings it out of engagement with one of the contacts whereby the lamp becomes extinct.

Train Control on Electric Systems.

9625.—1909. W. ROBINSON, Brooklyn, U.S.A. An adjustable chain control mechanism is located in relation to the railway track and arranged for actuation by electrically controlled fluid pressure under control of moving trains. A train operates to actuate the controlling circuit and causes the train mechanism to come into neutral or operative position. A following train or second train has mechanism whereby its electric current ceases working should it enter the same block as the preceding train.

Arc Lamp with Conducting Supporting Members.

11578.—1909. B. DUSCHNITZ, Berlin. The current is taken from the electrode or auxiliary member at the point of support. The current passes round the arc and again rejoins the main conductor behind the arc so that a current in shunt to the arc passes through the point of support and the supporting member, the strength of which and the corresponding feed effect increases or diminishes in exact proportion to the arc voltage.

Arc Lamps.

11579.—1909. B. DUSCHNITZ, Berlin. The feed of the electrodes, which is effected by means of the action of the current at the point of support, is assisted by means of auxiliary current carrying members, which are separated from the electrodes proper.

14239.—1909. SIEMENS & HALSKE, A. G., Berlin. To prevent double connections the relay energised by the testing current in an engaged line interrupts the connecting plug cords so as to make the calling of an engaged subscriber impossible.

Telephone Exchange.

18546.—1909. SIEMENS & HALSKE, A. G., Berlin. Intermediate distributors are interposed between selectors and selector call signals so as to allow an equal loading of the various panels at the exchange while the subscribers' lines provided with call lamps can be led direct from the main distributor to the call lamp.

Lamps Arranged in Series.

4694.—1909. C. STEARN, Westminster. This is an improvement in electric lighting systems in which lamps arranged in series and provided with means, so that when a lamp or filament fails the circuit is completed by a by-pass past the lamp or filament and through a resistance, so that the other lamps of the series remain in action. The completion of the by-pass is effected by what is normally an insulator having its insulating effect destroyed by the rise of potential which takes place on the failure. It has been found that such devices have not been certain in their action, especially in circuits of low voltage, and it is the object of this invention to provide means whereby the potential on a lamp or filament failing is increased to such an extent that destruction of the insulating effect of the material is rendered certain, so that the by-pass circuit is completed without risk of failure. In Fig. 1 the conductors which conduct the current to and from the group of lamps are marked 1 and 2. The lamps in series are presumed each to contain a metallic filament 3 and a coarse carbon resistance filament 4 to by-pass the current when the metallic filament fails,

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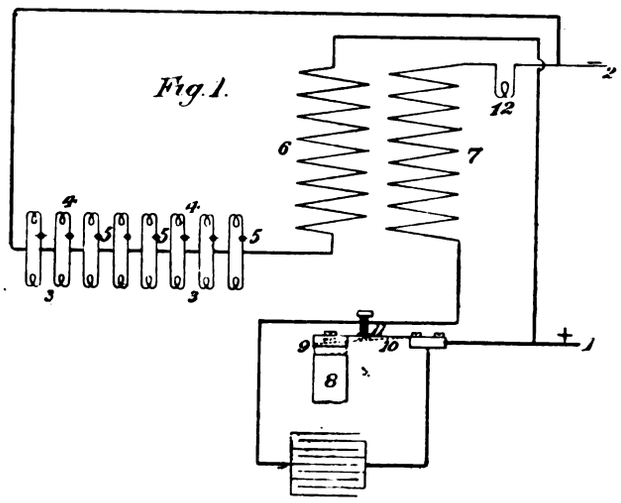
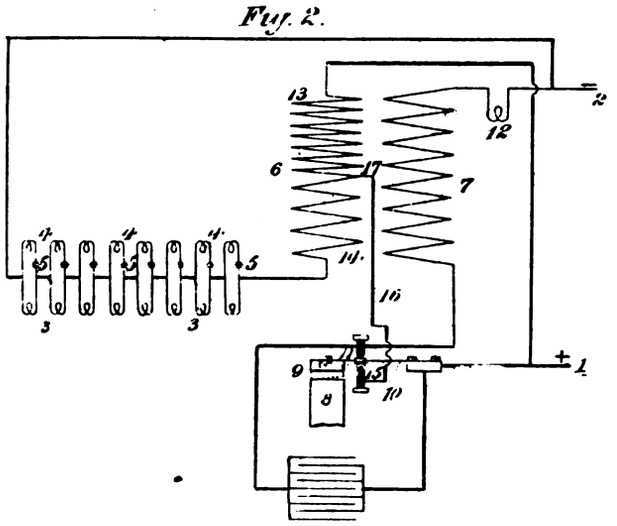
by destroying the insulating effect of what is normally an insulator. These normal insulating devices are indicated at 5. The current normally passes through the secondary 6 of an induction coil, the primary of which is marked 7.

Fig. 1.



The core of this induction coil arrangement is indicated at 8. It normally attracts the armature 9 on the spring 10 so as to break the contact at 11, as shown in dotted lines. When a lamp or filament fails, the core 8 momentarily loses its magnetism, so that the armature 9 under the action of the spring 10 leaves the core 8, and contact is made at 11, as shown in full lines, and the circuit is completed through the primary 7, and resistance 12 and the requisite high potential is produced to ensure the destruction of the

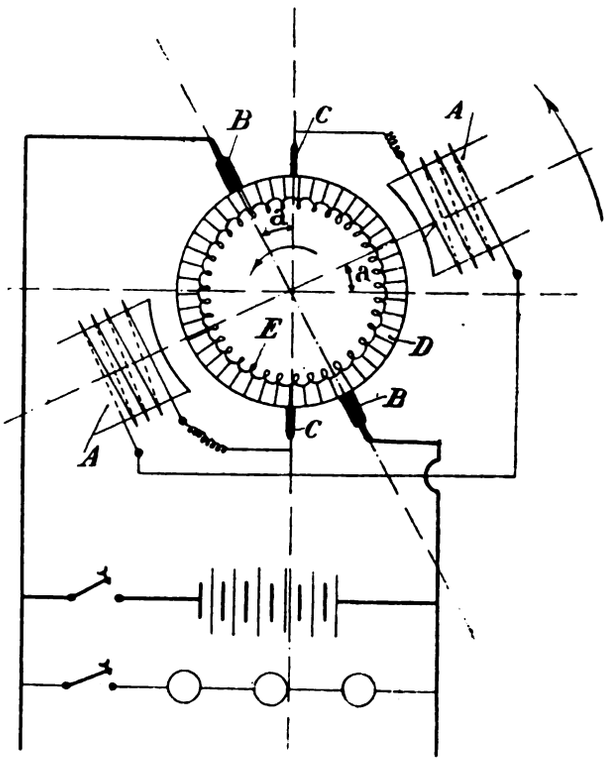
Fig. 2.



insulating effect of the insulating device 5 of the lamp which has failed. The normal potential being restored, the armature 9 is attracted by the core 8, and the circuit is again completed through the secondary 6. Fig. 2 shows an arrangement for giving a very high potential for destroying the insulating effect of the normal insulator in a lamp which has failed. The parts which correspond with those indicated in Fig. 1 are marked with similar reference numerals. The secondary 6 of the induction coil is made in two portions, the portion 13 being of high potential, and the portion 14 being of low potential. The connections are made so that both portions come into operation when a lamp fails, and the arrangement acts as an induction coil, but normally the contact 11 bears on the contact piece 15 of a conductor 16 connected to the secondary at 17, so that the current then only passes through the portion 14 of low potential.

Electric Generators giving Constant Pressure under Varying Speeds.

4837.—1909. G. Deran, Paris. This is an improvement in electric generators giving constant maximum pressure under varying speeds of the armature or rotor, and is designed more especially for use in lighting automobiles, railway trains, and generally in all cases where constant pressure is required under varying speeds. In the diagram the field magnets A of a bi-polar dynamo are excited through the intervention of two stationary brushes C receiving the current from the commutator D of the machine. The two movable brushes B are connected with the main circuit, and may be placed on the same commutator as the brushes C, or on a second commutator of the same armature or rotor E, the poles A being movable and, in some instances, directly connected with the brushes B. When the maximum pressure is exceeded the electro-magnet reaction displaces the magnetic poles in the direction of the rotation of the armature, and so dislodges the neutral line from the stationary brushes C. Thus the excitation furnished through the brushes C decreases until the pressure of the current in the brushes B becomes normal. In order to ensure the balance for any degree of excitation under each different speed, it is necessary to cause the resisting couple steadying the pole pieces to decrease according to the same law as the value of the exciting flux,



which latter is proportional to the difference of potential between the brushes C providing the magnetic circuit of the dynamo has not attained saturation. The difference of potential decreases sensibly according to a sinusoidal curve in proportion as the poles are displaced through an angle increasing from 0 to 90°. Therefore the mechanical equilibrium of the pole pieces will be ensured with any coupled with sinusoidal decrease. This resisting couple may be constituted by the body weight of the pole pieces; or by a weight fixed to them, or by a spring forming a decreasing couple; that is to say, by a tension spring tending to prevent the poles A from turning in the direction of rotation of the rotor E. Again, the electro-magnetic reactions need not directly affect the pole pieces, but may act on soft iron shutters interposed between the poles and the armature. These soft iron shutters are adapted more or less to cover the pole faces of stationary poles in order to obtain the same effect as when rotating the pole pieces A, whilst the brushes B which supply the current to the external circuit are carried by or secured to the shutters. The value of the acting couples is identical, and the equilibrium is realised equally well through the intervention of a weight as by a spring. It is to be understood that when the pole pieces are movable the main brushes B are fixed to them, whereas when shutters are employed the brushes B are movable with the shutters.

Electric Heaters for Liquids.

15786.—1909. A. Ponzini, Venice. The apparatus comprises a coil and a hollow cylinder of solid magnetic material, of considerable length relatively to the diameter, and distinguished by its outer walls being provided with grooves in a plane at right angles to the axis of the coil, at short distances from each other, forming on the cylinder a series of rings around the central part. An alternating current is passed through the coil, which induces in the cylinder currents having a very low tension. These currents by their skin effect tend to become intensified in the parts farthest from the axis of the cylinder, and, therefore, in the rings which act as short circuited turns of the secondary coil of a converter, and are heated by reason of their electric resistance. The heat thus generated is transmitted through the inner wall of the hollow cylinder to the fluid passing through the interior of the cylinder, which is thereby heated. From this operation some of the main features of the electric heater are derived. First, it can heat continuously and uninterruptedly an unlimited quantity of fluid; and, secondly, it is adapted to obtain a liquid or gas jet of a predetermined temperature by simply regulating

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the quantity of fluid passing through the inner canal of the cylinder in a unit of time. The resistances which the inner canal opposes to the circulation of the fluid being very small, the circulation in most appliances is brought about automatically by variation of temperature and, consequently, of the density of the fluid on its passage through the interior of the cylinder. A further feature of the heater

Fig. 1

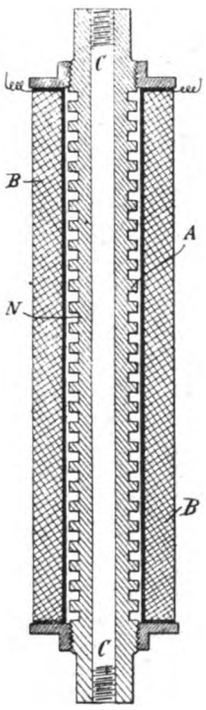
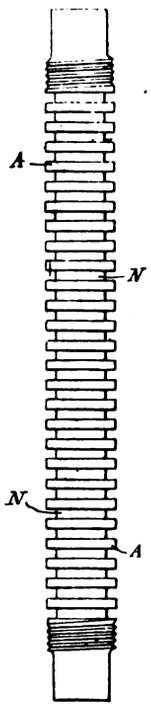


Fig. 2



consists in its heating effect being adjusted in a very simple way by varying the induction, and, therefore, the intensity of the induced currents, which is obtained by varying the number of turns traversed by current. In Fig. 1 is shown, by way of example, a sectional view of a form of an improved electric heater adapted for use with monophase current. Fig. 2 shows the structure of the hollow cylinder. B is the coil traversed by the alternating current, N the cylinder of magnetic material provided with a series of rings A. C is the bore along the axis of the cylinder through which the fluid to be heated flows. The device for varying

Fig. 3

Fig. 4

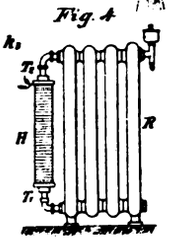


Fig. 5

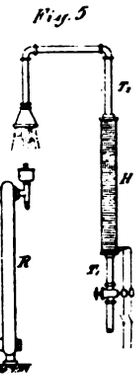
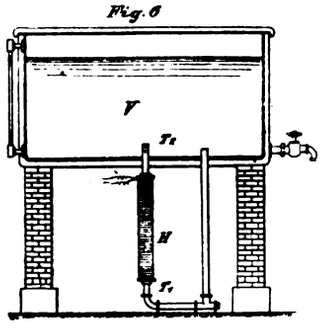


Fig. 6



the heating effect of the heater is shown in Fig. 3, where k, k^2, k^3 are different connections of the coils of a monophase heater. According to switch O closing the circuit at k, k^2, or k^3, the number of turns traversed by current is varied thereby varying the magnetic induction and heating effect of apparatus. Fig. 4 shows a heater used in combination with a hot water radiator. The water contained in the canal of apparatus H is heated and rises along tube T^2, thus sucking the water from down upwards through tube T^1, producing a continuous and automatic circulation of water, which on its passage up through the apparatus is heated, and cools when traversing down the radiator R. When the power of the heater is proportioned to the radia-

Fig. 7

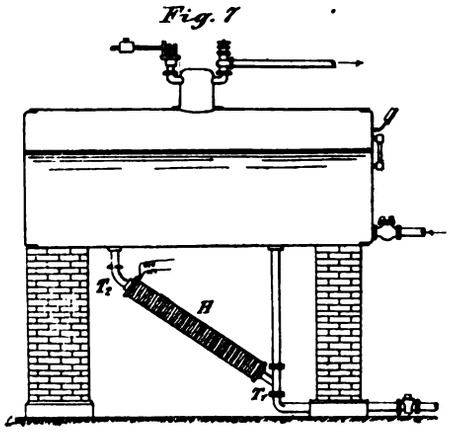
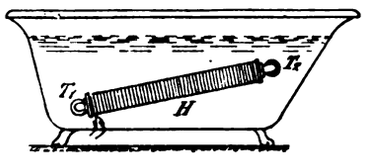
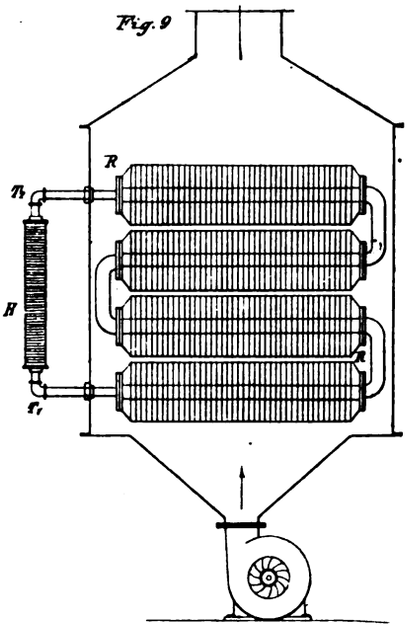


Fig. 8



ting surface of the radiator, so that the water does not reach the boiling point, an equilibrium is established between the quantity of heat generated by the generator and the quantity of heat given up by the radiator to the surrounding atmosphere, the whole of the combined heater and radiator forming a very practical electric stove. Fig. 5 shows a heater used for obtaining a continuous jet of water at a predetermined temperature. The regulation is obtained by varying the quantity of liquid traversing the radiator in a unit of time, or by varying the heating effect of the heater in the manner already described. In Fig. 6 an appliance is

Fig. 9



shown where a heater is used for heating a liquid contained in a tank V of any material. In this appliance, as in those already described, circulation of liquid is effected automatically by the difference of temperature, and, consequently, density of liquid at the admission and outlet of heater. A very important application of the heater is for generating steam. If the container of the liquid is a boiler capable of resisting the desired pressure when the liquid has arrived at boiling temperature, it continues to absorb heat and is converted into steam. The appliance is illustrated in Fig. 7. Fig. 8 shows a heater used for heating a bath tub. The new heater is also adapted for directly heating air passing through the inner canal of the solid cylinder. In this case, instead of one canal, a plurality of canals of smaller diameter may be provided in order to present a larger surface of contact to the gases. Indirect heating may be obtained by blowing air on to the ribs of a set of hot water radiators R, as in Fig. 9, in which the water acts as a conveyer of the heat from the heater to the radiators.

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COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last prices. £
British Insulated and Helsby Cables, Ord. 1-100,000	5	7-7¼
—— 6 p.c. Cum. Pref., 1-100,000	5	6¼-6¼
—— 4½ p.c. Mortgage Debentures	100	103-106
British Thomson-Houston Co., 4½ p.c. 1st Mort. Deb. Stock, Red.	100	89-94
British Westinghouse Elec. and Manuf. 10 p.c. Pref. 1-200,000 and 275,001-475,000	3	⅛ ⅛
—— 4 p.c. Mortgage Debenture Stock	100	48-52
Callender's Cable, Debentures	100	105-107
—— Ordinary	5	10-10⅛
—— 5 p.c. Pref.	5	5¼-5⅛
Consolidated Electrical Co., Ordinary, 1-110,000	1	⅛-¼
Dick, Kerr, and Co., Ordinary, 1,260,000	1	1-1⅛
—— 6 p.c. Cum. Pref., 1-305,000	1	1-1⅛
—— 4½ p.c. Debenture Stock.	100	100-103
Edison and Swan United, "A" Shares, 1-99,261	3	[illegible]
—— "A" Shares, 01-017,139	5	1-1⅛
—— 4 p.c. Deb. Stock, Red.	100	66-71
—— 5 p.c. 2nd Debentures	100	81-84
Electric Construction, Nos. 1 to 112,100	2	[illegible]
—— 7 p.c. Cumulative Pref.	2	1⅛-1⅛
—— 4 p.c. Perm. 1st Mort. Deb.	100	62-67
Ferranti, Limited, 5 p.c. 1st Mort. Deb. Stock, Red.	100	68½-74⅛
General Electric Company (1900) 5 p.c. Cum. Pref.	10	8-8⅛
—— 4 p.c. 1st Mort. Deb. Stock	100	83-87
W. T. Henley's Telegraph Works, Ordinary	5	12-12⅛
—— 4½ p.c. Preference	5	5¼-5¼
—— 4½ p.c. Debentures	100	104-106 xd
National Electric Construction Co., 1-170,000	1	⅛-⅛
Telegraph Construction and Maintenance	12	34-35⅛
—— 4 p.c. Bonds	100	101-103

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Bournemouth and Poole, Ordinary	10	9½-10
Brompton and Kensington, Ordinary	5	7¼-7¼
—— 7 p.c. Preference	5	7¼-7¼
Canadian General Electric Co., Common Shares	$100	112-117
—— 7 p.c. Cum. Pref. Stock	$100	115-118
Central Electric Supply, 4 p.c. Guar. Deb. Stock	100	97-100 xd
Charing Cross, West End, & City Electric Supply, Ord., 1-80,000	5	3⅛-4⅛
—— 4½ p.c. Cum.. Pref., 1-80,000	5	4⅛-4⅜
—— 4 p.c. Debenture Stock, Red.	100	98-101
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-80,000.	5	3⅛-4⅛
City of London, Ordinary	10	9⅞ 10⅛
—— 6 p.c. Cumulative Pref.	10	11⅛-12⅛
—— 5 p.c. Debenture Stock	100	121-124
—— 4½ p.c. 2nd Deb. Stk. Red.	100	100-103
County of Durham Electrical Power Distribution Co., Ordinary, 1-50,000	5	1⅛-2
—— 5 p.c. Preference, 1-50,000	5	2⅞-3⅛
County of London Elec. Supply, Ordinary	10	7⅛-8
—— 6 p.c. Cum. Pref.	10	10⅛-11⅛
—— 4½ p.c. Debentures Prov. Certs. All pd., Rd.	100	105-108
—— 4½ p.c. 2nd Debentures, Red	100	98-101
Edmundson's Electricity Corporation, Ord., 1-80,000	5	⅛-5/16
—— 6 p.c. Cum. Pref.	5	⅛-⅜
—— 4½ p.c. First Mort. Deb.	100	57-60
Electric Supply Co. of Victoria, 5 p.c. 1st Mt. Deb. Stock, Red.	100	91-94
Kalgoorlie Electric Power and Lighting, 6 p.c. Non. Cum. Pref., 1-150,000	1	[illegible]
Kensington and Knightsbridge Elec Lt., Ord., 1-21,000.	5	7-7⅛
Kensington and Knightsbridge and Notting Hill, 4 p.c. Debenture Stock, Red	100	95-98
London Electric Ordinary	3	1⅛-2
—— 6 p.c. Pref.	5	4⅛-5⅛
—— 4 p.c. 1st Mortgage Debenture Stock, Red.	100	92-95
Madras Electric Supply Corporation 5 p.c. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	50 55
Metropolitan Ordinary, 100,001-300,000	5	3⅜ 4⅛
—— 4½ p.c. First Mortgage Debenture Stock	100	106-109
—— 4½ p.c. Cum. Pref.	5	4⅛-5
—— 3½ p.c. Mortgage Debenture, Red.	100	83½-86⅛
Mexican Electric Light Co., 5 p.c. 1st Mort. Gold Bds. 1-935, C 1-1,000 ($100) D 1-3,050 ($500) M 1-4,400 ($1,000)	—	81-83%
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb. Red	—	98-100
Newcastle-upon-Tyne Electric Supply, Ord., 1-50,000 and 57,010 to 137,500	5	4 4⅛
—— do. 50,001 to 57,009	5	4-4⅛
—— do., 5 p.c. Pref., 1-137,500 Non. Cum.	5	4⅛-5⅛
Notting Hill Electric Lighting	10	12⅛-13⅛
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	6-6⅛
—— 4 p.c. Debenture Stock	100	95-98
River Plate Elec. Co., Ord., 1-119,687 & 120,501-120,507	1	1⅛-1⅛
—— 6 p.c. Non-Cum. Pref., 1-100,000	1	1⅜-1⅝
—— 5 p.c. Debenture Stock, Red.	100	103-106
Rosario Electric Co., 6 p.c. Cum. Pref., 1-20,000	5	5⅜-5⅝
—— 6 p.c. Cum. 2nd Pref., 1-15,000	5	6⅛-6⅞
Royal Electrical Company of Montreal, 4½ p.c. First Shares Mortgage Debentures	100	102-104
Shawinigan Water & Pwr. Co., 5 p.c. Cons. 1st Mt. Bds.	—	106¼-108 %
Smithfield Markets Electric Supply, Ord., 1-12,000	5	⅞-1⅛
South London, Ordinary	4	2⅛-3
South Metropolitan Electric Light and Power Ord.	1	5/16-9/16
—— 7 p.c. Cum. Pref.	1	1 1/16-1 3/16
—— 4½ p.c. 1st Mort. Deb.	100	100-103
St. James's and Pall Mall, Ordinary, 101-20,080 and 40,081 to 60,100	5	8⅛-9
—— 7 p.c. Pref. Non. Cum.	5	7-7⅛
—— 3½ p.c. Deb.	100	84-88
Urban Electric Supply Co., Ordinary	5	⅜-⅞
—— 5 p.c. Cumulative Preference, 50,001-100,000	5	1⅛-1⅜
—— 4½ p.c. First Mort. Debenture Stock, Red.	100	74½-78½
Westminster, Ordinary	5	8⅛-8⅝
—— 4½ p.c. Cum. Pref., 110,101-191,379	5	4⅝-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine 5 p.c. Cum. 1st Pref., 1-640,000	5	4⅜-4⅛
—— Debenture Stock, Red	100	90½-92
Bath Elec. Trams., Ld., Pref. Ord. Shares, 75,001-150,606	1	⅛-⅛
—— 5 p.c. Cum. Pref. Shares, 1-75,000	1	⅛-⅛
Bir'ham & Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	87-90
British Columbia Electric Railway Co., Ord. Def.	100	141-145
—— Ord. Pref.	100	120-124
—— 5 p.c. Cum. Perpetual Pref. Stock	100	107-110
—— 4½ p.c. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	102-104
—— 4½ p.c. Vancouver Power Deb.	100	102-105
British Electric Traction, Ord., 1-30,000 & 60,001-90,000	10	⅛-1
—— 6 p.c. Cm. Pf., 30,001-60,000	10	2⅛-3
—— 5 p.c. Perpetual Debenture Stock	100	84-87
—— 4½ p.c. 2nd Deb. Stock	100	60-65
Buenos Ayres Lacroze Trams. Co., Stg., 5 p.c. 1st Mort. Deb. Stock, Red.	100	97½-99½
Calcutta Tramways, Ord., No. 1 137,610	5	4⅛-5
—— 5 p.c. Cum. Pref., Nos. 1-30,000	5	4⅝-5
—— 4½ p.c. 1st Deb. Stock, Red.	100	101-104
Cape Electric Tramways, Nos. 1-491,222	1	3/16-7/16
City of Birmingham Tramways, 5 p.c. Cum. Pref.	5	4⅛-5⅛
—— 4 p.c. 1st Mortgage Deb., 1-3,000 (1917)	100	96-100
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5⅛-5⅜ xd
—— 4 p.c. Deb. Stock, Red. (1985)	100	98-101
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12⅛-13⅛
London United Trys. (1901) 5 p.c. Cum. Pref.	10	2⅛-2⅛
—— 4 p.c. 1st Mt. Db. Stock, Red.	100	67-70
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	1/32-3/32
—— 5 p.c. Cum. Pref., 500,001-1,000,000	1	[illegible]
—— 4½ p.c. Deb. Stock, Red.	100	93-96
Perth Elec. Tramways (W.A.), 5 p.c. 1 Mort. Deb. Stk.	100	100½-103⅛
Provincial Tramways Co., Ordinary, 1-24,912	10	4-4⅛
—— 6 p.c. Cum. Pref., 1-10,000	10	10-11
San Paulo Tramway, Light, and Power Co.	$100	153-156
—— 5 p.c. 1st Mort. Deb., Red. (1929) 1-12,000	$500	102 104
South Metropolitan Electric Tramways and Lighting Co. 6 p.c. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅛-⅛
—— 4 p.c. Deb. Stock, Red. (1940)	100	69-73
Yorkshire (W. R.) Elec. Tram. Co., Ord., 70,001-110,000	5	⅛-⅛
—— 6 p.c. Cum. Pref., 1-46,261	5	1⅛-2⅛
—— 4½ p.c. 1st Deb. Stock, Red.	100	81-85

Electric Railways.—

Name.	Amount paid. £	Last price. £
Central London, Ordinary	100	61-63
—— 4 p.c. Pref.	100	84-86
—— " " deferred	100	44-46
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	101-103
City and South London, Consolidated Ordinary	100	301-31⅛
—— 4 p.c. Debenture Stock	100	100-102
—— 5 p.c. Pref. Stock '91	100	108-110
—— " " " '96	100	104-107
—— " " " '01	100	100-103
—— " " " '03	100	96-100
Underground Electric Railways of London, 5 p.c. Prior Ln. Bds.	—	100-101

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10	3⅛-3⅜
—— 5 p.c. Debs., Red., within 1-1,609 Red	100	100-103
American Telephone and Telegraph Collat. Trust 4 p.c. Bonds, 1-28,000 and 53,001-78,000	$1,000	96-98
Anglo-American Telegraph Co., Ordinary	100	60-62
—— 6 p.c. Preferred Ordinary	100	100-101
—— Deferred Ordinary	100	21⅛-22⅛
Commercial Cable Co., Ster. 500 yr. 4 p.c. Db. Stk., Red.	100	86½-88⅛
Direct Spanish Telegraph Co., Ordinary	5	3-3⅛
—— 10 p.c. Cum. Preference	5	8-8⅛
—— 4½ p.c. Debs., 1-600	50	100½-102½
Direct United States Cable Co.	20	13-13⅛
Direct West India Cable Co., 4½ p.c. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 p.c. Mort. Debs., within 1-8,000 (1913)	25	99-101
—— 4 p.c. Reg. Mort. Debs. (Mauritius Subsidy) 1-8,000 (1913)	—	—
Eastern Extension, Australasia and China, 1-300,000	10	11⅛-12⅛
—— 4 p.c. Mort. Deb. Stock, Perm.	100	102-104
Eastern Telegraph Co., Ordinary Stock	100	129-132
—— 3½ p.c. Preference Stock	100	84½-86⅛
—— 4 p.c. Mortgage Debenture Stock	100	102-104
Great Northern Telegraph Co. (of Copenhagen)	10	29⅛-30⅛
Marconi's Wireless Telegraph Co., Nos. 1-394,190	1	⅛-⅛
National Telephone, Preferred	100	106½-108
—— Deferred Stock	100	120½-122⅛
—— 6 p.c. Cum. First Pref.	10	10⅛-11
—— 6 p.c. Cum. Second Pref.	10	10⅛-10⅞
—— 5 p.c. Non. Cum. Third Pref.	5	5⅛-5⅛
—— 3½ p.c. Deb. Stock, Red.	100	98-100
—— 4 p.c. Deb. Stock, Red.	100	100-102
Pacific & European Tel., 4 p.c. Guar. Dbs., Red., 1-1,000	100	100-102
West Coast of America, 1-30,000 and 53,001-53,008	2½	1⅛-1⅛
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	100-102
West India and Panama Telegraph Co., Ordinary	10	⅛-⅛
—— 6 p.c. Cum. 1st Preference	10	8⅛-9⅛ xd
—— 6 p.c. Cum. 2nd Preference	10	8-9
—— 5 p.c. Debs., Red., 1-800	100	102-104
Western Telegraph Co., 1-207,930	10	13⅛-13⅞
—— 4 p.c. Debenture Stock, Red.	100	103-105

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THE
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NOTES.

THE NOBEL PRIZE.

In congratulating Mr. Marconi on the award of the Nobel Prize for his work in connection with wireless telegraphy, we are voicing the general feeling of the electrical world. This gifted young Anglo-Italian has done splendid work, which shines all the brighter when we consider the labours of others before him, and the great activity brought about by his early successes. We may feel that in honouring one of its outstanding disciples, the Nobel Trustees have also honoured the science of electricity, which is doing so much for civilisation. In another column will be found the first portion of Mr. Marconi's own detailed account of that branch of science which he has made peculiarly his own.

LOSSES IN RADIOTELEGRAPHY.

Marvellous as have been the strides made in wireless telegraphy, a great deal yet remains to be done, as is evidenced by Professor J. A. Fleming's remarkable paper on quantitative measurements in connection with radiotelegraphy, which he read before the Institution of Electrical Engineers. The Professor remarked that it must always be borne in mind that in radiotelegraphic stations the standby costs are so vastly greater than the cost of power actually used in signalling that even a large improvement in the efficiency of transmission would not greatly reduce the total costs. Nevertheless, he shows that there is really room for improvement in this direction. It is rather startling even to the trained electrician who has not made "wireless" practice a special study to realise what the actual losses are. In his efficiency chart for N.C.L. radiotelegraphic plant with 5 mm. spark gap he shows the rotary input at 2,620 watts. The rotary losses amount to 1,139 watts, while the rotary output is 1,481 watts. At the next step we find transmission losses put down at 71 watts and choking coil losses at 610 watts, leaving a transformer input of 800 watts. Of these 800 watts 302 are accounted for by transformer resistance losses, and 53 by transformer iron losses, leaving 445 watts delivered to condenser. There is then a loss of 351 watts in primary oscillation circuit, leaving only 94 watts for delivery to antenna, and antenna resistance accounts for another 16 watts, so that ultimately of the 2,620 watts only 78 are used in final radiation work. Under these circumstances it is well that "the attention of designers and users of radiotelegraphic apparatus is being closely drawn to the energy losses in various parts of it." In striving to minimise these losses it is very probable that genuine advance in efficiency will incidentally be made.

FAULTS OF FLICKER PHOTOMETER.

Speaking before the Newcastle Section of the Institution of Electrical Engineers, Mr. H. Morris-Airey, said that in recent years photometers of the flicker type have obtained a certain degree of prominence, it being claimed that they enable the illuminating powers of sources of light of distinctly different colour to be compared with one another with an accuracy unattainable by means of photometers of the steady illumination type. But he had not been prepared to endorse this view, and from time to time it had been borne in upon him that the principle relied upon involved physiological phenomena likely to disturb true representation of illumination. So he carried out a long series of experiments, which assuredly justified his doubts. His experiments showed that the predominance of tints was due largely to the length of stimulus and its frequency. He came to the conclusion that the conditions under which the retina is excited during a measurement with the flicker type of photometer are not the practical conditions of illumination to which it is our object to apply the data we obtain from the experiment, therefore the whole position requires reconsideration. It is just one of those points which the new Illuminating Engineering Society might well take up.

WELSBACH LITIGATION.

The satisfactory ending of the case brought by the Wolfram (Tungsten) Metal Filament Lamps (Ltd.) and the General Electric Co. against the Welsbach Incandescent Gas Light Co. under the Merchandise Marks Act, will certainly be welcomed by all electrical contractors and dealers in electrical fittings. The defendant company will not withdraw its lamps from the market, but merely remodel its advertisements to prevent any possible confusion, and so all parties are satisfied. It is a most interesting case, as illustrating the complications and pitfalls of the Merchandise Marks Act.

THE SPANISH MARKET.

Manufacturers of electrical appliances have done, and are still doing well, with the Spanish speaking people across the Atlantic, but Spain itself is somewhat neglected. Yet considerable interest is taken in matters electrical in the Peninsula. According to a recent return of the Minister of Public Works, there were 861 electrical undertakings in Spain, of which 210 were of an industrial nature. Since that return was issued there has been considerable extension. Most of the heavy machinery is imported. The import duties are somewhat heavy, but the *Bulletin Commercial*, of Brussels, suggests that only pieces involving precise work should be sent in, the armatures and other heavy pieces being manufactured locally. Then all that would be necessary would be to establish an agency on such a footing that the erection, winding, and adjustment could also be undertaken locally.

ELECTRICITY TO THE RESCUE.

The town of Morley is going ahead, and so are its rates—to such an extent that the good Mayor suggested some time ago that the profitable undertakings—the water, gas and electricity—should sell their commodities on a higher scale, and so by increasing revenue keep down the rates. A proposal to raise the price of gas from 2s. 9d. to 3s. per 1,000 cubic ft. was defeated, and a like effort to increase the water rate to manufacturers met with no better fate. When, however, it was recommended that the price of electricity should be raised from 5d. to 6d. per unit for lighting purposes, the proposal was adopted. It is pleasant to find a manufacturing town such as Morley obtaining relief for ratepayers from its electrical undertaking, but we rather doubt the wisdom of the step taken. A different form of re-adjusting the tariff, on the "telephone" or rent-charge system, would be likely to give far better results as regards monetary returns, without frightening the consumers.

ELECTRIFICATION OF IRONWORKS.

Speaking at the 20th annual meeting of Dorman, Long & Co., Mr. A. J. Dorman gave some interesting particulars about the steel furnace extension and electrical mill. Although the mill has been in use only for a short time it is giving most satisfactory results, and is being largely employed in turning out steel bars for ferro-concrete work.

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HIGH TENSION INSULATORS.

In the course of the discussion on Messrs. Marchant & Watson's paper on "Long Distance Transmission on Overhead Lines," some useful hints were given as regards insulators. Professor Schwatz advocated long spans in order to minimise the number of insulators used. He said that they should be designed to work in compression. As regards the point where to use pin or suspension type insulators, the limit came when the stress between the line wire and the pin head became high. It was necessary to have a thick piece of porcelain between the line and pin.

LIGHTING CHURCHES.

The "dim religious light" long associated with cathedrals and large churches is rapidly giving way to electricity, the modern illuminant. Our German contemporary the *A. E. G. Zeitung* devotes almost an entire number to a beautifully illustrated article showing brilliantly lighted interiors of many sacred edifices in the Fatherland. After all, the religious light was dim because candles and lamps were powerless to illuminate the vast and lofty aisles, and it has the fault of blotting out many beauties and decorations and architectural art. Something also may be said about sparing the necks and labour of the unhappy individuals who used to be compelled to light up chandeliers placed at giddy elevations, but this is obviously a side issue only. It appears too, that the old chandeliers form ideal points of suspension for electric lights, being exactly in the right places, and saving much expense in the way of hanging wires. The arc lamp seems to afford the cheapest and best illumination, whether of cathedrals or less dignified ecclesiastical erections. The architects of the older churches and cathedrals made the mistake of planning edifices not well adapted for illumination by a few search lights. Hence the necessity of using many lower power lamps in addition to a few of greater potency. The Berlin Cathedral has incandescent lamps as well as arc lights. The Nernst lamp is also finding theological acceptance. The Catholic church of Oppenheim is lit solely with Nernst lamps. At the Hildesheim Cathedral some of the oldest chandeliers in the world serve now as supports for incandescent lamps. These chandeliers were designed 900 years ago by Bishop Bernward and made by Bishop Hezilo in 1045. Synagogues, too, are rapidly modernising their illumination, but most of the authorities still cling to the fleshpots of Egypt in the shape of candles. In some cases a compromise has been effected and both lights are used simultaneously. The electric light is used, besides, to produce scenic effects independently of mere illumination, to make halos, and to show up the details of the altar and the reredos. Such small matters as the use of electric motors for organ blowing, ventilation, and bell striking, are already commonplaces. A gramophone in the pulpit, wound up by a small motor automatically, may be the next novelty.

DUTCH EAST INDIES MARKET.

According to the *Chamber of Commerce Journal*, the Dutch East Indies are fast becoming an excellent market for electrical goods of every description. Two means of finding a market for electrical goods in the Netherlands Indies are suggested by the *Bulletin Commercial* of Brussels. The first is the formation of a syndicate of producers for the establishment of an agency at Batavia, with branches at Samarang and Soerabaya, which would seek not only to sell electrical machinery and apparatus but to interest itself in the formation of new undertakings, and even to initiate them. The second is to make offers to the parent firms or to the purchasing agents in Europe of companies in Java, etc., notably, Messrs. van der Linden and Teves (dynamos) and the Netherlands Indies Gas Co. (lighting accessories). It may be added that, in order to succeed, the apparatus offered should be of irreproachable quality and should compare favourably as regards prices with that of Germany. A list of the principal importers and users of electrical machinery and appliances in the Netherlands East Indies, including electric lighting, telephone, tramway, etc., companies may be consulted in the Statistical and Information Department, London Chamber of Commerce.

INSTITUTION OF ELECTRICAL ENGINEERS.

THE ANNUAL DINNER.

A brilliant and successful function was the annual dinner of the Institution of Electrical Engineers. It took place at the Hotel Cecil, London, on the 8th inst., Dr. Gisbert Kapp (President) presiding over a company numbering nearly 300. Lord Strathcona, G.C.M.G. (High Commissioner of Canada), Professor W. Grylls Adams, F.R.S. (Past President), Mr. C. E. Spagnoletti (Past President), Sir R. D. Powell (President, Royal College of Physicians), Mr. A. Siemens (Past President, and Vice-President Institution of Civil Engineers), Sir Wm. White (Chairman, Royal Society of Arts), Sir J. Larmor, D.Sc., F.R.S. (Secretary, Royal Society), Sir John Gavey, C.B. (Past President), Dr. B. A. Whitelegge (Chief Inspector of Factories, Home Office), Mr. R. A. S. Redmayne, M.Sc. (Chief Inspector of Mines), Colonel Sir C. B. Euan-Smith, K.C.B., C.S.I., Professor Silvanus P. Thompson, F.R.S. (Past President), Major-General Sir A. E. Turner, K.C.B., R.A., Sir T. E. Thorpe, K.C.B., D.Sc., F.R.S. (Principal, Government Laboratories), Sir Philip Magnus, Dr. R. T. Glazebrook (Past President), Sir R. Hunter (Solicitor, General Post Office), Sir E. G. Burls, C.S.I., Professor W. C. Unwin, F.R.S., Mr. W. M. Mordey (Past President), Mr. J. A. F. Aspinall (President, Institution of Mechanical Engineers), Mr. J. W. Jacomb-Hood, Mr. J. Ardron, C.B., Mr. R. H. Selbie (General Manager, Metropolitan Railway), Mr. R. Hammond (Hon. Treasurer), Mr. P. F. Rowell (Secretary), and Mr. R. Tree (chief Clerk) were among others participating in the festivities.

Sir William White proposed the toast of the evening: "The Institution of Electrical Engineers." This institution, he remarked, was one of the youngest of the great engineering institutions of this country; it was one of the most remarkable and the most useful. Since its foundation, not quite forty years ago, it had changed its name twice, but in 1899 it blossomed out in its present style, and it now had about 6,100 members. The constant effort of the Council had been to raise the standard of membership, to insist upon higher training and achievement, and that was the true way to make any engineering society or any other society live and flourish. There were certain features in this Society in which it was distinguished from the older societies, and particularly was that the case in regard to their local associations. He could quite understand that under the wise guidance and excellent arrangements the Institution of Electrical Engineers had in connection with their local associations, that there might be made a means of strengthening the Society. Sir William hoped that one remark which the President made in his address would always be kept in view by those who were entrusted with the governance of the Institution. The words which expressed a very fine idea were: "Electrical engineering was essential to all other branches of engineering, and was entwined with them all." As engineering science advanced and as science as a whole advanced, it was absolutely necessary that there should be specialisation. To the electrical engineer and the immediate future there belonged opportunities which were unrivalled.

The President, who met with a rousing reception, began an eloquent response by pointing out that they had always tried to follow in the footsteps of the Civil Engineers. "Their motto for making use of the forces of Nature for the convenience of man," said Dr. Kapp, "is our motto. But we cannot make use of those forces, or in many cases we cannot make direct use of those forces, and we must put our services at the disposal of men in other professions, especially the members of the Civil and Mechanical Engineers. Electrical engineering struck him as a kind of industrial mascot: herself poor, but willing to work for others and bringing prosperity to whoever employed her. The general tendency of our rivals abroad to make science the baserock on which their young industries must be built up found its expression also in the readiness with which American and Continental industries had called electricity to their aid. Electricity with them was no longer that poorly clad mascot she once was. Her masters had need of her, so they paid her well, and she became a great lady in silk and velvet, distributing bounties to her retainers; in common language, paying good dividends to her shareholders! What about this

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mascot in England? Well, he was afraid she was not so well dressed yet, and if they came to ask, "Why should she be here not poor, but in modest circumstances, when she is a 10% dividend lady in Germany?" Well, they had to go back to the causes. The great staple industries of England were so strong long before electricity came on the plane—and they were still very strong—that they thought they could do without new fangled helps. There were exceptions; these were far-sighted men in the leaders of the big industries who had already recognised the advantages of electricity, and others would surely follow. In this connection they, as an Institution, must welcome the establishment of engineering Chairs in the two great Universities of Cambridge and Oxford. Some of his colleagues who were technical professors at the younger universities shook their heads, and said: "What does Oxford want with engineering? Let them stick to Latin, Greek, history, and theology, but don't let them invade our special branch." Well, he did not think that was the right view to take. They did not expect either of those Universities to turn out finished engineers. No University could do that. The old Universities by their prestige might give them the leaders, and the technical universities, which were more modern and did equally good work, would give them their lieutenants. Here they had a strong argument, that which made them hope that this process of letting electricity penetrate the various industries and giving them opportunity of helping them and increasing their prosperity would go on at a much quicker rate than in the past. The old school of "let well alone," which grew up in pre-electric days, when managers and owners were satisfied with what they had, because it gave them a good profit, was gradually being superseded by more progressive elements. Engineers should encourage this tendency, but he was afraid there were some, even electrical engineers, who went quite the wrong way about this work. They told each other, which mattered little; and they told the world, which mattered a great deal, that we were behindhand in electrical engineering. Their last President showed by statistics that that was not the case. We were using more electrical energy per head of population than Germany, and we were supplying it at a cheaper rate. "Yes," said the Cassandras, "that may be so, but we are supplying it with foreign machines." Well, if that were really so, there must be a particularly curious kind of machine which had a knack of becoming invisible when a visitor entered the central station. He had been to a good many central stations, and very, very seldom found a foreign machine. He had seen some, but not many. A technical paper a year ago, and again quite recently, published a statement that 80,000 kw. of foreign machinery were at work in English central stations. That sounded a great deal, but after all it was small in comparison with the total plant installed, which was of the order of a million kw. Even on this estimate, which he had no means of verifying, the amount of machines of foreign make was only 8% of total. It was not to the advantage of the industry to say to the whole of the world, "Look how bad we are!" The fact was that progress in electrical engineering, as in all branches of intellectual activity, must always be a race between us and our rivals. Sometimes we led; sometimes they. If they wanted to make a case for either side it was quite easy to do so. Quoting a few instances, he said that direct driving and the rational use of storage batteries in central station work originated here. The first really workable electric railway was put up in Ireland by an English firm. Our competitors gave us the multipolar dynamo and three-phase machinery, both of which we took up after a little hesitation, and were making now in such perfection that a customer got better value for his money with us than with the foreigner. The Continent also showed the way with three-phase railways, a lead which we did not follow; but the lead given us in single-phase railways we followed. In these matters they willingly admitted that our rivals were ahead. But there was a set-off against that in a development which was due to an honorary member of this Institution, and which had completely changed the face of electrical engineering; he referred to the turbo-generator of the Hon. Charles Parsons. That was taken up very quickly by our rivals, but he did not think they had caught us up yet. Judging by results, we were a little ahead in power transmission. He did not compare our power transmission schemes with the gigantic schemes of the Pacific slope. This little island was too densely populated and has too cheap coal for that sort of engineering, but with the more modest work on the Continent of Europe we showed equally well. England had not much water power, and it did not always pay to utilise it, but where it did pay we could do it as well as our rivals. For instance, at the Kinlochleven works of the British Aluminium Co., opened last spring, there were 30,000 h.p. utilised, and every ounce of electrical plant—from that of the generator to the furnaces—were of British make. The basis of power work in this country was, however, thermic: either coal or waste gases. A magnificent example of how electricity may be pressed into the service of another industry was the installation at Bilston, where gas engines working with blast furnace gas were driving dynamos, which supplied current for a variety of purposes throughout the works, including two large rolling mills, which in point of design and workmanship were not surpassed by anything they would find on the Continent. Here also all the plant was British made. A very important advance in the power business had been made by Mr. Merz, of Newcastle and London, in the North-east coast district. The lead given had been quickly taken up by our foreign rivals. Mr. Merz estimated that between a quarter and a third of a million h.p., available night and day, might be obtained from the waste gases of the coke ovens in that district alone. This, in point of magnitude, was better than any Continental water power, and, in point of cost for works, enormously cheaper. Mr. Merz had already harnessed some of this power to the mutual advantage of the coke oven owner and his original power company, while the customer got the advantage of a power supply for industrial purposes at a rate lower than he could get anywhere in the world, countries of the so-called cheap water power not excluded. Sir Oliver Lodge, a British scientist, by his practical scientific research, had enabled the old idea—the stimulation of the growth of plants by electrification—to be taken up in a practical way. About twelve firms were now fitted with this apparatus. By means of electrifying the air over the plants the growth was stimulated, and the average result on the twelve firms was an increase of 30% in production in the crops. That was a very great advance. Perhaps a few years hence they would find that the land got exhausted under this very extensive culture, and should this be the case, electricity would supply the remedy.

Professor Silvanus Thompson, in the regrettable absence of the Right Hon. Lord Justice Fletcher Moulton, P.C., F.R.S., owing to indisposition, submitted "Science and Industries." They all knew, observed the speaker, how electrical engineering was rooted in the scientific basis in the study of electricity and its laws, and the interdependence of electricity upon mechanics and mathematics and chemistry, and they realised how little would be the importance of electrical engineering if it did not ramify into all the various industries and branches of commerce of to-day.

Sir Joseph Larmor, in his response, laid it down that the function of pure science was to lead humanity in sight of the Promised Land, and then the engineer took it up and entered into possession. The practice of electrical engineering was based on refined scientific principles. They had yet a great deal to learn from the analogies supplied so vividly by the very marvellous electrical machinery which had been evolved during the last twenty years.

Mr. J. A. F. Aspinall also briefly acknowledged the sentiment. By science, he said, they were able to point the way and by industries they were able to make the money. There was little doubt our youths were as well trained to-day as any of the young engineers throughout the whole of Europe. Discussing the electrification of railways, he said each single case had to be carefully considered. There were many cases where it would be impossible to electrify a line with any possible chance of commercial success; but, on the other hand, there were quite a number which were a very great boon.

The concluding toast, "Our Guests," was honoured on the invitation of Sir John Gavey, and acknowledged by Colonel Sir Charles B. Euan-Smith, in a witty and humorous speech.

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METALLIC FILAMENT LAMPS.*

By G. WILKINSON, M.I.E.E., and R. McCOURT, A.M.I.E.E.

In this paper it is intended to give some idea of what has been done in Harrogate to counteract the effect which the introduction of metallic filament lamps has produced in a system where the bulk of the demand on the station is for lighting purposes, and where the supply is alternating current, conditions which admittedly favoured the largest possible use of the new lamps in the shortest possible time.

In the first place, the question as to whether the price per unit ought to be increased had to be faced, and it was felt that inasmuch as consumers are naturally chary of introducing new lamps before being fully assured of the reality of the claimed advantage, the anticipated large adoption of them was bound to be gradual, and it was therefore decided not to recommend an increase in the price, but rather to adopt a policy which would educate the public to appreciate the economy and possibilities of the new lamps.

It has always been regarded as an axiom in central station circles that good street lighting is one of the best advertisements that an electricity department can have, and by way of experiment a 17-ampere open-type alternating-current arc lamp which had been in use over 12 years was displaced by a four-arm fitting having four 100 c.p. metallic filament lamps. The general public and the local press, without knowing anything of the saving in current, expressed themselves in no uncertain voice as being in favour of the incandescent lamps, largely because of the absence of the flickering and light variation so characteristic of the arc lamp. When it was further pointed out that not only was there a large saving in current consumed, but that the additional costs of arc lighting—viz., carbons, trimming, repairs and wages were not necessary in the case of the metallic lamps—instructions were given to convert the greater part of the arc lighting of the town to the newer form of illuminant. It was decided to deal first with a stretch of roadway then lighted by 20 open-type series alternating-current arc lamps, arranged in two circuits and supplied from two floating coil constant-current transformers, and it was arranged that 18 of these arc lamp-posts should be fitted each with two-arm fittings carrying two 100 c.p. 200-volt metallic filament lamps, and the remaining two posts fitted with four-arm fittings carrying four 100 c.p. 200-volt metallic filament lamps. The 100 c.p. lamps are not enclosed, but are exposed to the atmosphere, and this condition has undoubtedly tended to increase the life of the lamps. Each arm is fitted with a 13-in. holophane reflector, which, while giving a pleasing effect in the daytime, materially assists the effective illumination when the lamps are alight. This work was carried out and completed towards the middle of last March, and while the amount of illumination given by two 100 c.p. lamps is by no means equal to that given by the old arc lamps, yet it is admitted that the amount of effective illumination given on the roadway by the four-arm fittings is at least comparable with that given by the arc lamps, and much better round the base of the post itself. The roadway in which these lamps are fixed is in a residential district, and is now considered to be adequately lighted, the inference being that with the arc lamps it was over-lighted. In the case of a business street, it would not be sufficient simply to displace arc lamps by two 100 c.p. metallic filament lamps, but, in addition, new intermediate posts having similar fittings would have to be erected. As a matter of fact, this is the procedure which is being adopted in Harrogate. It is noteworthy at this point to observe that these lamps are being used in parallel on high voltage, and although up to the present moment they have been burning for, say, 1,000 hours, the renewals in that time have only amounted to seven out of 46, and of these seven two were broken by the post on which they were suspended having been run into by a motor van.

Careful photometric tests have been taken in the streets with a portable photometer, and the results show that the same average illumination is obtained at the following average distances :—

Arc lamp (17 amp. open-type, opaline globe) ..	28¼ ft.
Four-light fitting	27½ „
Two-light fitting	21½ „

The cost of the alteration of the 20-arc lamps to two and four-arm fittings, including ornamental arms, reflectors, lamps, and all labour, and without any allowance for scrapped material, was £91. This is very low, and is due to the fact that no alteration in the mains was required, as the cables formerly carrying the high-pressure constant current for the series arc lamps were of sufficient cross-sectional area to carry the current at 200 volts for the metallic filament lamps.

The cost of current at 1½d. per unit and maintenance per annum for the arc lamps, as compared with the metallic filament lamps, is shown below :—

Arc Lamps.	£	s.	d.	*Metallic Lamps.*	£	s.	d.
Current	169	0	0	Current ..	56	0	0
Trade account ..	22	0	0	Renewals ..	29	7	4
Wages	61	0	0	Wages ..	(10	0	
	£270	0	0		£91	17	4
					Say £100	0	0

In this comparison it is estimated that each metallic lamp will be renewed twice per year, which is undoubtedly higher than will occur in actual practice, as the Harrogate lamps are switched out at 12.30 a.m., excepting special corner lamps, so that it is evident that the capital cost of making the alteration is more than met by the saving in the running costs of the first year after the alteration has been made.

In addition to the marked economy which can be obtained in the case of arc lamps by substituting large candle-power metallic filament lamps, it can be proved that the smaller metal lamps may be used as a most effective competitor against the incandescent gas mantle for side-street lighting. From the result of many photometric tests of gas mantles in the roadways, it is proved that the average candle-power of a 3-ft. incandescent gas mantle does not exceed 30 candles, while with metallic filament lamps 30 c.p. can be obtained for 33 watts. Taking the price per unit for street-lighting purposes at 1½d., the price per hour for 30 c.p. is $\frac{50}{1000}$ d.; take the price of gas at 2s. 2½d. per 1,000 cub. ft., the cost of 30 c.p. per hour is $\frac{80}{1000}$ d.; so that for 1,000 hours the cost of electricity is 4s. 2d. against 6s. 8d. for gas, but the renewals in the case of electricity (assuming the life of the lamps to be 1,000 hours) cost 3s., and for gas (assuming the life of the mantles to be 400 hours) cost 10d., making the totals, electricity 7s. 2d., gas 7s. 4d. These figures do not include the extra cost of labour in the renewals of the gas mantles nor the cost of breakages of chimney glasses which frequently occur, nor extra cost of cleaning the gas lanterns. Since the carbon filament lamps have been displaced by metallic filament lamps in the converted gas lamp-posts, the lighting of all new roads, whether undertaken by the corporation or by private owners, has been given to the electricity department if there was a cable anywhere in the vicinity.

In connection with this point, the special attention of manufacturers of lamps is drawn to the fact that in nearly all street lamps changed over from gas to electricity, the convenient way for the metal lamps to be installed is in a lampholder screwed on the end of a vertical pipe standing up in the centre of the lantern and with the lamp cap downwards. There is, therefore, a good and immediate market for a lamp in which the leading-in wires are taken to the top of the glass support, and the filament suspended therefrom in exactly the opposite way from what is the standard practice to-day. There is good reason to assume that the life of these lamps would be substantially longer than that of the present lamps when used with the cap downwards.

While the lighting authority is making these drastic alterations in street-lighting arrangements the private consumers have not been slow to take advantage of the opportunity afforded them by the metal lamps to reduce their lighting accounts. This effect was noticed first in the business part of the town, where the shops are chiefly supplied at 100 volts. The local contractors for a time found themselves unable to supply the demands for lamps.

* Abstract of paper read before Institution of Electrical Engineers, Leeds Local Section, Dec. 15.

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One good result accruing from the change was in getting a number of installations re-connected which had gone back to gas. The general effect on the supply station, however, from this class of consumer was not so apparent in the reduction of the number of units sold so much as in a generally increased illumination. However, as the average householder began to realise that by installing a small transformer to reduce the supply pressure to 25 or 50 volts, and also that metallic filament lamps of 16 and 25 c.p. at 25 volts were quite as stable and dependable as the old carbon filament lamps, it was found by our monthly generation sheet that instead of, as formerly, having to record with unfailing regularity an increase in the number of units generated, as compared with the similar month in the previous year, the ominous word "decrease" was creeping in.

As an instance of the marvellous results which can be obtained by the use of metallic filament lamps at low voltages, the following figures relating to a large hotel in Harrogate which adopted the method are of interest: In the year ending December, 1906, they used 13,712 units, while in the year ending December, 1908, they increased their illumination and used only 7,672 units. Notwithstanding the possibility of such a remarkable reduction in the number of units used by the larger consumers, and in spite of the fact that approximately 30,000 to 40,000 metal filament lamps have been disposed of in Harrogate, the number of units sold for lighting purposes for the year ending March, 1909, are only 5% below the figure for the year ending March, 1908, and the figures for units sold for all purposes are only down 2·5%. While it was gratifying to realise that the gloomy prophets who prognosticated that in a short time the output of the majority of electricity supply stations would be so reduced that it would be necessary to increase the price per unit were entirely at fault, it was felt that some steps ought to be taken to use the weapon science had placed in our hands to try to introduce electric lighting into the smaller houses, and thus tap that source of revenue which the gas companies have found so remunerative, viz., the class of house which has seldom more than from two to six lamps alight at one time. This problem was complicated by the fact that in the past all the details in connection with services are arranged so as to be able to supply at least 10 times the capacity of such small installations, and that, unless cheaper services can be installed, the revenue from such consumers would scarcely more than pay the interest on the capital costs.

It was realised that in dealing with small consumers it would be a great advantage to have no meters, and to charge them for their supply on a contract system. The great disadvantage to such a system, as proved by previous experience, was that unlimited use of the supply was apt to be taken unfair advantage of, and in view of that it was decided to offer a contract system of charging on the following terms:—

I. Consumer must supply his own lamps.
II. Each apartment in which a lamp was installed must be adequately lighted by windows in the daytime.
III. The maximum number of lamps to be alight at one time to be declared at the commencement of the contract.
IV. The minimum number of lamps applied for to be two and the maximum six, each taking 30 watts.
V. The charge to be 2s. 9d. per quarter per 30-watt lamp, payable in advance.

Clause I. tends to counteract the temptation to use the light more than actually necessary because of the cost of renewals of these comparatively expensive lamps.

Clause III. enables the department to instal a current limiter which causes the lamps to flicker if more than the number contracted for are switched on.

For the purposes of comparison with the contract rate of 2s. 9d. per 30-watt lamp, the accounts of a number of representative consumers who are charged on the maximum demand indicator system were taken and worked out on this basis, and it was found that the average from these consumers in terms of 30-watt lamps was nearly 50% below this contract rate, so that a safe margin is left to balance the more free use of the supply which it is only natural to expect would take place.

The current limit indicator which has been adopted is of a simple thermal type, compensated for variation in atmospheric temperature, and is made by a well-known firm of instrument makers in London. The cost is less than half the price of a reliable meter.

The advantages of the contract method of charging for a supply of electricity on these lines are so obvious that it seems scarcely necessary to enumerate them, but it is interesting to note that they are almost equally as attractive to the consumer as to the supply authority.

They are as follows:—

1. Consumer knows exactly what the amount of his quarterly account will be. This is a strong point.
2. Consumer can have the use of the light in every apartment. This is a boon to him, particularly in the case of bedrooms, as it is found under the old *régime*; in the smaller houses the tendency is not to use electric light in these rooms.
3. The supply authority is saved the cost of demand indicators, half the cost of the meters, and the continuous expense of repairs and recalibrations and the excitation current taken by the meters, also the cost of meter readings.
4. The book-keeping is simplified, and the risk of incurring bad debts is banished, due to the payment being made in advance, a feature of some importance where tenants are on weekly tenancy and where "moonlight flits" are not unknown.

It has been found that, if builders are induced to wire their houses, the tenants are extremely anxious to avail themselves of the use of electricity; and on one new building estate, where 100 to 120 houses are being erected of the value of £20 per year or less, an agreement to supply on the contract tariff has been entered into, while the builder has agreed to wire the whole of the houses as they are built.

Reference has already been made to the very serious difficulty which had to be faced due to the fact that the requirements of these installations did not necessitate anything like the same expenditure on services as had been customary. Further, the more stringent regulations of the Local Government Board, in regard to the repayment of loans, have made it essential that at least 8 to 10% should be set aside each year out of the profits of the department to meet interest, sinking fund, and depreciation charges and thus made it impossible to make a satisfactory profit on these small consumers unless the cost of services could be very materially reduced. For example, it was found that the average cost of service, and the accessories, including meters in Harrogate for the four years ending March, 1908, was nearly £7. The interest on this sum at 10% is 14s., and if the service to a small house paying 22s. per year for two lamps was to cost that sum, there would only be left 8s. to pay for the current consumed. Under these circumstances it was necessary to consider in what direction a reduction could be made. First of all, in the matter of cable, our standard practice in services was to use 7/16s concentric paper insulated lead covered and armoured cable, costing about £160 per mile, and it was decided that a five-ampere cable would be of ample capacity to serve the smaller houses, costing £50 per mile. Then the cut-out box of 25-ampere size, costing 10s. to 12s., was displaced by a smaller box costing 4s. each. Again, the current limiter only costs 15s., as compared with the former price of 35s. to 40s. for a meter. Further, the cost of labour is reduced to one-half of what it formerly was, and it is conclusively proved that the cost of all these does not exceed 45s. to 50s. Having thus reduced the cost of services, it was felt that a most important difficulty had been overcome.

While on this point it is impossible to refrain from referring in the strongest possible terms to the unenterprising attitude of the cable manufacturers to our request for a cheaper service cable. Naturally it was desired that, for the sake of uniformity and facility in testing for and locating faults, the concentric type of cable should be retained, and quotations for sizes down to 7/22s were

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asked for. The manufacturers pointed out the difficulty of construction of cables of sizes below 7/18s, so another inquiry was sent out specifying 7/22s inner, and an outer of equivalent cross-sectional area to 7/18s. To our great surprise, the quoted prices for this class of cable were considerably in excess of that asked for our standard 7/16s service cable, and a protest brought the reply that specially to manufacture cables of this description, considerable expense is involved in addition to the ordinary cost, due to the machines having to be prepared specially for irregular sizes of material. Again, inquiries were sent out, this time for 7/22s inner, and the outer to be of either iron or aluminium wires of equivalent carrying capacity to the inner conductor; but the result was still more surprising, as the price asked for this cable was in excess of the price quoted for the standard 7/16s, and it was only after a lot of correspondence and several interviews that the special concentric cable which is now in use was evolved by a well known and somewhat more enterprising firm at the price of £50 per mile. (There is a sample of this cable on the table.) It is extremely disappointing at a time when central station engineers are doing all they can to reduce the cost of services and house wiring, to find the cable manufacturers take up such a conservative and unenterprising position in regard to this most important matter.

Electrical cooking and heating are aspects of the question which are receiving considerable attention in many quarters, but as they do not fall within the scope of this paper, it is not intended to refer to them at any length, other than to draw attention to the significance which may be attached to the fact that a great number of patents are being taken out for apparatus of this description, and no doubt considerable developments may be expected shortly.

It has been found that our efforts to popularise the metallic filament lamp, while they undoubtedly tend to decrease the amount of energy used by the old consumers, have enabled us to win over additional consumers, and we lately have frequently the satisfaction of seeing our monthly generation sheets showing the cheery word "increase" as compared with the previous year.

METROPOLITAN ASSOCIATION OF ELECTRIC TRAMWAYS MANAGERS.

The members of this Association held a meeting on Friday, the 10th inst., at the Municipal and County Club, Whitehall, S.W., those in attendance being: Sir Clifton Robinson (London United Tramways), Messrs. Blain (West Ham), Howard (Barking), Coveney (Erith), Mittelhausen (Bexley), Ullmann (East Ham), Schofield (Leyton), Hammond (Metropolitan Electric), Mason (South Metropolitan), and Goodyer (Croydon), hon. secretary. Apologies for absence were received from Messrs. Bruce (L.C.C.), Balfour (Dartford), and Murray (Walthamstow).

Sir Clifton Robinson was unanimously elected chairman of the Association, and Mr. Goodyer re-elected hon. secretary.

Various matters relating to Metropolitan tramway interests were discussed.

CHARGE AGAINST A SOCIETY'S TREASURER.

At Loughborough Petty Sessions, James W. Kennett, of Lewisham-street, Westminster, formerly of Charles-street, Loughborough, was charged with stealing £29 9s. 2d., the money of the Electrical Trades Union, at Loughborough, on March 31 last.

Mr. R. Lancaster, who prosecuted, said the warrant was issued on May 12, and prisoner was only arrested in London on Monday. The secretary of the trades union was at Manchester, and was unable to attend that day, and he asked for a remand for a week.

Prisoner asked for bail, but Mr. Lancaster strongly opposed, saying that it was too serious a charge, and other charges might be preferred against prisoner, who was local treasurer of the union.

Accused was remanded for a week, bail being refused.

WIRELESS TELEGRAPHY.*

By GUGLIELMO MARCONI, D.Sc. LL.D.

The discoveries connected with the propagation of electric waves over long distances and the practical applications of telegraphy through space, which have gained for me the supreme honour of sharing the Nobel Prize for Physics, have been to a great extent the result of one another.

The application of electric waves to the purposes of wireless telegraphic communication between distant parts of the earth, and the experiments which I have been fortunate enough to be able to carry out on a larger scale than is obtainable in ordinary laboratories, have made it possible to investigate phenomena and note results often novel and unexpected. In my opinion, many facts connected with the transmission of electric waves over great distances still await a satisfactory explanation, and I hope to be able in this lecture to refer to some observations which appear to require the attention of physicists. In sketching the history of my association with radio-telegraphy, I might mention that I never studied physics or electro-technics in the regular manner, although as a boy I was deeply interested in these subjects. I did, however, attend one course of lectures on physics under the late Professor Rosa, at Livorno, and I was, I think I might say, fairly well acquainted with the publications of that time dealing with scientific subjects, including the works of Hertz, Branly and Righi.

At my home, near Bologna, in Italy, I commenced early in 1895 to carry out tests and experiments with the object of determining whether it would be possible by means of Hertzian waves to transmit to a distance telegraphic signs and symbols without the aid of connecting wires After a few preliminary experiments with Hertzian waves I became very soon convinced that if these waves or similar waves could be reliably transmitted and received over considerable distances a new system of communication would become available, possessing enormous advantages over flashlights and optical methods, which are so much dependent for their success on the clearness of the atmosphere. My first tests were carried out with an ordinary Hertz oscillator and a Branly coherer as detector, but I soon found out that the Branly coherer was far too erratic and unreliable for practical work. After some experiments, I found that a coherer consisting of nickel and silver filings placed in a small gap between two silver plugs in a tube, was remarkably sensitive and reliable. This improvement, together with the inclusion of the coherer in a circuit tuned to the wave-length of the transmitted radiation, allowed me to gradually extend up to about a mile the distance at which I could affect the receiver.

Another, now well-known, arrangement which I adopted was to place the coherer in a circuit containing a voltaic cell and a sensitive telegraph relay actuating another circuit, which worked a tapper or trembler and a recording instrument. By means of a morse telegraphic key placed in one of the circuits of the oscillator or transmitter, it was possible to emit long or short successions of electric waves, which would affect the receiver at a distance and accurately reproduce the telegraphic signs transmitted through space by the oscillator. With such apparatus I was able to telegraph up to a distance of about half-a-mile. Some further improvements were obtained by using reflectors with both the transmitters and receivers, the transmitter being in this case a Righi oscillator. This arrangement made it possible to send signals in one definite direction, but was inoperative if hills or any large obstacle happened to intervene between the transmitter and receiver. In August, 1895, I discovered a new arrangement, which not only greatly increased the distance over which I could communicate, but also seemed to make the transmission independent from the effects of intervening obstacles.

This arrangement consisted in connecting one terminal of the Hertzian oscillator, or spark producer, to earth, and the other terminal to a wire or capacity area placed at a height above the ground, and in also connecting at the receiving end one terminal of the coherer to earth and the other to an elevated conductor.

* The Nobel Prize Lecture, delivered December 11.

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I then began to examine the relation between the distance at which the transmitter could affect the receiver and the elevation of the capacity areas above the earth, and I very soon definitely ascertained that the higher the wires or capacity areas the greater the distance over which it was possible to telegraph.

Thus I found that when using cubes of tin of about 30 cms. side as elevated conductors or capacities, placed at the top of poles 2 meters high, I could receive signals at 30 meters distance, and when placed on poles 4 meters high, at 100 meters, and at 8 meters high at 400 meters. With larger cubes 100 cms. side, fixed at a height of 8 meters, signals could be transmitted 2,400 meters all round.†

These experiments were continued in England, where in September, 1896, a distance of 1¾ miles was obtained in tests carried out for the British Government at Salisbury. The distance of communication was extended to 4 miles in March, 1897, and in May of the same year to 9 miles. Tape messages obtained during those tests, signed by the British Government officers who were present, are exhibited. In all these experiments a very small amount of electrical power was used, the high tension current being produced by an ordinary Rhumkoff coil. The results obtained attracted a good deal of public attention at the time, such distances of communication being considered remarkable.

As I have explained, the main feature in my system consisted in the use of elevated capacity areas or vertical wires attached to one pole of the high frequency oscillators and receivers, the other pole of which was earthed.

The practical value of this innovation was not understood by many physicists for quite a considerable period, and the results which I obtained were by many erroneously considered simply due to efficiency in details of construction of the receiver, and to the employment of a large amount of energy. Others did not overlook the fact that a radical change had been introduced by making these elevated capacities and the earth form part of the high frequency oscillators and receivers. Professor Ascoli, of Rome, gave a very interesting theory of the mode of operation of my transmitters and receivers in the *Elettricista*, Rome, issue of August, 1897, in which he correctly attributed the results obtained to the use of elevated wires or antennas.

Professor A. Slaby, of Charlottenburg, after witnessing my tests in England in 1897, came to somewhat similar conclusions.‡

Many technical writers have stated that an elevated capacity at the top of the vertical wire is unnecessary.

This is true if the length or height of the wire is made sufficiently great, but as this height may be much smaller for a given distance if a capacity area is used, it is more economical to use such capacities, which now usually consist of a number of wires spreading out from the top of the vertical conductor.

The necessity or utility of the earth connection has been sometimes questioned, but in my opinion no practical system of wireless telegraphy exists where the instruments are not connected to earth. By "connecting to earth" I do not necessarily mean an ordinary metallic connection as used for ordinary wire telegraphs. The earth wire may have a condenser in series with it, or it may be connected to what is really equivalent, a capacity area placed close to the surface of the ground.

It is now perfectly well-known that a condenser, if large enough does not prevent the passage of high frequency oscillations, and therefore in these cases the earth is for all practical purposes connected to the antennae.

After numerous tests and demonstrations in Italy and in England over distances varying up to 40 miles, communication was established for the first time across the English Channel between England and France in March, 1899.‖ From the beginning of 1898 I had practically abandoned the early system of connection, and instead of joining the coherer or detector directly to the aerial and earth, I connected it between the ends of the secondary of a suitable oscillation transformer containing a condenser and tuned to the period of the electrical waves received. The primary of this oscillation transformer was connected to the elevated wire and to earth. This arrangement allowed of a certain degree of syntony, as by varying the period of oscillation of the transmitting antenna, it was possible to send messages to a tuned receiver without interfering with others differently syntonized.§

As it is now well known, a transmitter consisting of a vertical wire discharging through a spark-gap is not a persistent oscillator, the radiation it produces is strongly damped. Its electrical capacity is comparatively so small and its capability of radiating energy so large that its oscillations decrease or die off with great rapidity. In this case receivers or resonators of a considerably different period or pitch are likely to be affected by it.

Early in 1899 I was able to improve the resonance effects obtainable by increasing the capacity of the elevated wires by placing adjacently to them earthed conductors, and inserting in series with the aerials suitable inductance coils.*

By these means the energy storing capacity of the aerial was increased, whilst its capability to radiate was decreased, with the result that the energy set in motion by the discharge formed a train of succession of feebly damped oscillations. By a modification of this arrangement, excellent results were obtained.

In 1900 I constructed and patented transmitters which consisted of the usual kind of elevated capacity area and earth connection, but these were inductively coupled to an oscillation circuit containing a condenser, an inductance, and a spark gap, the conditions which I found essential for efficiency being that the periods of electrical oscillation of the elevated wire or conductor should be in time or resonance with that of the condenser circuit.† The circuits consisting of the oscillating circuit and radiating circuit, were more or less closely "coupled" by varying the distance between them. By the adjustment of the inductance inserted in the elevated conductor and by the variation of the capacity of the condenser circuit, the two circuits were brought into resonance, a condition which, as I have said, I found essential in order to obtain efficient radiation.

Part of my work regarding the utilisation of condenser circuits in association with the radiating antennæ was carried out simultaneously to that of Professor Braun, without, however, either of us knowing at the time anything of the contemporary work of the other.

A syntonic receiver has already been shown, and consists also of a vertical conductor or aerial connected to earth through the primary of an oscillation transformer, the secondary circuit of which included a condenser and a detector, it being necessary that the circuit containing the aerial and the circuit containing the detector should be in electrical resonance with each other, and also in tune with the periodicity of the electric waves transmitted from the sending station.

It is also possible to couple to one sending conductor several differently tuned transmitters and to a receiving wire a number of corresponding receivers, each individual receiver responding only to the radiations of the transmitter with which it is in resonance.

At the time (12 years ago) when communication was first established by means of radio-telegraphy between England and France, much discussion and speculation took place as to whether or not wireless telegraphy would be practicable for much longer distances than those then covered, and a somewhat general opinion prevailed that the curvature of the earth would be an insurmountable obstacle to long-distance transmission, in the same way as it was, and is, an obstacle to signalling over considerable distances by means of light flashes.

Difficulties were also anticipated as to the possibility of being able to control the large amount of energy which it appeared would be necessary to cover long distances.

What often happens in pioneer work repeated itself in the case of radio-telegraphy—the anticipated obstacles or

† See Journal of the Institution of Electrical Engineers, London, 1899. Vol. XXVIII., page 278.

‡ See A. Slaby, "Die Funkentelegraphie," Berlin, 1897. Verlag von Breonhard Sinion; also A. Slaby, "The New Telegraphy," *The Century Magazine*. April, 1898. Vol. LV., page 867.

‖ See "Journal of the Institution of Electrical Engineers," 1899, London. Vol. XXVIII., page 291.

§ British Patent, No. 12326, of June 1, 1898; also No. 6982 of April 1 1899.

* See "Etat actuel et progres de la Telegraphie sans Fil," by A. Blondel and G. Ferrie, read at the Congres International d'Electricite, Paris, 1900; also, "Journal of the Soicety of Arts," 1901. Vol. XLIX., page 509.

† See British Patent, No. 7777, of April 26, 1900; also "Journal of the Society of Arts," Vol. XLIX., May 17, 1901, pages 510-11.

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difficulties were either purely imaginary or else easily surmountable, but in their place unexpected barriers manifested themselves, and recent work has been mainly directed to the solution of problems presented by difficulties which were certainly neither expected nor anticipated when long distances were first attempted.

With regard to the presumed obstacle of the curvature of the earth, I am of opinion that those who anticipated difficulties in consequence of the shape of our planet had not taken sufficient account of the particular effect of the earth connection to both transmitter and receiver, which earth connection introduced effects of conduction which were generally at that time overlooked.

Physicists seemed to consider for a long time that wireless telegraphy was solely dependent on the effects of free Hertzian radiation through space, and it was years before the probable effect of the conductivity of the earth between the stations was satisfactorily considered or discussed.

Lord Rayleigh, in referring to trans-Atlantic telegraphy stated in May, 1903, "The remarkable success of Marconi in signalling across the Atlantic suggests a more decided bending or diffraction of the waves round the pertuberant earth than had been expected, and it imparts a great interest to the theoretical problem."‡

Professor J. A. Fleming, in his book on "The Principles of Electric Wave Telegraphy,"‖ gives diagrams showing what is now believed to be the diagrammatic representation of the detachment of semi-loops of leectric strain from a simple vertical wire. As will be seen, these waves do not propagate in the same manner as free radiation from a classical Hertzian oscillator, but glide along the surface of the earth.

Professor Fleming further states in the above-quoted work :—

"The view we here take is that the ends of the semi-loops of electric force, which terminate perpendicularly on the earth, cannot move along unless there are movements of electrons in the earth corresponding to the wave-motions above it. From the point of view of the electronic theory of electricity, every line of electric force in the ether must be either a closed line or its ends must terminate on electrons of opposite sign. If the end of a line of strain abuts on the earth and move, there must be atom-to-atom exchange of electrons, or movements of electrons in it. We have many reasons for concluding that the substances we call conductors are those in which free movements of electrons can take place. Hence the movements of the semi-loops of electric force outwards from an earthed oscillator or Marconi aerial is hindered by bad conductivity on the surface of the earth and facilitated over the surface of a fairly good electrolytic, such as sea-water."

Professor Zenneck§ has carefully examined the effect of earthed transmitting and receiving aerials, and has endeavoured to show mathematically that when the lines of electrical force, constituting a wave front, pass along a surface of low specific inductive capacity, such as the earth, they become inclined forward, their lower ends being retarded by the resistance of the conductor to which they are attached.

It therefore seems well established that wireless telegraphy, as practised at the present day, is dependent for its operation over long distances on the conductivity of the earth, and that the difference in conductivity between the surface of the sea and land is sufficient to explain the increased distance obtainable with the same amount of energy in communicating over sea as compared to over land.

I carried out some tests between a shore station and a ship at Poole, in England, in 1902, for the purpose of obtaining some data on this point, and I noticed that at equal distances a perceptible diminution in the energy of the received waves always occurred when the ship was in such a position as to allow a low spit of sand about one kilometer broad to intervene between it and the land station.

(To be continued).

‡ See Proceedings of the Royal Society. Vol. LXXII., May 28, 1903.

‖ See page 348 (published by Longmans, Green & Co., London, 1906).

§ See J. Zenneck. Annalen der Physik. 24.5, page 846, September, 1908; Physikal Zeitschrift, No. 2, page 50; No. 17, page 553.

ADELAIDE ELECTRIC SUPPLY CO.

The fifth annual general meeting of the Adelaide Electric Supply Co., Ltd., was held on Monday, 6th, at Finsbury Pavement House, London, E.C., Mr. Joseph Bevan Braithwaite, M.Inst.E.E., Chairman of the Company, presiding.

The Chairman said last year we had £135,000 worth of Preference Shares issued; this year it will be seen that the whole £150,000 has been issued. The whole of this £15,000 additional Preference capital has been taken up in Adelaide, which I think is a very gratifying feature; and since the close of our financial year on August 31 last, we have also placed the balance of our Ordinary Share capital, amounting to £19,675, in Adelaide at par; so that, including this last issue, about £130,000 of the capital of this Company is held in South Australia. On the credit side of the balance sheet, the expenditure on our undertaking shows an increase of approximately £40,000. That represents our capital expenditure during the year in extending our mains into the outlying suburbs, in connecting new customers, and in paying for the additional plant, and also in buying some further land surrounding our generating station for purposes incidental to our business. The cash at bankers and in hand is £4,645. The debtors show an increase, which is, of course, due to the larger business we are doing—£6,407 as against £3,804. Stores in Australia also show a small increase for a similar reason. Plant, sotres and items in transit on the other hand show a decrease, due to the fact that we did not happen to have so much material on the water as at the corresponding date last year. Then the Suspense Account we reduced last year to £1,506, and we propose to write it off. The most interesting item you have to consider is the Revenue Account, and there I think you will be much gratified. In the figures which I am going to give you I am not taking into account the supply to the Adelaide Municipal Tramways Trust, because that is only a temporary business. The receipts from private lighting supply have gone up from £19,150 to £24,091, showing an advance of £4,941, which is just about the same as that which took place last year, while the receipts from power are £8,618 as compared with £6,814, showing an increase of £1,804, so that from our own business we have got nearly £7,000 increase in the earnings. Now you will say, "What does it cost us to earn that additional revenue?" Well, the generation of electricity has cost us £10,126 as against £8,371, showing an increased cost of £1,735. Distribution cost us £2,346 as against £1,903, that is an increase of £443. As regards repairs and renewals, it is our policy, as you know, to keep our plant in the best possible condition, rather than to put large sums aside in our balance sheet for depreciation, and we spent £2,878 in maintenance and renewals of our plant, against £2,132 for the previous year, showing an increase of £746. The net result is that our £7,000 additional revenue has been earned at an increased expense of less than £3,000, so that I think you will agree that our engineering and technical staff are to be congratulated on the greatly increased efficiency they have brought about in our generating station, and I hope that before this meeting closes you will see your way to do what is always appreciated by those working at a distance from their shareholders, in our case a distance of 12,000 miles, namely, to record on your proceedings a cordial vote of recognition of the efficient way in which you have been served by your Local Board and staff in Adelaide. I would specially mention your Local Managing Director, Mr. Clements, your Engineer, Mr. Wheadon, and his lieutenants, Mr. Onslow and Mr. Inglis. To return to the accounts, the total result is that the balance which we have to carry to our Profit and Loss Account is £25,226, which compares with £13,663 last year, showing an increase of £11,563, which I am sure you will feel is a very satisfactory result. Then you will say, "What do you propose to do with this profit." That is what we have been considering very carefully, and of course it has been a little difficult to know exactly what to do in view of the temporary character of the supply to the Tramways Trust. When that supply ceases there must necessarily be a certain interval while we are finding a new load amongst our own customers for the plant which will be set free, and it has been very important to your Directors to consider carefully what rate of dividend on the Ordinary Shares we could rightly declare, and such as we could see our way to maintain, for I am quite sure you would not wish us to increase the dividend to a point which we might not be able to maintain when the temporary supply to the Tramways Trust ceases. We propose, with your approval, after paying the Preference dividend, to declare a dividend of 6% for the year on the Ordinary Shares, which compares with 3½% last year, to extinguish the Suspense Account of £1,506, to place £1,000 to Depreciation Account raising it to £4,000, and to set aside a sum of £5,000 to Dividend Equalisation Account, with a view to that amount being available for use hereafter, if necessary. I do not think it will be necessary as far as I can see from the growth of the business, but it can be used if required to equalise the dividend pending the time when the plant that will be thrown out of use when the Tramways Trust are ready to supply themselves from their own station, can be loaded up by the normal growth of our own business. That will leave us a balance to carry forward of £1,009. With regard to the expansion of our normal business, the figures are on page 4 of the Report, and I think you will agree that they give us every cause for congratulation. In

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these figures also we have left out of consideration the units supplied to the Tramways Trust, so that you will be better able to see exactly what your own business is doing. You will see that taking the connections in lamps, we now have for lighting purposes 91,338 lamps, as against 71,138 last year, showing an increase of 20,200. In motors connected we have 2,369 h.p. as against 1,837, showing an increase of 532 h.p. The total connections, reckoned in 30 watt lamps, are equivalent to 167,146 as against 129,922, showing an increase of 37,224. The units sold are 2,073,550 as compared with 1,666,974, showing an increase of 406,576. You will see that that is an all-round advance of nearly 20%, which I think is thoroughly satisfactory. We have laid our mains during the year in 13 miles of new streets in the various suburbs, and there are now 2,314 consumers connected, being an increase of 37% on the year, so that in every way our progress can be regarded as thoroughly gratifying. The fact that so great a proportion of our capital has been taken up by local investors in Adelaide, shows what the people there think of our prospects for the future. I do not know that there is any other matter which I need speak about, except to say that we have authorised the extension of our mains to Glenelg, which I might call the Brighton of Adelaide. At any rate it is the popular seaside resort where a great many people live a large part of the year, and go to and from Adelaide. The supply will be available there shortly. I will now move "That the Report of the Directors and statement of accounts for the year ended August 31, 1909, duly audited and now presented to the shareholders, be received, approved and adopted; that the dividends paid on the Preference Shares be confirmed, and that a dividend of 6% on the 26,065 Ordinary Shares, numbered 1 to 26,065, for the year ended August 31, 1909, be declared and paid to the holders of such shares appearing on the register at the date of this meeting."

Mr. R. Percy Sellon seconded the resolution, which was put to the meeting and carried unanimously.

Mr. Sellon: I have now the pleasure to move that Mr. J. B. Braithwaite, the retiring Director, be re-elected a Director of the Company. Mr. Braithwaite's services to the electrical industry are, I have no doubt, known to all shareholders present, and his wide and varied experience in the commercial and financial problems surrounding our business of electricity supply make his services of special value on our Board. I think Mr. Braithwaite has stated on a previous occasion that in quite recent years he has had occasion to visit Australia, and the fact that he is personally acquainted with our undertaking in Adelaide, is an additional ground on which we, his colleagues, can testify to the value of his services at our councils. I have no doubt it will be the wish of the shareholders to re-elect him and I have great pleasure in moving his re-election. Mr. W. Parker seconded the resolution, which was carried unanimously.

NEW ELECTRICAL PRODUCTIONS.

AT THE PHYSICAL SOCIETY'S SHOW.

The outstanding feature of the Physical Society's Show at the Imperial College of Science, South Kensington, London, on Tuesday, was the remarkably fine collection of examples of the latest applications of electricity. Most of the stands were monopolised by electrical inventions, and few, indeed, could be found devoid of some new device of electrical interest. A number of the instruments were shown for the first time in use and their advantages demonstrated by experts. The Institution of Electrical Engineers, the Faraday Society and the Röntgen Society were of the leading organisations invited to attend, and the result was a representative assembly of electrical engineers and physicists.

Much interest was aroused by the new productions shown by Messrs. Nalder Bros. & Thompson, Ltd. The Telethermometer came in for special attention. The system has been designed on original lines for the purpose of measuring temperature electrically, and consists essentially of a moving coil Ohmmeter combined with a Wheatstone Bridge, three arms of which are of wire, having no temperature co-efficient, while the fourth consists of a coil of copper wire. The apparatus has the merit of being wonderfully accurate and dead beat, and should be particularly useful in cases where frequent records of temperature are required. By its use the temperature at a large number of points can be obtained with great rapidity. Another notable exhibit on this stand was a portable standard testing set, consisting of a dead beat moving coil ammeter and voltmeter. This set has also a high degree of accuracy on A.C. circuits at low power factors, and may also be used on D.C. circuits.

Messrs. Isenthal & Co. introduced a new pattern precision Wheatstone Bridge with decade resistance of variable sensitiveness and provision for the use of testing voltages from 2 to 20. In place of the ordinary terminals to which the unknown resistance is connected, this device is fitted with a novel form of clamp which accommodates with equal facility the finest wire or rods up to ¾ in. × ¼ in. New patterns of resistances, frequency indicators arranged for laboratory and switchboard use, and samples of Moscicki condensers for oscillation circuits were also brought under notice by this firm.

The stand of Messrs. Siemens Bros. & Co., Ltd., carried a selection of the newest models of switchboard instruments and portable and testing instruments. Of the latter, the Saladin double mirror-galvanometer for the purpose of reproducing a curve on a stationary photographic plate came in for special attention. Designed for tests of thermal analysis, the instrument consists of two galvanometers, the mirrors of which are optically connected by means of a prism. The horizontal movement of the beam of light from the mirror of the first instrument is converted by the prism into a vertical movement, and the light then thrown on to the mirror of the second instrument, where its vertical movement is combined with the horizontal movement of the mirror of the second instruments. The resultant of the horizontal and vertical movements gives the required curve. The apparatus can be worked for any speed of the ray of light up to 2.5 mm. per second, and with photographic plates of ordinary sensitiveness. Other notable examples shown included a high frequency machine for a normal frequency of about 3,500 cycles per second with loading machine, driving motor and starting switch for 110 or 220 volt circuit. On a 220 volt circuit, a maximum frequency of 6,000 cycles per second can be obtained, with contacts for connecting up frequency meter. Another type of this machine is arranged for a normal frequency of 1,000 cycles per second.

A popular attraction was provided by the British Radio-Telegraph & Telephone Co., Ltd., who had a complete receiving station for wireless telegraphy, comprising detector and tuner combined in one piece of apparatus.

The Cambridge Scientific Instrument Co., Ltd., submitted a wide range of interesting apparatus, referred to in our last issue.

The Hennah and Rissel patent automatic safety course recorder and indicator was shown by Messrs. C. F. Casella & Co., and attracted considerable attention. The device, which is equipped with electrically controlled bells, records the deviation of a ship from its proper course, ringing a bell at maximum deviation, etc. The invention has undoubtedly a promising future.

On view at Messrs. A. C. Cossor's exhibit were the Sir Oliver Lodge valves for high tension currents, specially constructed vacuum tubes for rectifying high tension alternating currents. The Gehrcke Oscilloscope tube was shown in operation with these tubes.

Various types of induction coils for research work, radiography and wireless telegraphy were staged by Messrs. H. W. Cox & Co., Ltd.; the *Daily Mirror* demonstrated with instruments for telegraphing photographs; Messrs. Elliott Bros. exhibited the Wimperis accelerometer and gradient measurer, ammeters, and voltmeters, etc.; and Messrs. Gallenkamp showed a new pyrometer set and other apparatus designed specially for students' use.

An excellent photometer bench for laboratory and central station use was exhibited by Messrs. Everett, Edgcumbe & Co., Ltd. The firm also prominently displayed a daylight illumination photometer, as well as speed indicators of various patterns for engine room and general testing work. These indicators are being tried by the Metropolitan Electric Tramway Co. and other undertakings may be reckoned to soon take up the invention.

A fool proof pointer and reflecting galvanometer, for which patent rights are being sought, was exhibited by Messrs. Gambrell Bros., who also came to the fore with moving coil galvanometers, etc.

Shown by Messrs. John Griffin & Sons were Sands' apparatus for the rapid electro-analytical separation of metals, the Gamma Ray electroscope and the R.H.S. radiometer.

Electric alarm thermometers and an anemometer, recording electrically, were to be seen at Mr. J. Hicks' stand; Mr. Leslie Miller exhibited current interruptors and the Lewis Jones current pulsators; the Lithanode Co. had a striking show of Lithanode unspillable 4-volt accumulators, cable type cells and other new specialities; Mr. Robert W. Paul displayed the Sumpner reflecting dynamometer, Melsom potentiometer, and laboratory apparatus of various kinds; Messrs. Ross introduced a Nernst microscope lamp; Messrs. Snell & Tinsley exhibited a new potentiometer designed by Mr. Tinsley, reading from 1-millionth of a volt to 18·1 volts, a patent A.C. potentiometer and the Sine flux phase shifter, and an improved design of siphon recorder by Mr. Tinsley; and the Electric Regulators & Economisers, Ltd., showed the Martin regulator.

The London Electric Firm, Croydon, showed an alluring invention calculated to do away with cog wheels and their attendant troubles. It is achieved by a cam groove arrangement, the whole of the mechanism being completely enclosed.

The India Rubber, Gutta Percha & Telegraph Works Co., Ltd., had one of the finest displays, including the Rymer Jones standard condenser. E. Raymond Barkers Two-tone transmitter, the Gott Fault-searcher coil, and four types of portable testing sets.

Two interesting novelties shown by Messrs. Negretti & Zambra were an electrical self-recording rain gauge and an electrical recording anemometer, both of which will probably be in great demand directly their advantages become known.

OBITUARY.

The many friends in England of Mr. T. C. Martin, late Editor of the *Electrical World* and now a Secretary of the National Electric Light Association, New York, will hear with regret that he has suffered a heavy bereavement by the death of his wife. Mrs. Martin (*nee* Elizabeth Gould) was a native of Gravesend, Kent.

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ELECTRIFICATION OF THE G.N.R. OF AMERICA.

BY CARY T. HUTCHINSON.

Continued from page 820.

Practically all metal work in the tunnel supports is copper or bronze, but experience has shown that galvanised iron, soon becoming protected by a slight coating of soot, would have been satisfactory. The insulators, when first put in service, were covered by a very thick coating of wet soot, but, even under these conditions, it was found possible gradually to bring the voltage up to normal without breakdown. Volumes of smoke and steam issuing from steam locomotives caused only a slight surface leakage, and one rough cleaning sufficed to put the insulators in reliable working condition.

This plant has demonstrated, in my opinion, that the three-phase induction motor has certain very marked advantages over any other form of motor for heavy traction on mountain grades; these advantages may be stated somewhat approximately.

1. Maximum electrical and mechanical simplicity. This point is of great importance, and was one of the principal reasons for using three-phase system; the motors will stand any amount of abuse and rough use.

2. Greater continuous output within a given space than can be obtained from any other form of motor. This, I believe, is shown by comparison with other electric locomotives; it is due to the fact that the losses can be kept lower in a three-phase motor than in any other type. As Fig. 3 shows, the electrical efficiency of the motor is high for a wide range of load.

3. Uniform torque. This is important, particularly at starting. I believe that a three-phase motor will work to a 3 or 4% greater coefficient of adhesion than a single-phase motor at 15 cycles.

4. The possibility of using 25 cycles. This is important, as it leads to a less cost and a better performance of power station apparatus; moreover, it is standard, and the power supply can readily be used for other purposes, as well as for traction; a commercial supply can be provided.

5. Constant speed. This is ordinarily stated as a disadvantage of the three-phase motor; but in my opinion it is a distinct advantage in mountain service, particularly the limitation of the speed on down grades. It has also the advantage on up grades that meeting points can be arranged with greater definiteness. There is a general notion that the impossibility of making up lost time with the three-phase motor will be a decided drawback to its use. This would be true if there were the same liability to lose time with three-phase motors; but when a train can be counted on to make a definite speed, without regard to conditions of tracks or of its load, there is less liability to lose time. Although I am not prepared to state that a three-phase motor is suitable for cases where the profile is very variable, yet it is by no means certain that it would not work out well; the question is merely one of making a given schedule between two points with greatest regularity.

6. Regeneration on down grades. This matter has been discussed since the earliest days of electric traction, but, as far as I know, has not been, up to the present, put into practice. Although this result can be attained with other forms of motors, yet it is most perfectly attained by three-phase motors, there being no complications involved. This is of importance in reducing the power-house capacity required for a given service; although, no doubt, the saving in power-house capacity will not be as great as indicated by theory, owing to the various emergencies that must be provided for, nevertheless there will be a material saving. A 2,500-ton train on the average down grade of 1·5% will deliver about 1,400 kw. to the system. The equivalent power house capacity would cost at least $200,000; hence, if only 20% of this can be utilised, the saving will equal the cost of one locomotive.

7. Excessive short-circuit current is impossible and, consequently, destructive torque on the gears and driving rigging is eliminated. There will be no necessity for the complication of a friction connection between the armature and driving wheels, as in the design of recent large direct-current electric locomotives.

8. Impossibility of excessive speeds. Even when the wheel slips, the speed remains constant. Therefore, the maximum stresses put on the motor are less and are more accurately known than with any other form of motor.

On the other hand, the principal disadvantages of three-phase motor, for traction use, are commonly stated to be:

1. The constant speed. This is rather an advantage for this class of service.

2. Constant power. The fact that the motor is a constant-power motor, and therefore requires the same power at starting and while accelerating at full speed. While this is true, it is not a matter of any particular consequence in a service where the stops are very few, and, consequently, the proportion of total time spent in acceleration is small, and where the additional power required to accelerate the train is a small percentage of the power used by the train at full speed. In this particular case, on the 2·2% grade, when accelerating at the rate of 10 lbs. to the ton, the power required during acceleration is only 20% greater than that required at full speed; this is not a serious matter.

3. Small mechanical clearance. In this particular motor the clearance is $\frac{1}{8}$ in., which is ample for all practical purposes.

4. Inequality of load on several motors of a locomotive due to differences in diameter of driving wheels. To meet this, an adjustable resistance is included in the rotor of each motor, the motors are then balanced up, and no further attention is required as long as the wear on the driving wheels is approximately the same. If, at any time, the load becomes badly unbalanced, it is a simple matter to readjust the resistances.

5. Low power-factor of the system. This does not seem to be borne out by practice. The power-factor, as shown by the switchboard instruments in the power house, is 85%. This is a good result, and is much higher than a power-factor of a well-known single-phase system that I recently had occasion to visit.

6. Two overhead wires. There is no doubt that two wires will cause more trouble than one, and in case of complicated yard structure it might not be practicable to use two overhead wires; but where the problem is that of a single track, with an occasional turn-out or crossing, there is, practically speaking, no more difficulty in maintaining two wires than one.

In brief, in service of this character the three-phase motor has marked advantages in capacity, reliability, simplicity, and general trustworthiness, when compared with any other motor.

In the many discussions of electric traction which have recently taken place, I do not find several minor advantages sufficiently emphasised. One of these advantages lies in the fact that with electric traction the exact performance and condition of the locomotives and of all elements of the system is accurately known at each moment; on the other hand, with steam locomotives neither the engineer nor the motive-power man can have any clear knowledge of the conditions of operation at the moment; he can only ascertain the performance of the locomotive by elaborate tests, which, as a matter of fact, are seldom made. The ratings and performance of steam locomotives are made up largely by "authority" based on a few tests from time to time, and take no cognisance of the actual condition of the locomotives. The importance of this, I think, is clearly brought out by the tests of the steam locomotive cited herein.

With electric locomotives the operation on a heavy grade becomes as simple as on the level; the engineers and train men feel much greater confidence in the electric locomotives, and, consequently, the mountain division ceases to be a terror to them.

Electric traction will permit the use of very long tunnels, which are not now possible on account of difficulty of ventilation. There is no particular reasons why tunnels of 10 or 12 miles should not be operated as easily as those of one mile.

The great increase possible in the speed of trains with electric traction and the consequent increase in the capacity of a single track will operate to postpone for a long time the necessity for double tracking. This double tracking on a mountain is a very expensive piece of business, and this saving alone will, in some cases, more than offset the cost of electrical equipment.

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Secretaries and Managers of Companies are asked to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers.

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CONTENTS.

	PAGE
Notes	839
Dutch East Indies Market	840
Institution of Electrical Engineers	840
Metallic Filament Lamps	842
Metropolitan Association of Electric Tramways Managers	844
Charge against a Society's Treasurer	844
Wireless Telegraphy	844
Adelaide Electric Supply Co.	846
New Electrical Productions	847
Electrification of the G.N.R. of America	848
British Columbian Advance	849
Correspondence	850
Electricity in Ironworks	851
Manchester Exhibitions' Building	851
Marine Propulsion by Electric Motors	852
Design of Generating Stations	852
Ball Bearing Polishing Lathes	853
Technical Problems, with Solutions by Practical Men	855
Methods and Practice in the German Electrical Industry	856
Tyneside Notes	861
Midland Notes	861
Lancashire Notes	862
American Notes	863
German Notes	865
Electricity in Mines	865
Lighting and General Notes	866
Traction Notes	867
Companies' Meetings and Reports	867
Contracts Open	867
Personal	868
Melbourne Electric Supply Co.	868
Welsbach Litigation	868
Educational	868
Patents	869

BRITISH COLUMBIAN ADVANCE.

As a sign of prosperity and of prospects in the richly endowed Pacific Province of the Dominion of Canada, the thirteenth ordinary general meeting of the British Columbia Railway Co., Ltd., was very welcome. We have, from time to time, given particulars of this well-managed concern's activities, both as regards extensions of line and equipment, but outside electrical circles, in the City, there have not been wanting rumours that the company was losing ground, and that as a result there was a considerable amount of inside selling of shares. As a matter of fact, the exact contrary is the truth. And when we come to consider what has been, and what is being, done by the company, we may well understand that there is rather a tendency among those who know to rally round the huge undertaking. Mr. R. M. Horne-Payne, the chairman, explained to his shareholders that the past year had been an excellent one, both as regards passenger and goods traffic, due in the one case to visitors to the World's Fair at Seattle going to British Columbia after seeing the Exhibition, and on the other hand to the exceptionally heavy salmon catch. This year there is likely to be a falling off in both classes of traffic, so it is well to be prepared for this. But the agricultural, mining and manufacturing resources of the Province are being developed at an astonishing rate, which will ultimately bring business to the company. Meanwhile, however, it has been necessary to push forward railway extension in sympathy with, and even in advance of such development, so that for the time being there has been a slight falling off in earning power. Such extensions cannot be avoided, nor is it advisable to attempt to do so. On another branch of its work the company has met with success, for in spite of a reduction of 17% in the charge for electricity for lighting purposes, there has been a large increase of revenue. As a net result, the cumulative perpetual preference stock receives its 5%, the preferred ordinary shares 6%, and the

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deferred ordinary 8%, with a good carry forward. Certainly there are signs of prosperity. As regards the increase of the company's capital to £2,500,000 by the emission of 700,000 new shares of £1 each, this is necessitated by the growth of the undertaking. Mr. Horne-Payne mentioned the threatened local competition, and wisely declared that he welcomed it, as it did away with all possible complaint as regards "monopoly." This competition, by the way, is to be in the form of another company, whose mission it will be to develop hydro-electrical generation of power. As further evidence of the electrical activity of British Columbia, our local correspondents send us a long list of new enterprises and extensions. We are told of the opening of a new municipal electric lighting station at Fernie, of the city of Revelstoke entering into a contract with the Canadian General Electric Co. to supply 50 arc lamps to replace incandescent globes in the streets, of the Electrical Construction Co., of Vancouver, lighting Vancouver's magnificent new bridge with 132 100-watt tungsten lamps, and so on. In industrial circles there is also much doing. For instance, we hear of the Western Canada Power Co. developing large water power on the Stave river, near Ruskin, some 45 miles east of Vancouver, and ordering five Eisser-Weiss water turbines to be delivered towards the close of next year, and meanwhile preparing to award contracts for machinery and equipment; of the Fraser River Lumber Co. ordering a 750 kw. steam turbo-generator, a 15 kw. engine driven exciter set, and motor driven exciter set, besides one 150 h.p. induction motor, one 75 h.p., seven 50 h.p., twelve 40 h.p., three 20 h.p., two 10 h.p., and two 5 h.p. induction motors; again, of the Imperial Rice Milling Co. ordering a 75 h.p. three-phase 60-cycle 2,200-volt motor for their Vancouver branch of the Kootenay Development Syndicate, Nelson, acquiring a 100 h.p. three-phase 550-volt induction motor for work at the Silver King Mine; while the North Pacific Lumber Co., Barnet, are also going in for the electric drive in their new premises. All this looks well, and should stimulate our manufacturing friends to make a strong stand in British Columbia, as in other parts of Canada, in competing with their American friends in this expanding market.

CORRESPONDENCE.

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "THE EDITOR, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

ELECTRIC DRIVING OF TEXTILE FACTORIES.

Sir,—Your issue of the 10th inst. contains a letter from the Council of the Bradford Engineering Society, the extraordinary contents of which require immediate correction. The words "full enquiry" and "very carefully considering" which appear respectively in this letter and in the document described as the "Report of Special Committee on Electric Driving of Textile Factories" seem to the gentlemen responsible for these publications to have a different meaning from that ordinarily connected therewith. We can only reiterate that this document has been published without our knowledge or approval and does not represent the views of the Committee. The actual facts regarding its origin are as follows:—

The substance of the clauses on pages 5, 6 and 7 was, with certain reservations, adopted by the Committee merely as a basis for a Discussion at a future meeting of the Society. The matter on pages 3 and 4 (to parts of which we take strong exception) was issued after the last meeting of the Committee, and there is no justification or authority for including this as part of the Committee's report. The Council now state that a meeting took place subsequently at which this report was finally adopted. This statement is exceedingly surprising, as the undersigned Members of the Committee cannot trace having received any notice of such a meeting. In fact, we have since learned from the Secretary that the last meeting of the Committee took place on July 30, whereas the typewritten copy as reproduced on pages 3 to 7 of the printed Report was not issued until the 31st, and was not previously seen by the Committee. This disposes of the Council's statements and of their claim to have since made a "full enquiry."

Whilst waiting for the Meeting of the Society, we found ourselves suddenly confronted with the broadcast Press publication of the "Report," which had not, and would not, have received our signatures. In addition it is headed by an "Introduction" of an entirely biased character which has never even been submitted to the Committee. We therefore reluctantly adopted the only course open to us, *i.e.*, to dissociate ourselves publicly from this document.

The letter from the Council of the Bradford Engineering Society concludes with personal remarks and the insinuation of trade advertisement, the taste of which is quite in keeping with the methods adopted in the publication of the "Report." In this connection it is significant that the meeting of the Council which decided on the issue of this letter, consisted of eight Mechanical Engineers, and that the only Electrical Engineer on the Council did not receive any notice of the meeting.

Yours, etc.,

H. ELLIS.
H. A. JONES,
R. POHL.
T. ROLES,
C. W. SALT.
W. B. WOODHOUSE.

Bradford, *December* 10, 1909.

ELECTRICAL PROPULSION OF SHIPS AND PROPELLER EFFICIENCY.

Sir,—Those electrical power engineers who have taken the trouble to investigate the matter of ship propulsion by means of electric motors, will hail with delight the announcement made by Sir William White (the famous Naval Architect), who took on himself the task of replying to some queries that the writer raised in the discussion on a very interesting paper on the matter of electrical propulsion by Mr. Henry A. Mavor., Sir William stated that he would ask the meeting not to take in what Mr. Durtnall stated as regards the supposed inefficiency of the high speed direct-coupled propeller, as Admiral Oram, the Chief Engineer of the Fleet, had stated that the propulsive efficiency of the propellers on the most recent warships had not fallen below that of the older ships.

If this is true, then it must be evident that either the older ships propellers were extremely inefficient, or that the propeller has been improved in design, which I sincerely hope is the case.

But I should be very interested to learn how it comes about that after building a special trial launch for testing the various propellers before building the large turbine driven "Cunard" liners, and it must be also admitted that the very finest talent that could be obtained was employed on the design of the propellers for these vessels, that the propulsive efficiency of the *Lusitania* was found to be only 48% for the shaft horse-power delivered, when the vessel was travelling at 25·4 knots, and the revolutions of the propellers were running at the low figure of 185 r.p.m., while on vessels with propellers only running at 80 to 100 r.p.m. the propulsive efficiency is often as much as 60%, which means that instead of requiring 68,500 shaft horse-power, the liner with slow speed propellers would have only required about 54,800 shaft horse-power, a saving of no less

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than 13,700 h.p. to produce the same amount of thrust, or what is the same thing to propel the vessel at the same speed, with the same displacement. This quite apart from the fact that in the electrical scheme, the turbines could be run at about 8 to 10 times the speed as the present direct-coupled ones, which would have enabled superheated steam to be used (with safety) in such small diameter trubines, these facts bringing with them a consequent further saving in steam and fuel of considerable extent.

It seems that the old argument is being adhered to by direct-coupled turbine engineers, that if the propeller is increased in efficiency, that it will only effect the direct-coupled turbine, but electrical engineers know full well that such increase in propeller speed (if ever it did come about) with the same efficiency as the low propeller speeds, that this would enable higher speeds to be given to both the turbine-generators and also the motors, which would make a further saving in both weight and steam per horse-power delivered to such possible high speed propellers.

It behoves the electrical engineering profession to put up a firm stand, or otherwise these statements coming from such authorities in marine engineering on the orthodox methods, who when publishing the trial results of certain vessels only give the steam used per shaft horse-power, and not the steam used per ton of displacement per mile travelled by the vessel, as it should be, and without which knowledge a correct estimate cannot be got by anyone, but the steam used looks mighty small per shaft horse-power.

However, it will not be long before a vessel will be tried under proper sea-going conditions on the new method of propulsion, and then it shall be published in right form what the cost of propelling ships can really be, as it will be given out on the lines above mentioned, and when the direct-coupled gentlemen take on the job to better, they will have a big contract on. I must say that it was noticeable what a few electrical engineers came forward to stick up for their rights in this most important new field of operations, while American and German electrical engineers are forging "ahead."

Yours faithfully,

WILLIAM P. DURTNALL, M.I.Mar.E., M.I.Auto.E.

"Electra House,"

Marine Parade, Herne Bay, Kent.

THE PRESENT ASPECT OF ELECTRIC LIGHTING.

Sir,—The paper by Messrs. H. W. Handcock and A. H. Dykes has opened up many new and interesting points, but the one which I found a difficulty in appreciating was the information given in Appendix A (Typical Gas Consumers Accounts), for at first sight I came to the conclusion that consumers did not pay as much for gas as for electricity, and that the examples could not represent an average. In order to obtain some information on this point, I issued forms containing a series of questions to 200 of my firm's employees and as they consist of mechanics and labourers, the results should represent a fair average for the artisan class. I was a little disappointed, for out of the 200 forms, only 51 were returned; the majority could not ascertain how much they spent, while the others were using "penny in the slot meters," and did not know the total amount which passed the opening.

Of the 51 who supplied information, they represented an average over the whole of the metropolitan area and some extended to Ealing, Wimbledon and Enfield, etc.

I give herewith the tabulated results for the quarter ending, Christmas, 1908.

Houses or consumers	51	
No. of rooms, not counting bathroom and Scullery	190	
No. of Gas jets	225	
„ „ Electric lamps	31	
„ „ Gas Cookers	29	
„ „ Oil lamps	8	rooms

Total amount paid for quarter ending Christmas, 1909:

	£	s.	d.
Gas Lighting and Cooking	38	9	10
Electric Light	3	4	5
Oil	1	4	4

One consumer used oil for lighting and gas for cooking, and his bill per quarter for gas amounts to 5s. 11d., which sum is so far as I can ascertain, a fair one, but rather under the average.

Taking as a basis that 6s. per quarter is a fair rate for gas cookers, the foregoing works out as follows:—

	s.	d.	
Gas light per quarter	2	8	per burner
Electric lighting	2	1	„ lamp
Oil for 8 rooms	3	0	„ room

In order to ascertain if 6s. was a fair average for a gas stove, I separated the 28 gas stove consumers from the others and still deducting the 6s. from each, the lighting average works out at 3s. 1d., so that a mean average would be somewhere between 2s. 8d. and 3s. 1d. (say 2s. 10d.) per quarter per burner for gas lighting, a sum which far exceeded my anticipation, while with electric light the average as before given, is only 2s. 1d. per lamp per quarter.

Those who are keenly interested in Tariffs may find these results useful, which is my apology for taking up so much of your space.

Yours faithfully,

W. R. RAWLINGS.

82, Gloucester-road,

South Kensington, S.W.

ELECTRICITY IN IRONWORKS.

At the 20th ordinary general meeting of Dorman, Long & Co., Ltd., held at Britannia Works, Middlesbrough, Mr. A. J. Dorman, the chairman, said that with regard to the electrical mill, "as some slight initial difficulties were met with, and as orders were scarce, we decided to wait until the cogging mill was finished before starting in earnest, and consequently this mill did nothing toward adding to the profits of your company during the year under review. I am glad to say that these difficulties have been overcome, and the mill is now working well, although to still further increase the output we have decided to make a slight alteration, which, however, will only entail a stoppage of a few days. We propose further to erect a new 12-in. guide-mill, driven on the same principle, alongside the electrical mill to roll small sections and round bars direct from the ingot, which will effect considerable saving in the cost of manufacture. Having regard to the large demand for bars, owing to the increasing use of ferro-concrete, your directors are confident that this extension will prove of great value to your company. As some difficulty was experienced in securing sufficient orders to keep the mills running full, it was found inadvisable to start the new furnace plant at Britannia until September, but this, together with the two new sheet-mills, is now working to our entire satisfaction. From the above remarks you will see that we have not yet obtained any benefit from the capital expenditure of the last two years, but as all the new plant, with the exception of the guide-mill, is now in operation, we are confident that further economies will be effected in cost, and output will be further increased, and that these extensions will prove equally successful as those of 1902 to 1905."

MANCHESTER EXHIBITION BUILDINGS.

We are informed that the erection in Manchester of Exhibition Buildings will be commenced next month. An exceptionally well-placed site has been secured in Old Hall-lane, and a handsome building with a floor surface of 100,000 sq. ft. for which the plans have already been passed by the Corporation, will be erected. The Proprietors of this building have already been able to secure contracts for four important undertakings and the scheme has so far commended itself to those business men who have been approached in the matter that it has been unnecessary to ask the public for a single penny of the capital involved. The scheme of erecting such a building had its genesis in the extraordinarily successful Electrical Exhibition that was held in October last year in a temporary hall on Platt Fields, Rusholme, and the architects of the present building have based their plans largely upon the requirements shown to be necessary, which were in many instances lacking in that temporary building.

The following particulars of the contracts already entered into will be of interest to our readers:—The Manchester Industrial Exhibition (May 12 to June 25, 1910); The Great Textile Exhibition (October 8 to 29, 1910); a General Engineering and Allied Trades' Exhibition (May and June 1911). All of these seem to lend themselves to the exhibition of various forms of electrical appliances. It may be mentioned that Mr. Walter Davenport is the Manager and the address of the Company is Ridler-place, Holland-street, Blackfriars, London, S.E.

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MARINE PROPULSION BY ELECTRIC MOTORS.*

By H. A. MAVOR, M.Inst.C.E.

At first sight it would appear that on a ship the direct connection between the power-generator and the propeller renders unnecessary the use of any intermediate transmission device, and so long as reciprocating steam-engines were the best attainable power-generators it was possible to correlate the speeds of generator and propeller so as to gain the best efficiency of each. The steam-turbine and the non-reversible internal-combustion engine introduce a new set of conditions. On land the turbine holds the field for the largest powers, and because its speed of revolution is unsuited to any ordinary mechanical direct application of power for industrial purposes, its evolution has been directly associated with electrical transmission. These turbines are many of them of the same order of magnitude as the turbines used on shipboard, and therefore a comparison of economy in the two conditions is inevitable.

Before the introduction of electric transmission the marine engineer had the more complete scientific data, and consequently the marine engine held the blue ribbon of economy which now belongs to the turbo-electric generator. Among the reasons for the higher efficiency of the land turbines are:—That the engineer on land is freer than is the marine engineer to adopt a suitable speed of revolution; that the land turbine runs at approximately constant speed for all loads, and can therefore be run on the governor, rendering easier the application of superheat and augmented vacuum; that on land it is possible to subdivide the power-units to meet the conditions of varying load, and thus maintain at the smaller loads an efficiency not materially different from the efficiency at the full load of the system; that the sea change of power is directly associated with change of speed, and the whole of the power-units must always be in motion while the ship is in motion. The same engine has to run the ship at 10 knots and at 20 knots, although the power varies very widely between those limits. Also the high economy on land of power-production associated with electric transmission is largely due to the possibility of exact measurement of power under all conditions of load-giving a complete knowledge of the effect of all changes in the apparatus of in the methods of working it.

The proposition here made is to provide an electric equipment intermediate between the prime mover and the propeller, extending the limits of practical economy in each by modifying the restrictions which the prime mover and propeller impose upon one another, and providing that the prime mover may operate at or near the constant speed required for the attainment of maximum efficiency and full power, and that the power expended in driving machinery not required for work is reduced to a minimum or entirely eliminated. At full power all the elements of the generating-plant are in full operation and the whole power-resources can be concentrated on driving the ship. When full power is not required the generating-plant may be shut down in sections.

To accomplish these ends special motors have been designed which give the necessary changes of speed and direction and permit of the advantageous combination or elimination of the power-generators. These motors involve no new electrical principle, but simply mechanical adaptation of well-known electric designs. Alternating current alone is available for the purpose in question, and normal motors have therefore a fixed speed of rotation which is a simple multiple of the generator-speed. Two methods of speed change are proposed each associated with a new form of motor. The principle of operation of the "Spinner" motor is that an ordinary normal motor driving the propeller at a fixed speed, with the shaft and propeller directly connected, is so arranged as to be rotatable as a whole about the propeller-shaft axis. This rotation is accomplished by a second motor concentrically arranged outside the first, so that the main motor system may be rotated in either direction—again at a fixed speed which is a simple multiple of the generator-speed—and the speed of rotation of the propeller-shaft and of the propeller in the water is the algebraic sum of the rotation of the main motor and of the rotation imposed upon it by the auxiliary motor.

As both motors are reversible it will be seen that in each direction there are three speeds:—

1. The speed of the main motor system: the middle speed.
2. The speed of the main motor system minus the speed of the auxiliary motor system: the low speed.
3. The speed of the main motor system plus the speed of the auxiliary motor system: the full speed.

The combination may be designed for any three-speed ratios, such as 1, 2, 3; 2, 3, 4, etc. Any intermediate speeds required are attainable by adjustment of the turbine or engine-governor, which can be operated economically through a range down to about 75% of full speed. The same method is applicable to non-reversible internal-combustion engines.

The "Multiple" motor is an ordinary squirrel-cage induction-motor in all respects, except that its stator is wound with two or more independent electric circuits each associated with a separate source of supply of energy. For example, the motor may be fed from two sources of supply at 25 to 50 periods respectively, the motor-windings being for 46 and 92 poles. At full power and speed both windings are in operation under their most advantageous conditions; each of these windings results in a synchronous speed of 66 revolutions per minute. When the 25-period current is supplied to the 92-pole winding the speed is 33 revolutions per minute. Either of these motors permits of one or more generators being used together in the same mechanical system without electrical connections or synchronizing devices.

The author discusses the application of electric propulsion to certain definite types of ship, and also gives diagrams illustrating the saving in space obtained. The examples worked out are as follows:—

(i) In a cargo-vessel of 840 shaft-horse-power the normal reciprocating engine equipment with a single screw would weigh 570 tons for engines, boiler and fuel. The electrical equipment, consisting of three oil-engines, three motors and three propellers would weigh only 270 tons, including fuel. Further, with coal at 20s. per ton and oil at 40s. per ton the saving in fuel-cost on a total of £17 would be £5 6s. per day at full power.

(ii) In a similar cargo-vessel gas-engines might be used. Taking an equipment of 770 shaft-horse-power, and using three gas-engines and one multiple motor, the respective weights of the normal and proposed equipments would be 446 tons and 229 tons. The consumption of fuel shows an equally favourable comparison.

(iii) A third cargo-vessel, but of 1,030 shaft-horse-power, is worked out for the purpose of illustrating the application of steam-turbines to the multiple motor. One plant drives the ship under normal conditions: extra power is supplied by a small turbo-generator, and is used to keep up the ship's speed in heavy or contrary weather.

(iv) On a passenger-vessel of, say, 16,200 shaft-horse-power, the electrical equipment permits of a sub-division of the plant, so that at ship-speeds lower than the maximum only part may be run, and that at full power. This advantage is gained without loss in full-power economy, and without additional complication.

*Abstract of paper read before the Institution of Civil Engineers, Dec 7.

DESIGN OF GENERATING STATIONS.

At the Students' meeting held at the Institution of Civil Engineers, London, Col. R. E. B. Crompton, C.B., M.Inst.C.E., in the chair, Mr. George Ingram, Stud.Inst.C.E. read a paper on "The Design of Generating Stations." The author, having discussed at length the conditions influencing the choice of plant, went on to describe a suggested arrangement of plant for a shipyard, and for a large high-tension alternating-current station suitable for a bulk supply scheme. The author concluded by showing a number of lantern slides of various generating stations. An interesting discussion followed in which the following took part:—Messrs. C. J. Guttmann, E. Timothy, E. H. Spence, W. G. Fairweather, G. Lees, N. Smith, W. H. Pirrie, T. H. Williams, F. F. Arroya y Caso, H. G. Butchart and W. D. Pile.

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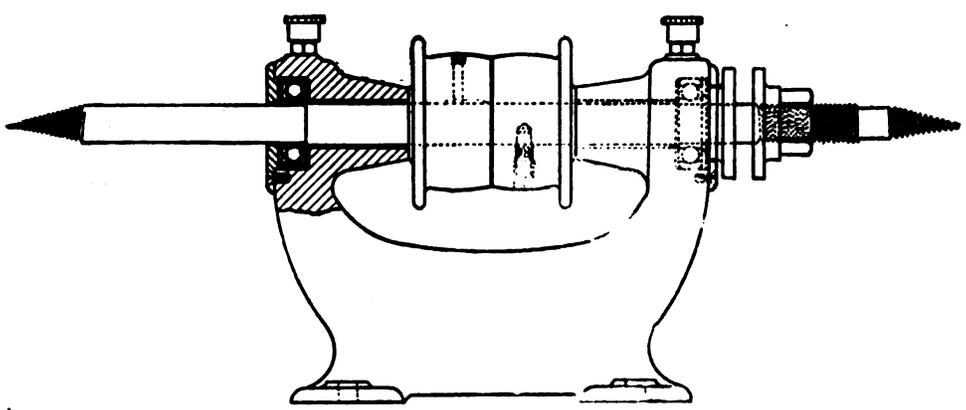
PUBLICITY.

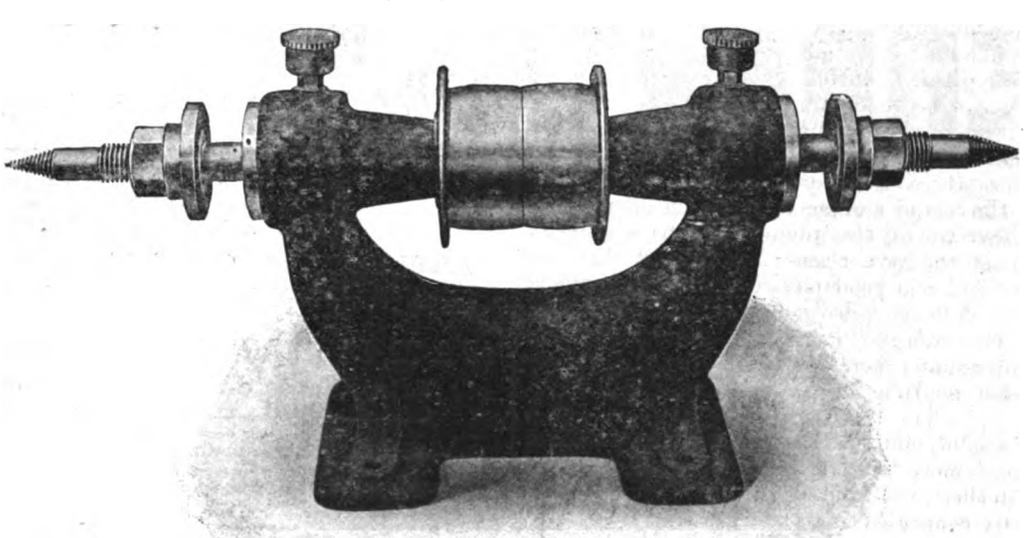
In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

Ball Bearing Polishing Lathes.

Among the latest developments in machine tool manufacture is the production by Mr. Charles Taylor, of Birmingham, of a new line of polishing lathes with ball bearings. These lathes are being made in three sizes, 9 in., 12 in. and 15 in. centre, and are likely to satisfy a long-felt want. There is no doubt that the loss of power in the majority of polishing shops is very great, and in many cases it goes on quite unsuspected where there is plenty of reserve power. By the use of really well designed and well constructed ball bearing lathes such as those under notice, a very large proportion of this loss of power is obviated. It need hardly be said that the ball bearings must be perfectly made and, when mounted, absolutely dust-proof. The saving in power and belts is obvious, and after actual practical tests extending over lengthened periods with the same class of work, first done on the ordinary type of polishing lathe, and then on the ball bearing lathe, the saving in favour of the latter may safely be set down for all round work at not less than 30%. In the above tests the ordinary type of polisher was a new one in first-class condition, and had the test been long enough for these bearings to have become worn and in the condition they are usually run in, the saving would no doubt have been nearer 50%. The accompanying illustrations show section through the bearing, and a complete machine.

The following are a few of the advantages of the ball-bearing type of polishing lathes: Reduction in power required in starting, 90%; reduction in power required in running full speed, 30%; bearings are absolutely dust-proof; lubricate with thick grease once a week only; no thin oil to drip or splash about; belts last three or four times as long; large saving in cost of belts, narrower belts do same work; no hot bearing and consequent loss of power; no wear in bearings and no adjustment to make; no lift or vibration in spindle due to wear. Moreover, all spindles are interchangeable, as also are all ball races; while any fitter can replace bearing or spindles with the certainty that they will run smoothly and with complete satisfaction.





ACCUMULATORS FOR CENTRAL STATIONS.

For many years electrical engineers looked upon a storage battery as something to be avoided; it was considered uneconomical and unreliable owing to its alleged unaccountable defects. The perfecting of the processes of formation, improvements in the mechanical construction of the plates, and the financial advantages which have

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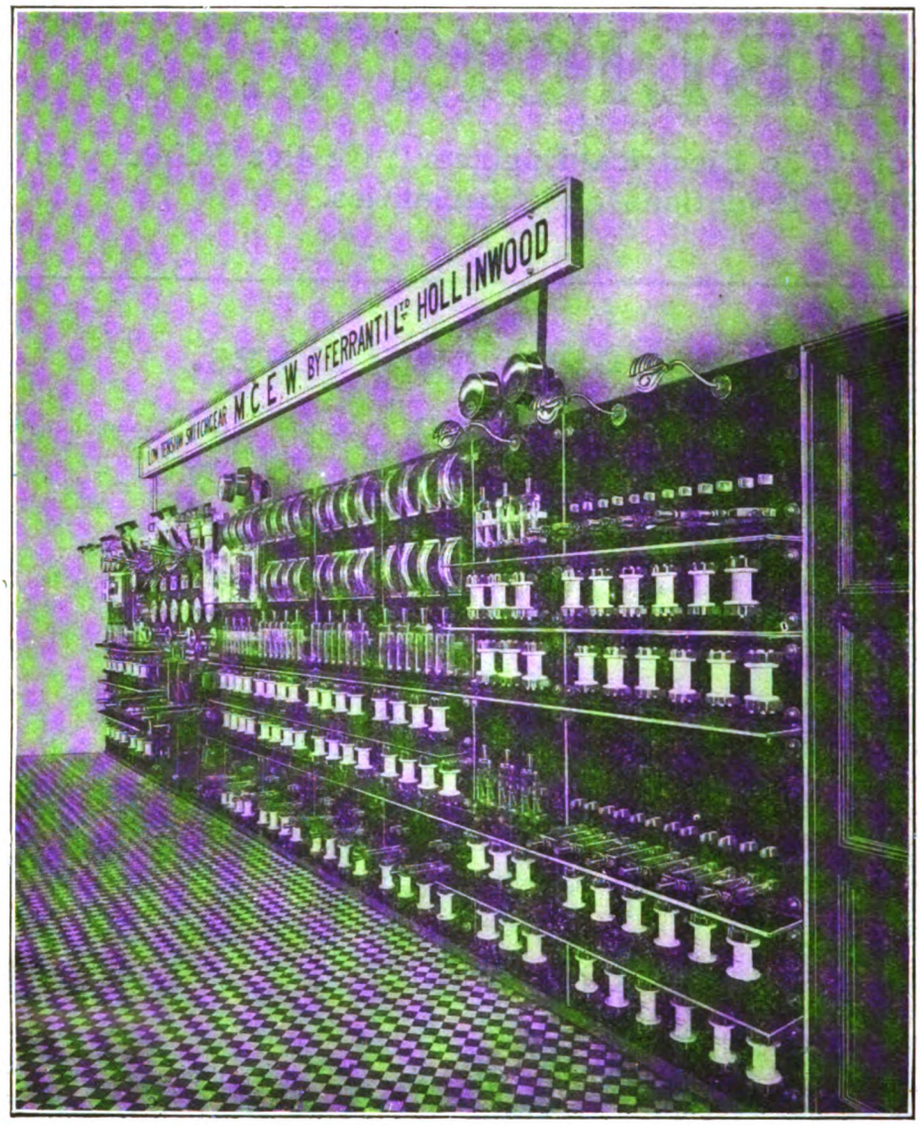

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resulted from the use of storage batteries, in all parts of the country, have caused this prejudice to be a thing of the past. Engineers have always appreciated that the storage battery had one great advantage over generating plant, viz., that it never failed suddenly under load, but until the last few years they have been under the impression that this immunity was secured only by an addition to their working costs, a fact which has now been disproved.

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G. H. RYAN, General Manager.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

Owing to our steadily increasing circulation and the ever widening interest taken in these Technical Problems, it has been found necessary to revise the old regulations.

The new Rules have been framed in order to encourage fresh talent to enter the field; at the same time it is hoped that the progressive lines adopted will meet with the cordial approval and support of our old and valued correspondents.

It is to be noted that these Rules only apply to Questions 1213 and onward. The first replies under the new conditions will appear in our issue of January 7, 1910.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

QUESTIONS.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

WEEKLY PRIZES FOR SOLUTIONS.—For the best solution of any question we offer a cash prize of *seven shillings and sixpence*. For the second best solution (if published) we offer a prize of *five shillings*.

For the third best solution (if published) we offer a prize of *two shillings and sixpence*.

QUARTERLY PRIZES.—No competitor will be awarded more than three third prizes, two second prizes, or one first prize during any one quarter. But, in adjudicating upon the merits of the various solutions, marks will be allotted to the four best solutions to each question, and at the end of each quarter extra prizes will be awarded to those competitors receiving the highest aggregate number of marks.

These prizes will be awarded in kind, the winners being at liberty to choose any book advertised or reviewed in our columns, or any instrument or appliance manufactured by any advertiser in our pages. These quarterly prizes will be of the value of *one guinea*, *half-a-guinea* and *five shillings*. Winners may, if they should so desire, order through us books or appliances of a higher value than their prizes, by forwarding to us the difference in price.

MSS. AND SKETCHES.—All answers to problems must be sent in within fourteen days of the question appearing in our columns. Replies should be concise and ought not to exceed one thousand words in length.

Quarto paper (10 in. by 8 in.) should be used, only one side being used, a margin 1½ in. wide being provided on the left side of each sheet. The number *only* of each question should be written legibly at the top left-hand corner of each solution. The solution should be signed with initials or pseudonym, and the name and full address of the contributor must be appended. Any formula should be set out on a line by itself; all letters and symbols in the text should be clearly written, to make them conspicuous.

Loose sketches should bear the *number* of the question and the author's name and pseudonym, and should be pinned to the MS.

Sketches must be drawn in ink, with good solid lines. Squared paper may be used, but as the faint blue lines are not reproduced by the photographic process, all horizontal or vertical lines to appear must be inked in with heavy, full dotted or chain dotted lines as required. Column width blocks are preferred, so it is well to draw sketches 6½ in. wide, for reduction to one-half.

Copyright of all solutions awarded prizes becomes the property of The Electrical Engineer, Ltd.

QUESTIONS.

Question No. 1209.—Describe the best arrangement of single-phase 2,000 volt 50 ~ switchgear and transformers for sub-stations up to 300 kw., allowing for six 50 kw. transformers and one rotary transformer for Röntgen raywork. Show clearly by cross sections and plans the best positions for transformers and plant and cables, showing clearly how the cables are led in and laid.

Answer to Question No. 1209 (*awarded* 10*s.*).—To deal fully with "E. L's." query would require many complex diagrams, and would first require considerably more information regarding the proposed plant than is given by the querist. However, I think the sketches Figs. 1 to 7 will be of some assistance. The design here dealt with assumes a rather elaborate equipment, and by sacrificing certain features which are not absolutely essential, a somewhat cheaper installation could be obtained. All the diagrams are similarly lettered, the key to the symbols employed being:

H = horn type lighting or "surge" arrester.
N = cone type ditto. D = isolating switches.
B = busbars. C = choking coils. O = oil switches.
F = oil fuses. H.T. and L.T. = high and low tension gear respectively.
A = ammeter. V = voltmeter. W = wattmeter.
~ = synchroscope. TR = transformer. FD = field switch.
R = reverse current relay.

Fig. 7 shows the connections proposed in a diagrammatic form. On long H.T. mains, even if these be entirely underground, it is usual to fit some form of lightning arrestor to enable the harmless discharge of pressure surges which may be set up by a number of causes. Horn arrestors H fitted in parallel with multi-gap cone arrestors N (or a water resistance) form good practice. H takes heavy discharges and N all minor surges. The choker C, composed

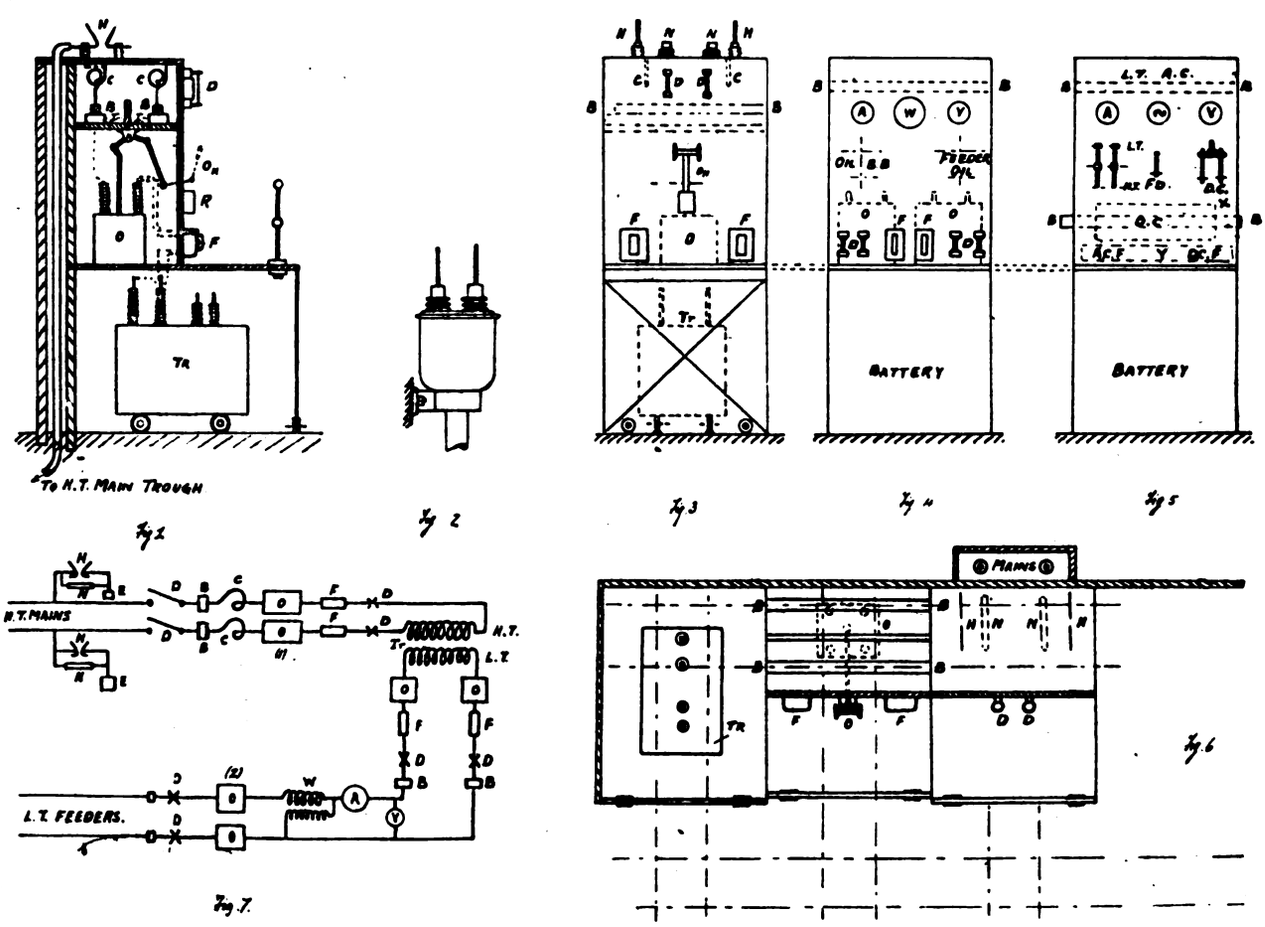

Fig 1. Fig 2. Fig 3. Fig 4. Fig 5. Fig 6. Fig 7.

of a few turns of thick copper strip, suffices to force high frequency oscillations *viâ* the discharge path. The isolating switches shown enable the isolation of the whole plant or of a faulty transformer or feeder. The measuring instruments need no comment beyond that they should be low voltage and low current types actuated by pressure or current transformers, as the case may be. The switches that will have to be opened on load are of the oil immersed type and, it being assumed that all the transformers are fed from one pair of H.T. busbars and fed on to one pair of L.T. bars, the switches (1) (2) Fig. 7 should be fitted with reverse current relays to prevent extended damage in the case of a fault on any of the parallelled circuits. If the L.T. sides of the transformers be not parallelled, the reverse relay on (2) is unnecessary.

Fig. 1 gives an end sectional view of a H.T. panel. The cable is taken right up the back of the board to the horn arrester H and to N (see also Fig. 6), or is brought into a sealing chamber (Fig. 2) at the bottom of the board and led up, as before, through insulators, the wire being bare or lightly insulated. The main isolating switches and the choking coils are placed at the top of the board, as shown, and the H.T. busbars are carried on insulators, are separated by an insulating partition. The main oil switch may be placed as shown, the oil fuses being on the front of the board. The whole of the above gear forms the upper tier or story of the switchboard, the ground floor chambers, of height to suit convenience and the size of the transformer cases, being occupied by the transformers. Presumably these transformers being small, will be of the self-cooling oil immersed type. Each transformer should be installed in a separate fire-proof chamber, which may conveniently be provided with a sliding door (interlocked with the main switches). The transformer is mounted on wheels, and rails are provided in the flooring (see Fig. 6) from the switchboard to the repair shop. These rails are normally covered by wooden strips. At least one spare transformer should be kept ready filled and dry. Replacement of a broken down set is then easily effected, and the sub-station need not be out of commission more than 15-20 minutes.

A separate panel may be allowed for each transformer, or two or more may be controlled from one large panel. All the H.T. panels may be grouped together, and all the low tension boards similarly grouped, or the whole gear for one transformer may be collected on one board or two adjacent panels. Assuming the former arrangement and the connections shown in Fig. 7, the L.T. panels may be arranged somewhat as in Fig. 4, the two oil switches being for the L.T. busbars and feeders respectively. If no L.T. busbar is used, but each transformer is switched straight on to its feeders, the first oil switch is unnecessary. Where busbars are used the feeder switches should be controlled by reverse current relays. The space under the switchboard gallery may now be used to accommodate the small accumulator battery probably installed and, if room permits, the rotary converter. In such a case the acid fumes from the battery must be drawn off well by a suitable fan and system of enclosure of the battery. Fig. 5 represents the converter panel; the arrangement of this will depend entirely on the method of working employed. The converter may be started from the D.C. side by the battery already mentioned or by the use of a small auxiliary transformer, the two-way switch S being then employed. The field switch and main D.C. switch, also the L.T. A.C. busbars and the D.C. busbars may be as shown. The dotted space marked Y, Fig. 5, may be devoted to the A.C. and D.C. circuit fuses, and the space marked X to such D.C. distributing switches, measuring instruments and accumulator control gear as may be necessitated by the exact conditions to be met.

With regard to the laying of the cables, this is a matter purely dependent on the sub-station concerned and on the arrangement of the switchboards round its walls. The type of sealing off chamber shown in Fig. 2 is almost universal for underground cables. The cable troughs in the station should be of concrete, wood covered, easily accessible and, of course, perfectly dry. In cases where vault-sub-stations are used, especially in tropical countries where severe storms are prevalent, it may be necessary to make the whole equipment of the mining ironclad-watertight construction as a safeguard against flood.—"S. M. P."

METHODS AND PRACTICE IN THE GERMAN ELECTRICAL INDUSTRY.*

By L. J. LEPINE and A. R. STELLING, Dipl. Ing., Students.

The financial development of the German electrical industry presents many features of interest and importance. To appreciate the present position of the industry, the successive stages of this development should be considered separately in conjunction with their bearing upon the present situation. Prior to 1899 the industry in Germany was divided up among a great many firms, none of which were as large or as powerful as the present-day leading electrical manufacturers. Even at this early date German financiers seem to have realised the advantages which would accrue from association of interests, and they commenced a policy of amalgamation. With each of the more financially powerful firms was associated a trading or investment company; the majority of the shares in the latter were held by the manufacturing company. With the capital at their disposal the investment companies were enabled to finance supply undertakings, the electrification of tramways, etc., and so obtain markets for the parent manufacturing firm. The remainder of the shares in the investment company were, as a rule, held by syndicates of financiers or by banks. Banks in Germany are of a different constitution to English banks. In the first place, their capital is usually much larger than is customary in England, and a large portion of this capital is always at the disposal of the directors for investment in industrial concerns. There are other so-called banks which are purely trading syndicates, and whose capital, or rather financial power derived from their capital, is solely used for the purpose of financing industrial undertakings.

As regards the electrical industry, the principal sphere of action of both wholly industrial banks and deposit banks having an industrial development department was in connection with supply companies and electric tramways or railways. When such a company was floated, the bank or investment syndicate took up or underwrote a certain number of shares. The necessary capital was obtained by the issue of bonds on the share capital of the bank and on the shares already held in other companies. The manufacturing company also took up a number of shares, shares already held being mortgaged for a purpose of obtaining the ready money. Where advances were made to companies for extensions, these were redeemed later by mortgages on the new plant or by a new issue of capital.

This system, as will be observed, readily lends itself to reckless speculation. During 1899 and 1900 a boom in electrical engineering led to much speculative promotion of electrical schemes and exaggerated extensions of existing ones; the result was an inevitable reaction. Depositors became alarmed at the investments made by their banks, and two banks, the Dresden and Leipzig Credit Banks, had to go into liquidation. It should be noted that both these institutions were deposit banks. The feeling of insecurity which succeeded caused a set back in all branches of electrical engineering, and we may describe the period from 1901 to the end of 1903 as one of reconstruction and amalgamation. In the first place, several firms had to undergo entire reconstruction, but the investment companies and private financial syndicates enabled other firms to successfully weather the depression. Many of the smaller firms which suffered were absorbed by the larger and more influential ones, and there emerged from this period the three great German combinations of Allgemeine Elektrizitäts Gesellschaft, the Siemens-Schuckert group, and Felten-Guilleaume-Lahmeyer. The amalgamated firms proceeded to strengthen their position and prevent *injurious* competition by completing certain working agreements. At the same time they left certain branches open to competition among themselves, especially those in which they found rivals in the smaller firms, whose interests were purely local.

During the years that followed, the trade in Germany as a whole slowly recovered. The direct result of the amalgamation and working agreements was that these powerful combinations and their associated syndicates were able to control the market, cause a steadying of prices.

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and an ultimate recovery of confidence. The heavy electrical machinery trade in Germany is now almost entirely in the hands of four large companies—the three already mentioned and the Bergmann Co.—the latter to a certain extent are a party to these working agreements. The capital of these firms stands at the figures in Table I.

TABLE I.

	£
A.E.G.	4,200,000 share.
	1,930,000 bond.
Siemens-Schuckert	4,500,000 share.
	990,500 bond.
F. & G.-Lahmeyer	2,750,000 share.
	1,250,000 bond.
Bergmann	1,050,000 share.
	500,000 bond.

The best proof of their success is to be found in the dividends paid by these firms during the last few years. We give the dividends for the last two years in Table II.:

TABLE II.

	1908.	1907.
A.E.G.	12% ..	12%
Siemens-Schuckert	10% ..	10%
F. & G.-Lahmeyer	8% ..	10%
Bergmann	18% ..	18%

One great advantage of their large capital is their ability to meet sudden demands caused by the advancement of engineering science, such as the erection of special plant for the construction of turbo-generators. As another example may be cited the participation of German firms in the Victoria Falls power scheme. Not only have they contributed a large portion of the necessary capital, but they are also erecting special shops for the construction of the generating plant, *i.e.*, 20,000 kw. sets. Turning to the investment companies, many of these became entirely merged in manufacturing concerns, and were thus enabled to substantially reduce their capital; others improved their financial position by disposing of their shares in unremunerative concerns and in the opening up of new fields.

A glance at the latest report of one of these investment companies shows that no supply company in which they are interested pays less than 6% dividend; the investment company themselves pay 10% dividend on a share capital of £1,600,000. In the improvement of the trade, the material assistance afforded by financial syndicates has been of such value that during 1908 a further step in electrical finance was taken. This was the establishing of two electro-trustee banks (Elektrotreuhandbanken) under the control of the large German electrical companies.

The present situation is one which in spite of the general trade depression must be described as satisfactory; electrical undertakings are readily able to find working capital independent of the state of the money market and of the manufacturing industry in general. Looking ahead, developments of a less pleasing nature appear to threaten. The various financial institutions, by providing the manufacturers with working capital and credit, enable them to compete successfully in all markets and render each firm independent of the others where capital is required; but should the activity of the banks be reduced from any cause, or should foreign and local competition become so keen as to cause repeated price-cutting, then the great disadvantages of over-capitalisation will make themselves felt, and the large firms will be driven to the formation of a huge trust, with their associated banks as a nucleus, their existing intimate relationship rendering the accomplishment of this all the more easy.

INTERNAL ORGANISATION.

In the offices of the firms in question a bureaucratic rule obtains. The keynote of the whole system is that each man's work is specialised. Each branch of manufacture is an organisation in itself, having its own drawing office, designing, costing, and clerical staff. Alternating-current induction motors, alternating-current generators and synchronous motors, direct-current small and large machines, and turbo-generators are treated in separate departments, as are also alternating-current and direct-current instruments, wattmeters and switchgear. There are separate drawing offices for estimating purposes for transmission schemes, lighting schemes and central station designs. A publicity department run by University graduates in literature is responsible for the catalogue and journalistic work. This department is officially termed the "literary" or "propaganda" department.

Besides this department and the estimating offices for the home trade, each firm has a foreign department which deals exclusively with inquiries from abroad, and which is in correspondence with the branch offices (outside Germany) and the subsidiary companies. The value of this department cannot be too highly estimated. All these various departments are subject to the "Verwaltung" or central authority, which also deals directly with the employees.

The average technical employee is more highly theoretically trained than in England. All members of the technical staff go through one of the drawing offices; in fact, it is in these departments where all German engineers start on a level footing, the chances of promotion depending chiefly on the quality of their training. Technical employees are usually bound under a contract which is all in favour of the employer. In this contract the employee agrees to publish no technical matter without the consent of his firm, to give no private tuition on technical subjects, nor to divulge any methods of the firm by whom he is employed. Further, all designs which may be patented are the property of his employer. The draughtsman is usually forbidden to enter the shops. Salaries are kept low; after leaving college the engineer commencing work at about 24 years of age receives £6 5s. a month. This increases with machine-like regularity until it reaches the maximum wage for the department. Holidays of more than three days either from head office or from a branch office must be granted by the central authority.

EXTERNAL ORGANISATION.

Each firm's trade in Germany is attended to by the head office and branch offices, while to subsidiary companies with their own branch offices is entrusted the control of their trade with other countries. In dealing with their home trade, the German method of working up connections is thorough. Besides obtaining business by the ordinary methods which are employed in England, they spend considerable sums of money in educating the masses. For instance, the following procedure is employed in districts where electricity is an unknown quality: Invitations are sent out to the principal householders to attend a lantern-slide lecture on the benefits to be derived from the application of electricity in the home or factory, and the interest of the population is thus aroused. The engineer then approaches the local mayor and other officials and persuades them to apply (either alone or in conjunction with other villages, as the case may be) for the necessary grant and powers to finance and erect the plant required. In this way many overland central stations have been erected in which the manufacturers have a pecuniary interest. Not only do they then supply the power plant, but also the whole of the fittings required by the consumers, and this on a very profitable basis.

With regard to European trade, this is developed chiefly by means of subsidiary companies having share capitals varying from £100,000 to £600,000, according to the country. These companies are all provided with branch offices, which are controlled by the subsidiary company financially, but which deal directly with the factory in technical matters. Again, complete staffs are maintained in the countries outside Europe where many competitive English firms are content to employ agents; often enough the latter have but the faintest ideas on the subject of electricity and its application. It will be seen from this and the foregoing paragraph that German firms are always in a position to treat inquiries from all countries with the utmost consideration, and to furnish very complete tenders which are sure to meet customers' requirements. They make a point of accurately ascertaining these requirements, to put it figuratively, "if a screw is required they are not content with being told the size, they want to see the place into which it is to fit." As the English firms rarely trouble to send experts to investigate proposed schemes, but are content to let branch managers or agents muddle through as best they can, it is not to be wondered at that German firms obtain so many profitable orders in open competition

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The following figures, taken from Board of Trade returns, will perhaps be of interest; they are given for the last few months:—

TABLE III.

	Electrical Imports to Great Britain from Germany.	Electrical Exports to Germany from Great Britain.
	£	£
May	72,843	3,933
June	89,779	4,494
July	92,708	2,137
August	73,321	881
September	82,313	1,841

These figures show a pretty good average of the trade done between England and Germany, as is evident from Table IV.

TABLE IV.

Electrical Exports of Germany and Great Britain.

	From Germany.		From Great Britain.	
	To Great Britain.	To other Countries.	To Germany	To other Countries.
	£	£	£	£
1907 ..	553,882	7,673,118	45,532	3,419,583
1908 ..	712,251	8,394,750	46,873	3,240,249

The sums included in the figures under "Exports to Great Britain" for electrical machinery are, for 1907, £227,991, and 1908, £250,402, these being the largest figures in any one section. Lamps also account for large amounts, viz., £129,244 and £240,989 respectively, these large figures being accounted for by the advent and popularity of the tantalum lamps.

WORKS AND THEIR SYSTEMS.

One is struck when passing through the works of all the four large firms already mentioned by the order and cleanliness which there obtains, though the ventilation leaves much to be desired. The machinery is most advantageously distributed with regard to light, transport, and the rotation of machining operations. For instance, in the new shop for building 20,000 kw. sets, the scheme is to move stator and rotor along ground and first floor respectively, entering the shop at one end in the rough, and leaving at the other end after testing. The large machine-erecting shops are also made to serve for advertising purposes in a very effective way. On each large stator or magnet yoke is stencilled its destination and output, so that the visitor or prospective customer is duly impressed in favour of the particular firm as he walks through their shops and finds that his friends or competitors have already placed their orders. Where narrow and long buildings of four and five storeys are in use, lighting shafts are arranged every 30 ft. or so. The very stringent factory inspection and regulations are responsible for the excellent protective devices on machine tools, these guards being more thorough and efficient than those in the average English works. Group driving of machines seems to be preferred by most firms, but one of the largest has nothing but independent motor drives. Each department has its own stores, and the departments are so arranged that a minimum amount of transport is necessary to pass each unit from one stage of manufacture to the next.

The capital at their disposal has enabled these firms to lay down large numbers of special machines, thereby reducing the time taken in machining and the wages of the machinists. German designers work with a view of adapting their designs to suit their machine tools. Automatic machinery is largely used, as are also turret lathes, but jig-work does not receive the same attention given to it by up-to-date English firms. Large machining plates for portable tools are in evidence. The majority of the machine tools are of American manufacture. Among the smaller special tools in use we may mention small circular electrically driven files used for slot-broaching and generally taking off odd corners, and electric soldering irons, especially one for sweating commutator connections. Practically all firms buy their iron and steel castings from outside, but have their own brass and aluminium foundries. The most striking feature in the works system is the working day. This consists of 18 hours worked in two shifts of 9 hours each, with ½-hour intervals in the middle of each shift and half an hour between the two. Thus the shifts are from 7 a.m. to 4.15 p.m., and from 4.45 p.m. to 2 a.m. This system has many great advantages; quick delivery is possible without the necessity of high wages and establishment charges due to overtime and "night-shifts," because the rates of pay in the two shifts vary but slightly. Overtime is an unknown quantity, the output per machine tool is doubled, capital charges are consequently reduced, and a larger number of men can be kept in constant employment. We regard this 18-hour day as one of the most important factors of Germany's competitive powers.

The system presents very few technical difficulties in management, the connection between the shifts can be maintained by means of detailed reports and co-operation between the foremen and charge hands of the respective shifts. The Trades' Unions have acquiesced in this system of double shift, and, moreover, are not likely ever to attack it. It is a system worthy of consideration by English firms, but the opposition of Trades' Unions would probably stand in the way of its adoption. The labour problem in Germany does not present the difficulties that it does in this country, two factors being mainly responsible for this. The first is the political nature of most of the Trades' Unions, these unions not having arisen as a result of evil conditions in the trades as was the case in England. When German industries were established, the examples they had from the previous 30 years in England enabled the Government to commence a series of legislative measures for the protection of the workman; in this way he was assured the many benefits for which his English brother had had to go through troublous times. To-day the German Unions have achieved much in the way of arrangements for arbitration, but, unfortunately, their tendencies are too political to obtain for them the strength of union which as non-political organisations they would possess. Another variety of Union is that supported by the employers, but this is more of the nature of a benevolent society.

The other factor is the thoughtful legislation on the part of the German Government; the labour question has been tackled in a most scientific way, and measures of great value to the workmen have been made law as a result of thoughtful consideration of the problem arising, without the misery of strikes on the part of the workmen. Strikes there are still, but statistics prove their decrease year by year. The Government cannot control all phases of the question, especially the question of minimum wages, but the laws regarding factory inspection, protective devices on machinery, and the hours and conditions of labour are excellently drawn up. Besides these, the laws relating to strikes and arbitration ensure fair treatment to the workmen. The system of labour exchanges has been so widely dealt with in the daily papers that we will not discuss it here. For the reasons detailed above, we do not think Germany will ever have to face such a labour problem as English manufacturers have experienced.

Another important feature in the cheap production is the low rate of wages paid. We have already mentioned the large amount of unskilled labour employed, but even the skilled labourer is paid at an extremely low rate. Thus we find that the average wage for mechanics is 32s., and winders on high-tension stators earn all in all 36s. a week as a maximum. Male winders of small induction motor stators and rotors earn anything up to 30s. a week. Female labour is employed very largely, all the taping of induction motor stators being done by females as well as actual winding of small rotors and direct-current armatures. Small coil forming and magnet windings are, of course, done by girls. We observed girls working turret lathes, tending automatic machines, testing arc lamps and instruments, and doing many other kinds of work usually done by men in England. We are bound to state that females

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can earn higher wages than those employed in English works, and they possess especial privileges under a very thoughtful legislation. Piece-work is the rule, with the "Kollonnen-system" in erecting. This system, under which one man is given finished units, a number of assistants and a fixed sum for the erection, out of which all wages are to be paid, is in vogue in England in the machine-tool trade. As regards individual workmanship, the German electrical engineering firms do not compare favourably with the English; "deep scratch and high polish," careless and untidy taping and stringing of coils and a lack of finish are too often noticeable in work of many first-class firms.

General Features and Design of Machinery.

Almost all German firms insist upon the acceptance of their own specifications, and will rarely, if ever, depart from these. Under this system makers stand or fall by their own designs and productions; they do not suffer the annoyance of petty alterations, and the experience of their experts in each branch enables them to supply an adequate article without having to submit to outside individual ideas. However strict a specification may be, bad workmanship will destroy its object. As regards dynamo electric machinery, an 80° F. rise after a six hours' run on full load seems to be the standard figure. Motors are rated to stand 25% overload for one hour, and 40% for three minutes, these overloads varying according to the size of the machines, and not being so high as those offered by some of the English makers.

Direct-current Machines.—The designers differentiate between slow, high, and extra high-speed machines, the latter being classed as "turbo-machinery," and are treated in a separate department. We shall also discuss this class under a separate heading. The line of demarcation between slow and high speeds is 20 m./sec. peripheral speed. Slow-speed machines are designed with a moderate ratio of iron to copper, and are often fitted with laminated poles. High speed have a larger ratio of iron to copper, and are often fitted with solid poles, either cast in or cut from a steel billet. Crane motors are designed on distinctive lines, and form a separate range. For smaller size of motors up to 40 and 50 B.H.P., cast-iron yokes seem popular. Manufacturers specify high magnetic qualities for this cast iron, and the founders are endeavouring with moderate success to meet such requirements. On larger sizes cast-in poles find very little favour, the most popular form being laminated poles in a steel yoke. The practice in winding field coils differs somewhat from the English. Large field coils are wound in three or four layers with ventilating paces between each layer. Bare strip for interpole winding has not yet been experimented with, though varnished wire has become practically universal for small size interpole coils. Brass bridges between the main pole-tips are used wherever interpoles are fitted.

Brushgear shows nothing new or interesting except that one firm use sheet-iron stampings exclusively in their brush-holders. It might be mentioned that the makers do not rely on one or two types of brushgear, some firms possessing from 15 to 20 different patterns. End-plates are very crudely designed; they are often too heavy and clumsy, though usually they have the advantage of permitting greater accessibility than do some of the English designs. Slot insulation varies considerably, but pressspahn and micanite on cloth seem to be the most extensively used materials. Core plates are still insulated by means of thin layers of paper pressed on to the plates. The plates are held together in almost every case by bolts which are usually insulated where they pass through the laminations.

The practice of cutting down the mica between commutator bars is very prevalent. Ball bearings are not adopted as standard practice. Taken all round, the English direct-current machine shows more modern principles of design, and except for slow-speed haulage motors, with which the Germans are very successful, England is in no way behind as regards design and workmanship.

Fig. 1 shows a set of curves plotted for the purpose of comparison of English and German direct-current motors up to 100 B.H.P. with the horse-power per 1,000 r.p.m. plotted against the weights. The motors were all taken on a 440-volt rating. It will be seen that the average German machines appear to be heavier than the English above 30 B.H.P., but under 30 B.H.P. there is not much difference. With regard to machines above 100 B.H.P., it was rather difficult to make a comparison owing to the fact that German makers favour slow-speed machinery, while the tendency in England is towards high speed. This variance is the result of the different engine makers standards in the respective countries. The German high-speed machines are built chiefly for belt driving. Regarding the electrical design, German firms used to design their machines with very large diameters and short length of core. This practice led to a large ratio of iron to copper in the armatures, the ratio of 2·7 to 1 often being reached. New designs have been brought out in which the weights of active iron have been reduced, and the ratios of 1·8 to 1

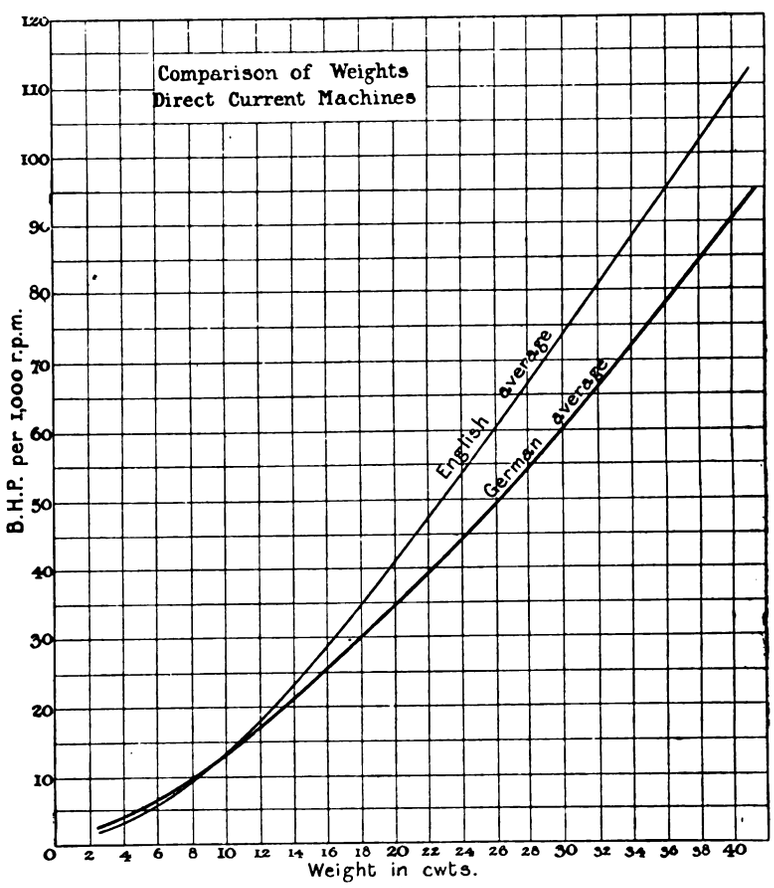
Comparison of Weights
Direct Current Machines
B.H.P. per 1,000 r.p.m.
Weight in cwts.
English average
German average
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
10 20 30 40 50 60 70 80 90 100 110 120

FIG. 1.

and 2 to 1 are now more prevalent. The saturation of the teeth is carried high, 24,000 lines per square cm. being a good average maximum density.

Induction Motors.—The tendency in the design of this class of motor appears to be towards long length of core and smaller diameter, possibly on account of their frequent use in driving high-speed centrifugal pumps, etc.; combined with this we find that forced ventilation is becoming more popular, most end-plate type motors being designed for driving a current of air through the motor parallel to the shaft. German engineers have been the first to recognise that vent ducts through the cores parallel to the axis are more efficient than radial ducts, and have begun to adopt this principle. The motors are very liberally designed with regard to iron, and most designers give a larger ratio of iron to copper than is English practice. This applies to inactive as well as active iron; there are large spaces between stator core and stator case, and there seems plenty of room for the end windings inside the end plates. Small motors without forced ventilation are built without any

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ventilation holes in the stator case. The stator windings of small motors are usually of the threaded through type in closed insulating troughs, semi-enclosed slots being invariably used. Steel rods are used to fill out the troughs when winding. All the taping is female labour, and is very often slovenly. It comes as a shock to an English engineer to see the primitive formers and methods in winding in vogue in German works. Large rotors are often wound with closed circuits as distinct from "squirrel-cage," and rotors are designed with one bar per slot connected in 3, 5, 7, or 11 phases according to size. Slip-rings are almost always gunmetal held on insulated rods with copper-gauze brushes as a general rule. They are arranged between rotor and bearing as standard practice, and are usually fitted with a short-circuiting and brush-lifting device. The terminals appear to have been very carefully designed, and are arranged on the stator core in a hole cored out of the stator case; this hole is covered as a standard practice with perforated zinc, and the whole presents a very neat finish. Altogether we are more favourably impressed by German induction motors than by direct-current motors, though English designs are in no way behind those of Germany. In Fig. 2 we give a curve of weights against outputs of German and English induction motors.

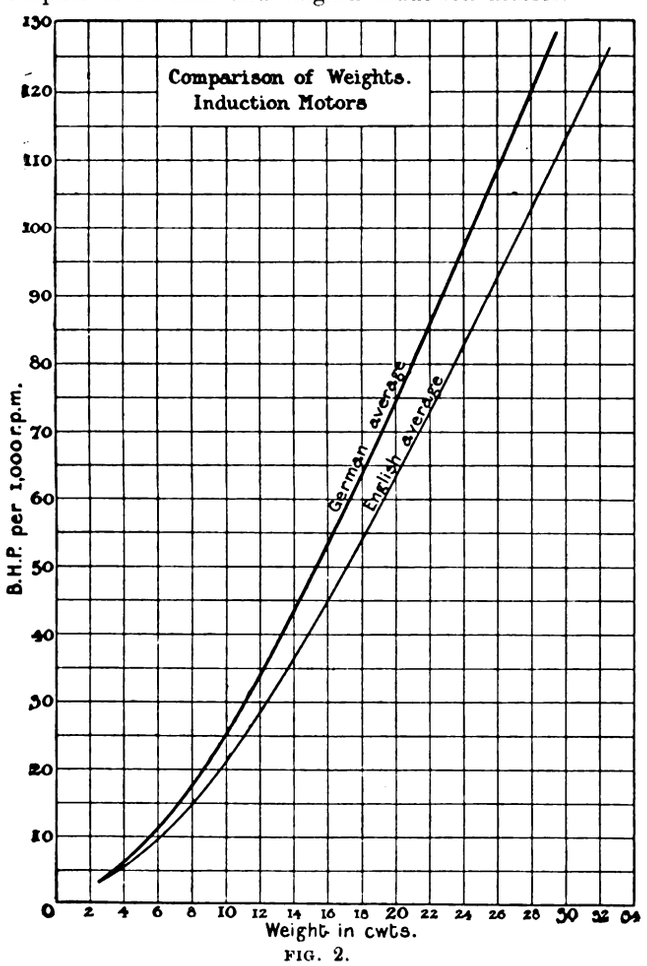

FIG. 2.

Alternating-current Generators.—Owing to the frequent use of long-distance transmission and "overland" central station, there is a larger demand for high-tension alternators than in England, and manufacturers have consequently gained large experience in the design of this class of machine. Here again are noticed the long cores and small diameters, and the axial ventilating ducts. The air-space between stator core and case is very large. In the design of rotating fields many variations are noticeable. Cast-steel hubs with cast-on pole-pieces are fitted with cast-steel shoes bolted on, or with laminated pole-shoes either bolted or dovetailed on to the pole-pieces. Solid pole-pieces are dovetailed into the yoke, and laminated pole-pieces are held in the same way. Where laminated shoes are used, they are fitted with phosphor bronze end-shields to support the windings. In a certain instance four copper rods were placed in holes through the laminated pole-shoes so near the surface that when turned up the copper was laid bare. These copper rods are short-circuited at their ends by strips into which they are riveted. For the field-winding square section insulated copper is generally used, though flat strip wound on edge and insulated by layers of paper is often used. For high-speed alternators the hub is built up of forged slabs 3 in. thick, into which the poles are dovetailed. In some cases the poles and hub are built up of slabs, pole-shoes being dovetailed on, and the windings held in place by special rings and wedges. In one interesting case, that of an eight-pole alternator 8 or 9 ft. diameter, and, consequently, worthy of being classed as a turbo-alternator, the whole magnet, yoke, poles, and pole-shoes are formed of slabs cut from solid forgings to the required shape. Eccentricity of the pole-shoes is obtained as follows:—

Grooves 2¼ in. wide are milled along the pole-faces; that is to say, one groove in each slab. In this groove laminations are placed whose outer radius is eccentric to the stator bore. The field windings are made as follows:—

Copper strip is wound on edge on a mandrel so designed that the turns are too long in the axis parallel to the shaft. The turns are cut forming two U-shaped pieces, and are then placed on the pole (which has been packed with insulation to the exact shape required), alternately with sheets of insulation in such a manner that one end of each of two adjacent coils overlaps the other without insulation, the pressure being sufficient to give good contact. Thus a complete circuit is formed. The coils are pressed against the pole-tips by means of wedges, and V-shaped pieces between the poles take up the component of the centrifugal force which would tend to pull the coils apart. The whole forms a remarkably solid and simple job. The wire for the high-tension windings, and, indeed, for all large machines is baked thoroughly before using, and kept in a warm, dry store-room until required. Mica on cloth forms the chief slot insulation, the layers of conductors in high-tension work being wound in separate tubes arranged in the mica trough. The practice as regards impregnating varies considerably. Wire impregnated before using is rarely employed; in most cases the whole stator is dipped and baked, but on large machines with open slots the practice is to impregnate and insulate the coils before placing them in the stator, and we have seen coils wound in position taken out to be insulated and impregnated, and then replaced. One firm tapes up the coils with a particularly coarse tape which has been previously treated with some bituminous compound. The result is a particularly porous article, but one which lends itself to very thorough impregnation and varnishing. The taping is done by females; it has been found quite practicable to have both men and women working together on big machines, the men winding and the women taping. On the whole, we are not favourably impressed by the insulation of the end connections of the stator winding, but the ample space which designers allow for their windings forms their factor of safety. Forced ventilation of alternators is rapidly being adopted, and the axial cooling ducts already described are becoming almost universal in their use. The stator plates are invariably held by means of bolts arranged outside the magnetic circuit. Until recently makers did not make a standard line of medium-speed alternators for large outputs, slow-speed machines for coupling to slow-speed steam or gas engines (slow speeds being general practice among German engine makers), and high-speed machines for coupling to water and steam turbines being the rule. It is interesting to note that the exciters are specially designed, and for direct-coupled units are fitted with an abnormally large number of poles for their output. Compounding of alternators is carried out by all firms even on medium-sized units.

Turbo-alternators.—No stator cases are made split on the horizontal centre line now, and, further, all large units are so arranged that the hot air from the stator is not delivered into the engine house, but is driven outside the building. Stator plates are held together by bolts, and are arranged with axial ventilation ducts. The winding of the stator coils is done by hand by most makers, the only formers for winding the end connections being the supporting clamps themselves. The winding is otherwise the same as on slow-speed alternators, except that we did not see female labour employed here. There are several interesting types of rotor construction, each firm has its own design.

(*To be continued*).

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ELECTRICAL PROGRESS AT HOME & ABROAD

FROM OUR SPECIAL CORRESPONDENTS.

TYNESIDE NOTES.

NEWCASTLE-ON-TYNE.

A paper of unusual interest to electrical engineers was read on Saturday, the 11th inst., before the North of England Institute of Mining and Mechanical Engineers at Newcastle-on-Tyne, by Mr. James Douglas, on electric simultaneous shot firing from a switchboard outside the mine. This has been advocated as an absolute safeguard against loss of life, although the risk of fire and of explosions of coal dust through mis-shots, still remains. A description of its application at Dawson, New Mexico, obtained from Mr. David Crow, the General Superintendent of the Stag Canon Fuel Co., was given. Speaking generally, this consisted of making use of the electric trolley wires in the mine for electric shot firing from a special station outside the pit by means of suitable tappings and special switching gear, The firing is done after all the men are checked out of the mine, and as the pitmen work from 7 a.m. to 5.30 p.m., and no work is done for an hour and a half before the shots are fired, it is possible to make sure by personal inspection that all the men are really out of the mine. In connection with the firing system, a wireman or firer and two fire bosses are employed; the former has to see that all the pitmen are out of the mine and that the power is off before he connects up the firing circuits to the various rooms. He has also to make sure that all the firing circuits are disconnected from the power lines after the shot has been fired; to see that the wiring is kept up in insulation, and that the miners are furnished with wire for extensions. Where workings are abandoned, he has also to see that the wiring for shot wiring is removed. The actual firing is done about 7 p.m., and after this he has to enter with a safety lamp and disconnect the switches, looking to see if there are any indications of fires in the mine. The fire bosses enter the mine at 3 a.m., examine the districts, and are out in time to inform the men as to the conditions of their working places. They also distribute electric caps and examine all the shot holes in their districts before they are charged. The explosive is fired by means of 6 ft. reliable exploders, clay being employed for tamping. At the point where the firing line is tapped on to the trolley wires there are two switches, one being in a box interlocked and keyed, so constructed that it cannot be closed and locked when the switch is thrown in, the other being open and auxiliary. There is another set of switches inside the pit mouth between the outside and the inside trolley wires; another set outside and inside the feed wires, and a third between the outside feed wire and the wire to the shot firers cabin. The main switch by which the firing is done is in the shot firers cabin. This paper is doubly interesting as being read at a time when electricity is being looked upon with suspicion as applied to mines, inasmuch as it demonstrates that in this connection, at any rate, the use of electricity is a positive life saver.

Activity in Mining Apparatus.

One of the Tyneside firms, Messrs. E. Scott & Mountain, Ltd., is progressing favourably with regard to the supply of apparatus for collieries, iron and steel works, etc. Among other plant which is now approaching completion is a set of two pumps for the Consett Iron Co., Ltd., each of which gives an output of 350 gallons per minute against a head of 470 ft. The pumps have rams of 12½ in. diameter and 18 in. stroke, and are driven through flexible couplings by means of 125 b.h.p. motors. These pumps are intended for use at the Langley Park Colliery. A similar pump to the Consett plant is being built for the Broomhill Collieries, Ltd., capable of lifting 500 gallons per minute against a 500 ft. head. The pump rams have a diameter of 11 in. and a stroke of 15 in., and the pump will be driven by means of cotton ropes from a 125 effective b.h.p. motor. There is also in course of construction a smaller pump for the Lothian Coal Co., Ltd., with rams 9 in. in diameter by 15 in. stroke, to deliver 300 gallons per minute against 1,336 ft. head. This will be driven by a Scott & Mountain 200 h.p. motor. They have also under construction two electric winding gears for Messrs. James Ross & Co., of Linlithgow, one being 350 b.h.p. and the smaller one being of 100 b.h.p. The larger winding gear has two drums of 7 ft. diameter and 30 in. wide, the power being transmitted to the drums by means of machine cut helical gear wheels. The gear has to wind from a total depth of 970 ft., and has an entirely new design of depth indicator. The smaller gear has a winding drum 5 ft. in diameter and 30 in. wide, and is designed for winding from the same depth. It has a jaw clutch for regulating the length of rope, and a post brake in addition.

Other Mining Work.

There are also other indications of the extension of electricity in connection with mining. One of these is owing to the fact that colliery companies are utilising electricity, not only for the actual purposes of the mine, but are also developing it in connection with the lighting of streets and houses, as under conditions of supply to collieries this forms the cheapest available illuminant. An instance of this occurs in a lighting scheme for the parish of Sherburn, which has been carried out on an overhead system by Messrs. Sydney Stobart & Co., electric lighting and power contractors, of Newcastle-on-Tyne, under the supervision of the bulk electricity supply companies which operates in this area. There is also probability of further electrical work in connection with the pit which is to be opened shortly by Messrs. Bowes & Partners at Dipton. Sinking operations are already in progress, and in the meantime electric light supply from a local electric generating plant is being utilised to carry forward operations during hours of darkness.

North-Eastern Railway Developments.

A report of the annual meeting of the North-Eastern Railway Institute contains important statements by Mr. A. F. Pease, one of the directors of the North-Eastern Railway Co. Among other things he mentioned that there would be considerable extensions to the locomotive works at Darlington, and the main offices were about to be moved to that town. This involves the employment of a large staff which would be removed from Gateshead as soon as the necessary buildings were completed. It is probable that the necessary work will be very shortly put in hand. Mr. Pease also predicted that if the chief officials were located in Darlington there would be no doubt that the main portion of building engines for the North-Eastern Railway Co. would be carried out in that town. I understand from another source that considerable progress has been made in the erection of a large boiler shop in Darlington, which will shortly be completed, and in connection with this works there is likely to be a considerable amount of electricity used, including some cranes of considerable proportions.

MIDLAND NOTES.

BIRMINGHAM.

Leamington is one of the places where the demand for electricity does not appear to have been affected adversely by the advent of metallic filament lamps. During the last two years the number of consumers has increased 28%, and on this and other accounts it has been found necessary to lay an important extension main. The cables have been manufactured by Callender's Cable & Construction Co., Ltd., to whom the whole of the electrical main work of the Birmingham Corporation was entrusted, as well as that in many other Midland towns, and the work in Leamington has been carried out under the personal supervision of their Midland District Engineer and Manager, Mr. George Barnard. The new main is a three-wire feeder running from the station in Wise-street through Warwick-street. It consists of stranded copper conductors, the outer conductors having a sectional area of ·60 sq. in., and the neutral wire one of ·30 sq. in. A small three-core pilot cable has

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also been provided, so that the pressure at Warwick-street or at Kenilworth-road can be recorded at the generating station. The cables are insulated with Lake Trinidad bitumen, filled in on the solid system in earthenware troughs finished off with hard blue Staffordshire tile covers.

Handsworth's Electrical Undertaking.

Probably, the keenest fight in connection with the Greater Birmingham Scheme, which includes the proposed absorption of Handsworth, has raged around the Handsworth electrical undertaking, and the various tramway projects which Handsworth is promoting. At a number of meetings held in the Handsworth district the figures have been differently approached with somewhat curious results. In regard to the Handsworth electrical undertaking, noticed some weeks ago under this column, the local Council claims to have made a profit last year. To this the Birmingham representatives retort that this profit is only arrived at by the omission to charge amounts in respect of sinking fund and depreciation. At a meeting held the other evening, Councillor Walthall, of Birmingham, asserted that the department had so far cost the ratepayers £3,000 as a burden on the rates. A more serious discrepancy relates to the cable route, which, on the Handsworth side of the city boundary, will presently come into the possession of the Council, and the electrification of which is foreshadowed. The Handsworth Councillors, basing their calculations upon the profits of the present company, the British Electric Traction Co., anticipate a profit of £12,000 a year, or, at a moderate estimate, £10,000. But the Birmingham representatives point out that £72,000 has to be paid under a recent arbitration for the Hockley Dep't, and the rolling stock. The former will have to be pulled down, and the latter scrapped and, by a calculation based upon this expenditure, and the requisite amounts for loan, interest, and sinking fund, the advocates of annexation arrive at the conclusion that Handsworth cannot depend upon a profit of more than £6,000. They point out that £5,000 for law costs, added to £72,000, makes £77,000, and, deducting the scrap value of the undertaking, this would represent £64,000 as the net amount for goodwill, while £50,000 would be expended on reconstruction, including new tram sheds and works, bringing the liability to £114,000, which at 6% for interest and sinking fund represents £6,840. The calculation adds 2% for depreciation, making a total of £9,120. The Birmingham calculation is that the earnings will not be more than 2¾d. per car mile for 725,000 miles run, which totals £8,307, and will thus leave Handsworth with a loss of £800 per annum. The above calculation was put forward by Councillor Barrow, and is likely to figure prominently in connection with the Local Government Inquiry now in progress in Birmingham. At a meeting of the Handsworth Council, an effort was made by a minority of the Council to postpone the application to Parliament for powers to construct new tramways, of which particulars have already been given in THE ELECTRICAL ENGINEER. But the effort was a failure, and the Council purpose applying to Parliament next session. On this scheme, there is considerable variety of opinion, and, at a meeting the other night, one of its critics, an ex-councillor, denounced it as "a wild-cat scheme." The Handsworth Council, however, mean to stick to their guns, and fight to a finish for their local independence.

Protecting Mains.

One of the troubles of small stations, the revenue of which does not justify the most expensive methods of laying out plant, is the liability of damage to the mains by those disturbing the soil for other purposes. A great deal of trouble from this cause has been experienced at Redditch, but the difficulty is now believed to have been overcome, partly through the publicity given to the engineers' complaint, but chiefly through the precaution which is now taken. Each of the mains has been covered with 6-inch boards. This, in most cases, will serve as a protection against unwitting injury, and will in all cases indicate to persons disturbing the ground the need of proceeding cautiously.

Accident to Mr. Ferguson.

The manager of the electricity department at Redditch, Mr. W. J. Ferguson, recently met with an alarming accident. He was superintending some alterations on a new transforming chamber on Prospect-hill, when he came in contact with a live wire. He not only received a severe shock, but almost all the flesh was burnt off his left hand. We are glad to say that Mr. Ferguson has recovered from the shock, and is going about his duties as usual, while the injury to his hand, though severe and painful, and not likely to be healed for some time, is not expected to have any permanent effects.

The Electric Club.

The fifth annual meeting of the Birmingham and District Electric Club was held at the Colonnade Hotel, Birmingham, on Saturday last, Mr. G. A. Pope (Vice-President) occupying the chair, in the absence, through illness, of the President (Mr. George T. Wood). The annual report, while recording a good year's work, stated that the membership remained steady. Eleven new members had been added during the year, but as other members, owing to fluctuations in the electrical trade, were constantly migrating to other centres, this had produced no increase. The finances of the club were considered to be in a good condition, with a balance in hand of £13 12s., compared with a balance at the commencement of the year of £10 9s. 7d. The members selected as their new president, Mr. G. O. Donovan, M.I.E.E., in succession to Mr. G. T. Wood, and Messrs. F. W. Foster and T. H. Hunter as vice-presidents, the Secretary (Mr. Riddle), Assistant Secretary (Mr. D. G. Page), and the Treasurer (Mr. E. A. Morgan) being re-elected. A committee of three was chosen as follows: Messrs. A. B. Mudie, E. W. Kay, and F. O. Thompson. A paper to be read during the coming session by Mr. Dudley on "Mond Gas" was announced, and Mr. Jolly will read a paper on the application of electricity to printing machinery. Many electricians, he said, who were proficient in their calling, were unacquainted with the exacting and special requirements of this type of machine.

LANCASHIRE NOTES.

MANCHESTER.

There are some signs of a real revival in the state of the electrical industry. One or two of the larger firms in the district report that during the past fortnight they have had a sudden rush of orders which will keep them busy for some time. As usual, a large proportion of these orders are from abroad, where Lancashire electrical goods have acquired great popularity. It is pleasing to notice, however, that the number of home orders shows a considerable improvement. This applies particularly to the demand for electrical machinery, a branch which has felt the recent bad state of trade more than any other. This is a very healthy sign, and there is no doubt that the demand for cable, switchgear and general accessories will also largely increase within the next few weeks. The accessories business will also receive many orders, for the use of electricity among small consumers is extending rapdily in the Lancashire district, thanks to the very energetic efforts of all the supply authorities to increase their loads and maintain their revenue.

Governing of Exhaust Turbines.

In view of the great interest that electrical engineers are taking in the exhaust steam turbine for plant extensions, the following method of governing, suggested in Mr. T. W. Bailey's recent paper before the Manchester Association of Engineers, is worth notice. He suggests a combination of reciprocating engine, turbo-dynamo, and "motor-dynamo." The turbine would take the exhaust steam from the engine and drive the generator. The "motor-dynamo" is mounted on the shaft of the engine and acts either as a dynamo or motor according to conditions of load. Take the usual case of the power required from the turbo set being less than its rated output. Now, unless special governing arrangements are made, the output of the turbo set is determined by the governor of the reciprocating engine, which is controlled by its speed, and this again by the load on the engine (this load would usually be independent of the load on the turbine). Under these circumstances, the surplus power from the turbine would be passed into the motor-dynamo on the engine shaft, thus helping to drive its load,

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and so reducing the steam otherwise required by the engine. The steam supply to the turbine would then be correspondingly reduced, and also the surplus electric power with it. A balance would thus be obtained and steam economised. In this way the problem of governing a turbine which receives a quantity of steam determined by a quite different load is overcome. There is, of course, the extra cost and complication of the motor-dynamo, which would have to be large enough to deal with the temporary out of balance load likely to be put on to it.

The Lancashire Power Co.

In East Lancashire, the district covered by the present operations of the Lancashire Power Co., progress during the last half-year have been very satisfactory from every point of view. Up to the end of 1908 they had great hopes that textile manufacturers would have been very large, if not the largest consumers of electrical energy. Owing to the bad state of the cotton trade, however, manufacturers have not been in a position to change over from steam driving. At the present time, the greatest demand for electricity comes from colliery owners, who use the power for pumping, ventilating, driving air compressors, lighting and, in some cases, for hauling. So far no coal cutters in the district are electrically driven, nor are there any electric winding plants. However, this is only a matter of time. East Lancashire has been, perhaps, the last of the great colliery districts to recognise the great value of electricity in the mining service; but it seems from the recent connections to the company's mains that it is now determined to make up leeway, and at least use the most up-to-date plant. Installations have been completed by the Power Co. in the neighbourhoods of Westhoughton, Little Lever, etc. The large colliery at Outwood, in the Pendlebury district has also an installation, while important work is in hand for the Earl of Ellesmere's collieries. Perhaps one of the most important installations is in connection with the engineering trade. This is the supply to the large new works near Bolton, of Messrs. Dobson & Barlow, who have a world-wide reputation for textile machinery. One gratifying feature in connection with the company's power supply is that to bleach works. Some four or five bleaching firms who commenced their initial supply 12 or 18 months ago are now preparing for the almost exclusive use of electrical energy. This proves that great economies have been shown in this service and that the cleanliness and convenience of electricity is particularly valuable in such trades as the bleaching, calico printing and dyeing industries. Here, I understand, the electrolytic bleach has not yet been successfully employed, although one firm in the district made the experiment on a fairly large scale, using their own plant. Weaving concerns are probably making the slowest advance in the conversion from steam to electric driving, but no doubt the cotton market has been the cause of the delay. In addition to having made great "conversions" in their district, the company have made other important advances. About a dozen provisional orders have been recently taken over, and the work of laying mains to several of these districts is already well in hand.

AMERICAN NOTES.

NEW YORK.

An interesting and valuable paper on the application of electricity to the propulsion of naval vessels has been read by Mr. W. L. Emmet, at a meeting of the New York Society of Naval Architects and Marine Engineers. Mr. Emmet first described a combination drive using both electric motors and low pressure steam turbines mounted on each of twin screw propeller shafts. The mtor would receive energy from a generator driven by a high-pressure turbine which would exhaust through the low-pressure turbine. The adjustments would be so made that at full speed the motor would deliver two-fifths and the low-pressure turbine three-fifths of the power taken by the propeller shafts. At low speeds the low-pressure turbine would carry no load. The motors would be of the two-speed squirrel-cage induction type without provision for reversal; the low-pressure turbine would be fitted with two reversing stages similar to those that would be adopted with direct turbine drive. As already mentioned in these notes, this plan has been made the subject of a proposition to the Government for one of the new battleships, the turbine part being designed by the Fore River Shipbuilding Company and the electrical part by the General Electric Company.

Complete Electric Drive.

The second portion of Mr. Emmet's paper was devoted to the plans for a complete electric drive under which it is proposed to mount on each propeller shaft two motors, one of which would be arranged with pole-changing switches so as to adapt it to use at lower speeds, this motor being similar in construction and performance to that proposed with the combination drive. The other motor would have only a small number of poles for use at high speeds, but would be of the wound-rotor type adapted to producing the high torque desirable in rapid changes of the ship's direction. Mr. Emmet says that the electric speed change involves no kind of complication, difficulty or uncertainty. The efficiency of the electric speed-reducing arrangement is 92 per cent., which is higher than any other arrangement that can be used for the same service. Calculations show that with the electric drive there would be a reduction in the machinery weight from 520 tons for the steam turbine drive to 354 tons; a decrease in the steam consumption from 25·6 lb. to 17·8 lb. per hourly horse-power; and with the same boiler equipment, an increase in cruising range from 4,700 to 7,600 miles at 12-knot speed, or in maximum speed from 20·5 to 21·2 knots.

The Melville-McAlpine Gear.

In this connection it is important to note that the invention of Rear-Admiral G. W. Melville and Mr. J. H. McAlpine, of which I gave some preliminary details a few months ago, is now ready for immediate practical demonstration. The essence of this scheme is the use of direct gearing with a ratio of reduction of 5 to 1, which would permit a speed for a 6,000 h.p. turbine of 300 r.p.m. at the propeller shaft. The gear problems involved have been worked out by means of a set of two helical involute gears, with a floating frame for the pinion to equalize the wear and insure permanent alignment. The saving in weight claimed for such a device over reciprocating engines and their auxiliary equipment is from 50 to 65% a very important consideration in marine work, especially in warships, where every gain in weight means added strength in armour or capacity in guns. In experimental operation the gearing has transmitted 6,000 h.p. under practical working conditions at an efficiency of 98·7%.

The Monorail Criticised.

There are some very outspoken editorial remarks on the Brennan Gyroscope Car in the current number of the *Electric Railway Journal* of this city. The writer says: "We have never enthused greatly over any of the many monorail projects, all of which have been widely heralded as about to revolutionize the transportation industry and as desirable substitutes for ordinary two-rail track construction. But of them all that which depends upon a large flywheel or on several flywheels, carried on the car, as the only projection against the derailment of the car and the death of all the passengers, is about the most impracticable. Some dangers exist in all means of transportation, but they are at least minimized in a railway of the ordinary construction where, if the machinery breaks down and a stop has to be made, the car is in a state of stable equilibrium. We cannot look upon the new car of Mr. Brennan's in any other way than as a magnified toy, so far as the practical requirements of transportation are concerened."

Electricity and Christmas.

The electrical trade papers in this country are beginning to blossom out with attractively displayed advertisements calling the attention of dealers to the wide range of electrical appliances which are suitable for Christmas presents. Nothing could indicate with greater force the advance which has been made here in the manufacture of such devices as electric toasters, hair-dryers, curling-tong heaters, chafing dishes, electric kettles and irons, cigar lighters, foot-warmers, egg boilers, coffee-makers, and kindred appliances. All these articles are brought to an absolute perfection of finish, and are sold at prices which are tempting to the public, while still leaving the dealer

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an excellent profit. The General Electric Company's advertisement may be cited as a type of these announcements. It covers a full page, on which several domestic adjuncts are illustrated with half-tone blocks. "Make Christmas Shopping Electric Shopping" runs the heading in bold but graceful lettering, and then follows the application: "Most people are now puzzling over the selection of Christmas presents. They are on the look-out for gifts that will bring especial pleasure to their friends. G. E. Electric Heating Devices are just the thing for gift purposes. They possess the superior qualities of novelty, attractiveness, and utility, a combination which makes a strong appeal to Christmas Shoppers."

St. Nicholas and Dayload.

Another of these announcements depicts a merry St. Nicholas bearing a chafing dish to a charming lady in evening dress who is gracefully operating another electrical device. "Let St. Nicholas bring you Dayload Customers," runs the caption. "Those who want their Christmas presents to be different from the rest; those who at this time of the year have something extra to spend on their friends; those who are looking for useful as well as ornamental gifts; are the ones to whom Central Stations can successfully present the merits of General Electric Heating devices"; and so forth.

Electric versus Steam Drive.

Mr. F. W. Ballard, President of the Ohio Society of Mechanical Electrical and Steam Engineers, in the course of a paper on power costs for factories gave calculations showing that the steam consumption of steam pumps is often at least five times that required by large central engines driving generators for supplying energy to motors for doing the same work, and in extreme cases with long lines of steam pipe and intermittent service the steam consumption has been found to be ten times what would have been required by central units for the same service. In the discussion which followed the reading of the paper Professor W. T. Magruder reported the results of an investigation which showed that the cost of operating a certain boiler plant for steam heating alone, in the wintertime, was nearly equal to the cost of running the plant for both the motor service and the heating service combined. In speaking of group drives, he cited a case where 800 h.p. was required to run the shafting during the noon hour while only 1,000 h.p. was needed to operate the shop during working hours. With mechanical transmission the losses may be from 40 to 50%, while with electrical transmission the losses may be reduced to 15%.

For and Against Electrification.

Chicago, writes my correspondent in that city, is now in the throes of a public inquiry into the question of the electrification of the railway terminals within the city limits. Speaking quite impartially, it must be recorded that the witnesses called by the railway companies have so far had nothing very convincing to put forward in opposition to the proposed reform. The most important point made occurred in the testimony of Mr. P. Calkins, of the Brotherhood of Locomotive Engineers, who urged that, in the event of electrification being adopted, many members of that Brotherhood would be thrown out of work. He overstepped the limit, however, when he urged as another argument against the proposal that electrification in New York had resulted in great loss of life and injuries to trainmen; the fact being that the loss of life under electrification has only been 62% of what it used to be under steam. The vice-grand-master of the Locomotive Firemen's Union, Mr. A. P. Kelly, supported Mr. Calkins. His chief point was that smoke could not be unhealthful because he had been stoking for fifteen years, enjoyed splendid health, and weighed 250 pounds! The Illinois Central was legally represented by Mr. Blowett Lee, who, however, had not much to say beyond suggesting that the time limit of the electrification Ordinance was too short, and the penalty of $200 a day for non-compliance too heavy. Mr. W. A. Gardner, vice-president of the Chicago and North-Western made several strong points. The railroads are bound up so intimately," he said, "with the industrial and commercial life of the city, that it will be impossible to effect this great change without affecting the business interests. The North-Western alone has approximately 375 miles of track in the city, and it has never less than 10,000 freight cars on these tracks. Considering all the railroads, 2,000 passenger trains enter and depart from the city every day, and there is a movement of no less than 65,000 freight cars in and out of Chicago daily. The change proposed in the ordinance is a revolution, and should receive very careful and long-continued investigation. Conditions in New York and Chicago are very different. For instance, there are 13,000 track switches in Chicago, and every one of them means a complication of the electrification problem." Mr. Gardner admitted that his company makes some smoke, but less than it ever made before, and it promises to make still less in the future. Smokeless coal is used, for which the company pays $3·05 a ton, although Illinois soft coal could be bought for $1·70. It is evident that there is going to be a strong fight on both sides.

Current Items.

Tungsten lamps of 600 and 1,000 c.p. have been imported this week from the Just factory in Germany by the Electrical Accessories Company of New York.

The Rockland Railroad Company, a New York incorporation, which proposes to construct an electric railway to connect Tappan, Suffern, Stony Point and Nyack, will be ready to begin work on construction of the railway early in the spring. The railway will be about 40 miles in length.

The demand for small motors is reported by the Garwood Electric Company to be so unusually heavy that prices have recently been advanced 5%, and in spite of this it is found necessary to operate the plant both night and day. Officials of the company say that the books are full of orders and that inquiries are coming in from all parts of the country.

The Canadian Light and Power Company has awarded a contract for three 5,000 kw., 2,200 volt generators, and for transformers to step up to 44,000 volts, to the Allis-Chalmers-Bullock Company.

Titanium ore in the form of rutile, or titanium dioxide, has been mined in Nelson County, Virginia, where a plant has been erected to extract the metal from the ore. Titaniferous iron ores are mined in New York, Minnesota and Wyoming. A report on the production of titanium and other rare metals in 1908, prepared by Frank L. Hess, has just been issued by the United States Geological Survey.

The Carnegie Steel Company, of Pittsburg, has received orders from Brooklyn for 7,000 steel wheels for electric cars, the intention being to do away with the chilled iron wheels which have been used under the Brooklyn cars so long. The Carnegie company has promised to deliver the entire order before February 1. It is estimated that 4,000 tons of steel will be required in making the wheels.

The Grand Rapids Electric Railway Company proposes to construct an electric railway from Bay City to Grand Rapids and thence to Kalamazoo; also to extend the railway from Kalamazoo to Battle Creek, thence to Coldwater, Montgomery and Camden.

The County Electric Company, of Manistee, Mich., will construct dams in the Manistee River for the purpose of developing water-power. It is proposed to erect six dams at High Bridge Junction and other places varying in height from 15 to 45 ft. Electrical energy is to be generated, and the city of Manistee and other municipalities in the county will have the first right to purchase it, and, following them, private business concerns.

The McClintic-Marshall Construction Company, of Pittsburg, has purchased a tract of ground comprising 50 acres in Indiana Harbour, Ind., at the southern end of Lake Michigan, near the boundary of Chicago, on which to erect a structural steel plant which will be in readiness for manufacturing operations within a year. Its capacity will be from 60,000 to 70,000 tons of structural steel annually, and a considerable use will be made of electricity for light and power. At Lebanon, Pa., the American Iron and Steel Manufacturing Company will erect a steel billet mill. The plant with its machinery will involve an expenditure of more than $500,000, and extensive use will be made of electricity for operating motors as well as for lighting

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GERMAN NOTES.

BERLIN.

The Prussian authorities are seriously studying the usefulness of wave telegraphy in fogs, and have established two small experimental stations on the Muggelsee, and very satisfactory results as regards penetration and also as regards the determination of the direction from which the signal received has come are said to have been already obtained.

Determination of Locality by Wave Telegraphy.

The rapid development of aerial navigation has made the question of enabling the aeronauts to determine their position at any hour and in any weather extremely urgent. Light signals are useless in many atmospheric conditions. Sound signals are often damped in the same way and can only be made from inhabited places. Astronomical observations can only be made in clear weather. The solution of the problem seems to be afforded by wave telegraphy. A system has been proposed by F. Lux, of Ludwigshafen, which seems to be very promising. He proposed to establish over the land a network of wireless stations of moderate reach, each station to give an identifying signal automatically at definite intervals of time. The aeronauts must carry a receiving apparatus so that they can tell from the signals they receive where they are. Herr Lux considers that 90 such stations would suffice for the whole of Germany. When there is an electrical station at or near the place of one of the proposed stations it should be utilised for the purpose. Each signal would consist of two, or at most three letters of the alphabet, and the times of sending the signals out would have to be arranged so that it would be impossible for two or more of them to arrive together. The receiving apparatus for the balloon or airship would weight about 3 kg., and cost from 100 to 150 marks, and the land transmission apparatus for each station would cost about 1,000 marks. Herr Lux estimates the cost of the upkeep for the 90 German stations at about 50,000 marks a year.

Alternating Currents in Surgery.

According to the *Zeitschrift fur Schwachstromteknik*, alternating currents of high frequency can cure calcification of the arteries, a frequent concomitant of old age, and a constant cause of death. It has long been known that strong currents of low voltage diminish blood pressure, which is increased by high voltages. The power of high frequency alternating currents of curing selerosis of the arterial coats depends upon the former fact. It is possible that these currents decompose the carbonate of lime, so that it can be dissolved away from the muscular fibre. Montier, of Paris, considers that calcification is due to the presence of some specific poison, which is destroyed by alternating currents. Forceau de Cormelles and others think, however, that the infiltration of lime is due to over pressure, and that when the blood pressure is reduced by the air of alternating currents, the vis medicatrix does the rest.

Improved Galvanising.

It is obviously important to galvanise as rapidly as possible, and for this purpose strong currents are used. They have the drawback, however, that the electrolyte at the cathode becomes so dilute very quickly that the deposition is made useless. The same trouble occurs at the anode, less quickly, it is true, but fast enough to cause great inequalities in the thickness of the metal laid down. Stirrers working in the liquid are a remedy to a certain extent, but do no more than mitigate the evil. Maximowitsch has found that the trouble can be completely removed by having the electrodes lying horizontally, with the anode above the cathode. When this arrangement is adopted the stronger liquid around the anode sinks and enriches the weak liquor around the anode. In fact, the cell is made to stir itself and does so for nothing, and more effectually than solid stirrers which cost money to provide and drive. A silk cloth is stretched between the two poles to catch fragments which may become detached from the anode. Excellent results are got with a solution of 250 parts by weight of copper sulphate crystals and 25 of concentrated sulphuric acid in 1,000 of water, using a current density of from 6 to 10 amperes per square decimetre. The distance between the electrodes should be 8 cm. and the potential 0·8 volt.

Current Notes.

The Hildebrandsche Automatische Telefon Zentrale, G.m.b.H., has been registered at Cologne with a capital of 300,000 marks, to work the Hildebrand patents.

The Siemens Elektrische Betriebe A.G., of Berlin, made a profit of 519,937 marks for 1908–9 as against 512,637; a dividend of 6%, the same as last year, will be paid on the capital of 7½ million marks.

The Rheinisch-Westfalisches Elektrizitatswerk A.G., received for current and meter rents 6,120,000 marks in 1908–9 (6,230,000 in 1907–8). The dividend of 8% absorbs 2,400,000 marks, and the carry-over is 1,999 marks, 133,450 being added to reserve.

The Elektrische Licht und Kraftanlagen A.G., Berlin, will pay a 7% dividend for 1908–9 as for 1907–8 on issued capital of 18,750,000 marks. The net profit was 1,704,260 marks (1,697,097 in 1907–8). The carry-over is 169,258 marks. The unissued capital is 11,250,000 marks.

The Erfurt Electric street tramways took 535,142 marks in fares in 1908–9, an increase on the previous year of 15,607 marks. 105,000 marks go to pay a 7% dividend as last year. About two million car miles were run.

The Elektrizitats A.G., vorm Schuckert & Co., of Nuremberg, made for 1908–9 a net profit of 4,535,953 marks, as against 3,866,598 marks for 1907–8. Of this 215,610 marks have been devoted to increasing the reserve to exactly 5,000,000 marks, *i.e.*, one-tenth of the capital. A dividend of 6% absorbing three million marks will be paid, a substantial increase on the previous dividend, which was 5% only. No less than 1,212,633 marks are carried forward to 1909–10.

The Berliner Elektrizitats Werke, of Berlin, is another of these big German electrical concerns, which are extremely prosperous. At the annual general meeting over 30 million marks of capital were represented. The report gave striking evidence of the prosperity of the company. In the four months July–October, 1909, it sold 48,548,262 kw. hours in Berlin and suburbs, an increase of nearly two millions over the corresponding period of 1908. The dividend will be 11% for all the shares, new and old issues alike. The new issue formerly received 4% only.

The Elektrische Licht und Kraftanlagen A.G., of Berlin, has, of course, had equally good fortune, although on a smaller scale. The net profit for 1908–9 was 1,704,260 marks, a slight increase on the previous year. At the general meeting on December 20 the board will propose a 7% dividend, the same as last year, and a carry-over of 169,258 marks.

ELECTRICITY IN MINES.

The hearing was resumed at the Dunfermline Sheriff Court of the charges against William Richardson, Henry Rowan, and Charles Augustus Carlow, officials of the Fife Coal Co., of having, in the Foulford pit, Cowdenbeath, violated the rules under the Coal Mines Regulation Act for the use of electricity in mines.

The evidence for the defence was to a large extent of a general nature, and the main contention was that in connection with the installation and working of the electric plant everything had been done to comply with the rules and to avert danger to the workers. The manager relied upon the advice of an expert, and the company never refused to supply any material that was required. On the occasion of a visit by a Home Office expert he stated that he could effect improvements, but he admitted that he had seen worse cases.

A Glasgow electrician gave evidence to the effect that the appliances, in the circumstances, complied with the rules, and that everything was done to ensure perfect insulation.

It was also stated that no complaints had been received from workmen as to shocks being received.

The Procurator-Fiscal (Mr. John S. Soutar) submitted that, if the evidence for the prosecution was to be believed, the whole system at the pits was bad from beginning to end.

After a further adjournment, Sheriff Shennan dismissed the complaint against Mr. Augustus Carlow on the ground that he was neither an agent nor manager appointed by the company within the terms of the Coal Mines Regulation Act. Verdicts of "Not guilty" were returned in the cases of the managers, Mr. Rowan and Mr. Richardson, primarily because the letter of Mr. McLaren, his Majesty's Inspector of Mines, was not sent to them, and, therefore, they were not aware that any directions had been given for the plant being brought into conformity with the electrical special rules. The Sheriff was satisfied that Mr. McLaren's letter was not an intimation in accordance with the rules. He approved of the system adopted by the company of appointing agents for groups of mines.

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BUSINESS NOTES AND NEWS.

LIGHTING AND GENERAL—Home.

ACTON.—The question of wiring consumers' premises was discussed by the Acton Electricity Committee, and on the motion of Councillor Shillaker it was resolved that the Engineer prepare a schedule of prices for the wiring of consumers' premises, and that local electricians willing to carry out work of the Council on that scale be allowed to do so. This is in lieu of the present method of giving the contract for free wiring to one firm, and it was considered that it would be an inducement to others to obtain customers for the Council. The committee re-considered its decision in regard to the variation of prices to be paid for the use of electricity, and decided to make no alteration in the existing rates.

BURTON.—The Town Council's Electrical Engineer's return for November shows that during the past month the consumption of electricity in the town was 101,543 Board of Trade units for lighting, motors, heating, etc., and 64,283 for traction, showing an increase of 13,634 for lighting, etc., and an increase of 1,114 for traction in the corresponding month of last year. The Gas Manager's return for November shows that the quantity of gas consumed during the five weeks ending November 26 was 43,288,000 cubic ft., an increase of 2,163,000 on the corresponding period last year.

BRIGHTON.—The Lighting Committee, on the report of Mr. Christie, their chief Engineer, recommend the expenditure of £14,500 on a new turbine and accessories for Southwick, and £3,500 for fittings at the North-road sub-station.

CARMARTHEN.—The Carmarthen Electric Supply Co. (Ltd.) has been formed with a capital of £10,000, to supply the borough of Carmarthen with electric light and power. The company has acquired a Provisional Order granted by the Board of Trade and confirmed by Parliament. The capital is divided into 5,000 Preference Shares of £1 each and 5,000 Ordinary Shares of a like value, which are now offered for subscription. Carmarthen town is at present lighted by gas, but an agreement has been entered into with the Carmarthen Borough Council for the lighting of the street lamps by electricity, and the Council have consented to the use of overhead mains throughout the borough. The contract price for the electric installation is £7,205. The directors are Messrs. W. A. Schultz, J.P., Brockley; John B. Arthur, Carmarthen; Rees Davies (managing director), Carmarthen, and S. G. Leech, M.I.E.E., Westminster, engineer.

CARNARVON.—In a letter read at a meeting of the Town Council, the National Electric Construction Co., with whom the Corporation have an agreement giving them the option of acquiring the works at the expiration of stated alternative periods, favourably reported upon the progress of the works, which promised to continue next year. They, however, pointed out that if progress was to be ensured representations must be made for the necessary borrowing powers for extending the works. They also suggested that the electricity be utilised for street lighting, the estimated cost of installing eight arc lamps being £400, and the annual cost of lighting £150. The matter was referred to the Highway Committee.

DOVER.—The Constable's Tower, Dover Castle, is to be lighted by the Corporation Electricity Department.

EDINBURGH.—The reports by the consulting engineer, Sir A. Kennedy, to the Electric Light Committee of the Town Council on the future working of the two electric power stations have been issued. The first report deals with the Dewar Place Station. There are several arrangements, the report states, by which the output of the Dewar Place Station could be increased by at least 2,000 kw. (probably more) without increase in coal consumption, and, therefore, without further expenditure in boilers, by the use of exhaust turbines, such as were now in use at M'Donald-road. To enable this result to be obtained it was, of course, necessary to use condensation. There were now several modern designs of cooling towers, which were not so bulky as those of the older types, and by increasing the height the nuisance of escaping steam, which formerly was considerable, appears to be obviated. By a plan submitted the total available output consisted of 6,000 kw., 3,500 of which represented the present maximum load on the station; and 2,500 the amount which might be added by the exhaust turbines. The steel towers cost much less than brick chimney towers, and from some prices he had obtained, brick towers would cost, for the output suggested, about £18,000, while steel towers would be only about £12,000. It was obvious, therefore, that the ues of steel towers should be very seriously considered. The probable alternative at M'Donald-road to the use of cooling towers, either on the site or at Redbraes, would be the erection of a distant power station, generating at high tension, distributing to the existing stations, and possibly to new sub-stations, by means of high tension feeders. In the sub-stations motor generators would have to be provided, so that the ultimate distribution of direct current at low pressure would be similar to the present distribution. Such a scheme would be at the same time more expensive and less efficient than the present system of direct distribution, and would also entail considerably increased running cost.

ELLAND.—At a meeting of the Electricity Committee of the District Council the engineer submitted estimates of cost of taking cable to Hullen Edge *via* Hullen Edge-road and Victoria-road. It was resolved that the supply mains be extended to Hullen Edge if all the owners of houses will sign an agreement to take a supply.

FAREHAM.—Mr. Hawes, of Messrs. May & Hawes, electrical engineers, reported as to the present position at the new Electricity Works, All the generating plant had now been erected, and, with the exception of a few minor details, was practically completed. All the arc lamps had been delivered. and they were shortly to be placed in position on the posts. It was hoped by starting early in the morning to effect the change of the whole of the new arc lamps for the old in a single day.

HORSHAM.—A local correspondent says that the Electrical Engineer of the Urban Council is not a little worried by the fact that there is a considerable amount of amateur wiring going on in the town. The work is done without notice to him, and therefore is never tested, and there is the possibility that a meter may be burnt out through having too much load upon it. The work is usually carried out in utter disregard of the Council's wiring rules, and if a fire occurred the undertaking would suffer from the scare that would be caused, although the Council could not be blamed. The Council have, therefore, decided that the Engineer is to be authorised to insist on the Council's regulations as to notice of wiring being complied with, and, in case of non-compliance, to exercise his power of cutting off the supply.

HUDDERSFIELD.—At a special statutory meeting of the County Borough Council it was decided to make application to the Board of Trade for a provisional order whereby the Council may be enabled to supply the South Crosland Urban District with electric light.

LONDON: SMITHFIELD MARKET.—The Smithfield Market Electric Supply Co. have raised the price from 3½d. to 4½d. per unit for electricity consumed where metallic filament lamps are used, while retaining the lower scale for carbon lamps. Mr. G. M. Powell, the manager, states that even at this rate, a saving of 40% is effected by consumers using the new lamps.

LONDON: STEPNEY.—The Borough Council will be recommended to adopt proposals of the electrical engineer and manager for the expenditure of £40,500 in providing additional plant at the Limehouse and Whitechapel stations and a sub-station in Wapping.

LYNN.—The Electrical Engineer reported to the Town Council that two additional applications had been made for private connections, making a total of 721, not including about 600 lamps and a 2 h.p. motor at the Corn Hall Skating Rink. Various additional lamps for public lighting were sanctioned.

MANCHESTER.—A letter from the committee appointed by the Home Office to consider the rules and regulations under which electricity should be employed in mining enterprises, having conveyed an invitation to the Manchester Chamber of Commerce to appoint witnesses to give evidence, the Board requested the Engineering Section to consider the advisability of putting forward the names of one or more gentlemen for this purpose.

OLDHAM.—At a meeting of the Town Council Alderman Thompson (chairman of the Gas-works Committee) remarked that people had criticised the action of the Lighting Sub-Committee because the whole of Union-street had not been lit up. The Lighting Sub-Committee met on November 10, and went into the matter very thoroughly, and all depended on the question of cost. The approximate cost of two suspended lamps from each pillar would be £500 per annum. To light Union-street with gas as at present cost £62 per annum. The lighting would be from dusk to eleven o'clock; after that smaller incandescent lights would be turned on. The Sub-Committee he added, had agreed to give electricity a fair trial in comparison with an improved gas light. From Star Inn to Greaves-street would be lighted by electricity. The ex-Mayor (Alderman Bolton) who is chairman of the Electricity Committee, protested against the undue comparison between electric lighting at £500 and gas at £62. When the improved gas lamps were got complete the cost, he said, would not be far short of £400. He would have been pleased if electric lighting could have been taken along King-street and St. Domingo-street, two very dark streets.

PEMBROKE (Ireland).—The Pembroke Urban Council decided to appeal to the Irish Local Government Board to disallow or remit surcharges made by the auditor of £13 3s., as the expenditure was incurred in respect of an exhibition of electrical cooking promoted in the interests of the Council's electric lighting concern, and which had proved beneficial and remunerative to that undertaking.

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TORQUAY.—It was reported to the Town Council that, notwithstanding the large number of lamps connected for private lighting, the demand on the generating station was practically identical with that at the corresponding period of last year, this being due to the charges made by old consumers from carbon to metal filament lamps and new consumers adopting the latter type. The position of the works to deal with the lighting demand was a much better one than last year, as the whole of the alternating current plant was now available for lighting purposes, whereas last year it was liable to be called upon at any time to supply power for traction. A scheme to extend the main to Chelston, at an estimated cost of £1,312, was referred to a sub-committee, and a similar reference was made with regard to the proposed extension of the main to the higher part of St. Marychurch-road.

WEDNESBURY.—Councillor Griffiths reported to the Town Council that owing to the increase in the number of customers and the development of the electrical undertaking, it had become necessary for the committee to engage additional clerical assistance. He had no hesitation in saying that the course adopted in ceasing to take a supply from the Midland Power Co. was one that they looked back to with satisfaction.

YORK.—At the City Council meeting Alderman Meyer said the electricity undertaking was in a perfectly healthy state, being well maintained, with increasing revenue on every branch. The loans sanctioned to cover the estimated capital expenditure during the two years ending March 31st. 1910, for main services, motors and meters, were nearly exhausted, and the Committee asked the Corporation's authority to apply to the Local Government Board for sanction to meet the estimated expenditure for a further period of two years, the amounts required being £1,100 for mains' services £800 for motors; and £575 for meters —2,475. This proposition was passed without comment.

LIGHTING AND GENERAL—Overseas.

MEXICO.—The text has been issued of a contract between the Mexican Ministry of Fomento and Don Diego Redo, empowering the latter to utilise the waters of the river San Lorenzo, in the State of Sinaloa, to an extent not exceeding thirty cubic metres per second, for irrigation purposes and for generating motive power. The contract is for a term of 20 years. The concessionaire engages to commence operations within 24 months, and to complete the work within seven years. The electric energy may be carried overhead by means of aerial wires, or underground by means of insulated conductors. The concessionaire is granted the right to import free of duty, once only, all the machinery and apparatus necessary for carrying out the work, and is also authorised to construct any bridges, telegraph and telephone lines, according to his discretion.

WINNIPEG.—The new power plant recently installed by the city of Edmonton was started for regular operation. It provides ample electric energy for the lighting and street railway systems, and allows a good margin for future extensions.

TRACTION—Home.

BELFAST.—The Tramways General Manager reported to the Corporation Tramways Committee that as soon as there was a surplus in hand over the cars required for the regular all-day service, top-covered cars would be provided for the workmen's services. The first three top-covered cars which were available would be put on the Greencastle service.

LONDON.—The Parliamentary Committee of the London County Council have prepared a Bill which it is proposed to promote next year authorising the various tramway extensions and improvements of which particulars have already been published. It embodies schemes for the construction of upwards of 15 miles of new lines, and the electrification of some 6 miles of existing tramways. The total expenditure under the Bill is estimated at £1,680,000, of which £962,000 is in respect of tramways and £718,000 relates to street improvements.

TRACTION—Overseas.

BRAZIL.—The British Legation report that the Bill for the electrification of part of the Central of Brazil Railway, has not been passed by the Chamber of Deputies.

BRITISH COLUMBIA.—According to the *Standard of Empire*, arrangements have been completed for extension of the British Columbia Electric Railway Co.'s routes to the north, west, and east of the city. The west route will open up the Capilano district, always a favourite tourist resort.

HAMILTON (Ontario).—The City Council has entered into a contract with the Ontario Hydro-Electric Power Commission for 1,000 h.p., on terms outlined by the Commission.

JAPAN.—The Kobe-Akashi Electric Railway Co., with a nominal capital of about £210,000, intend to build an electric railway from Kobe *via* Suma to Akashi, a distance of 11½ miles. The first section of 5½ miles is to have a double track, the rest of the line a single track. The Minomo-Arima Electric Railway Co. propose to build an electric railway, 15½ miles in length, from Osaka *via* Ikeda to Takaradzuka, with a branch 2½ miles long to Minomo. The cost of the work is estimated at about £300,000.

LONDON (Ontario).—A contract with the London Electric Co. for street lighting has been made for one year, with a three-months' cancellation clause. If the city desire to break the contract by giving the necessary notice, a sliding scale of prices as presented by Mr. Chas. B. Hunt, the manager, will be paid, but if it runs the whole year, the present price, 23 cents per lamp per night, will hold good.

MESSINA.—The Minister of Public Works has forwarded to the Prefect of Messina, for his approval, a proposal submitted by the Director of Sicilian Tramways relative to the temporary re-opening of the service, and to the granting of a concession to a new company to be formed for the purpose of electrifying the Giampieleri-Messina-Fora line, and for the purpose of installing a complete urban system of tramways.

NORWAY.—The British Vice-Consul at Bergen (Mr. E. F. Gray) reports that a concession has been granted by the municipal authorities of that town for an electric cable railway for passenger traffic from the town to a spot on the mountain side overlooking the harbour. The work is to be completed by September 1, 1910. The name of the concessionaire may be obtained by British firms interested on application at the Commercial Intelligence Branch of the Board of Trade, Basinghall-street, London, E.C.

SWITZERLAND.—A decree has been issued granting to Messrs. Hunger, Braun, Wolf, Hitz and Durrer a concession for the construction and working of an electric funicular railway from Coire to Mittenberg. The concession is for a term of 80 years, and the construction of the line must be completed within two years. The line will be single track of 1 metre gauge.

COMPANIES' MEETINGS AND REPORTS.

WINNIPEG ELECTRIC RAILWAY.

The British Empire Trust Co., Ltd., notifies that the Winnipeg Electric Railway Co. (Canada) has declared a dividend of 2½% for the quarter ending 31st instant.

ELECTRICAL SECURITIES TRUST.

The report of the Electrical Securities Trust, Ltd., states that, after providing for Debenture interest, the accounts for the year to November 14 show a loss of £5,442, increasing the debit balance brought down to £10,486.

ISLE OF THANET ELECTRIC TRAMWAYS.

The report of the Isle of Thanet Electric Tramways and Lighting Co., Ltd., for the year ended September 30 last, submitted to the meeting on the 16th inst., shows a balance of £15,053, compared with £13,390 17s. 10d. for the previous year. The amount of undivided revenue at the disposal of the company is £7,851. The directors propose to place £3,000 to reserve and to pay a dividend of 1½% on the Preference shares, which will absorb £1,875, leaving a balance of £2,976. It is proposed to appropriate £1,500 of this sum towards future maintenance of permanent way and to carry forward £1,476. Capital expenditure was incurred during the year, amounting to £4,962, for additional plant and machinery at the power house, and to £1,809 for extensions of the electric lighting mains. The sale of electricity, compared with the previous year, increased by £398, or nearly 10%, and, with the additional plant now at their disposal, the directors hope to further increase the income of the company from this source.

CONTRACTS OPEN.

OVERSEAS.

AUSTRALIA.—Secretary, Postmaster-General's Department, Melbourne.—For the supply and erection of two installations for wireless telegraphy, one at Sydney and one at Freemantle. Tenders have to be made for the erection of stations with a range of 500 miles, 750 miles, or 1,000 miles. By noon February 22 next.

BELGIUM.—Bourse de Bruxelles, Brussels.—Electric lighting material for trains. December 22.

ROME.—Italian State Railway Offices.—To supply 50,000 incandescent electric lamps with metal filaments. January 26 next.

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TENDERS ACCEPTED.

BELFAST.—The Corporation Tramway and Electricity Committee selected the tender of Messrs. Dempster, Moore and W. H. Wilcox for the supply of drilling machines, smiths' hearth, etc., and that of Messrs. Toward & Co., for the provision of two bitumen boilers for the electricity station.

PERSONAL.

The Electric Construction Co., Ltd., have appointed Messrs. Fyfe, Wilson & Co., 145, Bath-street, Glasgow, to represent them in Scotland, with the exception of Collieries. For Colliery work they will be represented, as heretofore, by Messrs. Hunter and Jack, 101, St. Vincent-street, Glasgow.

Dr. Alexander Russell, Principal of Faraday House, London, has been appointed by the Board of Trade as Electric Inspector under the Willesden Electric Lighting Order, 1896.

Mr. Rowland Stanley Jull was appointed Assistant Engineer at the new Electricity Works, Farcham, Hants, for a period of six months; and a switchboard attendant was also appointed.

Mr. H. E. Yerbury, Chief Electrical Engineer of the Sheffield Corporation Tramways, has just been elected a member of the Institution of Civil Engineers.

MELBOURNE ELECTRIC SUPPLY CO.

The Directors, in their annual report for the year ended August 31, 1909, show that during the year capital expenditure in Australia on additional land, buildings, plant and mains, etc., has been incurred as follows:—On the Melbourne undertaking, £22,807 5s. 6d.; on the Geelong undertaking, £1,744 14s. 1d.; together, £24,551 19s. 7d.

The profit and loss account shows that the gross profit derived during the year from the Melbourne and Geelong undertakings was £23,012 12s. 6d. Adding the dividend received on the Company's holding of Ordinary Shares in the Adelaide Electric Supply Co., Ltd., together with discounts, transfer fees, etc., the total gross profit for the year amounted to £29,733 7s. 7d., which compares with £22,030 3s. 9d. for the previous year. Management and general expenses at the London Head Office absorbed £2,045 0s. 10d., and interest on Debenture Stock and sundry loans amounted to £14,218 9s. 10d. After payment of these charges, there remains a balance to the credit of profit and loss of £13,469 16s. 11d., to which must be added the amount of £1,771 15s. 9d. brought forward from the previous year, making a total credit balance of £15,241 12s. 8d. Of this sum the Directors have applied amounts of £978 18s. 7d., £503 15s., and £1,037 8s. 9d., in writing off the special charges, expenses, and losses, as shown in detail in the profit and loss account, leaving an available balance of £12,721 10s. 4d., which the Directors recommend should be applied as follows:—Dividend on 20,000 7% First Preference Shares to August 31, 1909, paid on September 1, 1909, £1,821 10s. 6d.; transfer to depreciation and general reserve account, £5,123 17s. 6d.; writing down suspense account, £2,039; writing down head office furniture, £42 13s. 1d.; leaving a balance to carry forward of £3,694 9s. 3d.; total, £12,721 10s. 4d.

In order to pay off loans from the Company's bankers and others, and to make provision for future necessary expenditure, the capital account of the Company has been readjusted during the past year. With the consent of the Debenture Stock and shareholders, an issue of a further £100,000 5% First Mortgage Debenture Stock, and of £100,000 7% First Cumulative Preference Shares of £5 each, ranking in priority to the existing £150,000 6% Cumulative Preference Stock, was made in May last. Out of the proceeds of this issue, all outstanding loans have been paid off. Simultaneously the 30,000 6% Cumulative Preference Shares of £5 each were converted into £150,000 6% Cumulative Stock. The Board have under consideration proposals for dealing with the arrears of dividend on this stock, amounting at August 31, 1909, to £71,950.

Mr. David Finlayson has joined the Board of the Company in London; and a Local Board has been formed in Melbourne, consisting of the Hon. William L. Baillieu, M.L.C., the Hon. Agar Wynne, M.H.R., and the Company's Engineer and Manager, Mr. F. W. Clements.

WELSBACH LITIGATION.

On Saturday adjourned summonses against the Welsbach Incandescent Gas Light Co., under the Merchandise Marks Act, were before Mr. Bros, at Clerkenwell, for the fifth day of hearing.

Mr. Rufus Isaacs, K.C., was for the prosecution, and Mr. Walter, K.C., for the defence.

As already reported in our columns, Wolfram (Tungstan Metal Filament Lamps (Ltd.) and the General Electric Co. complained of an advertisement issued by the defendant company bearing a picture of a lamp with the words "Welsbach" and "Aur" upon it, alleging breaches of the Act.

Mr. Isaacs stated that the parties had had an opportunity of discussing the matter, and proposed taking a course which he hoped might have the approval of the magistrate, having regard to all the circumstances of the case. As the result of a long and expensive enquiry, it seemed that the parties ought to be able to arrive at some means of settling the dispute, and so avoid a continuance of these proceedings. And they now thought they had arrived at a point when it was useless to continue this investigation or to ask for the magistrate's judgment. Mr. Walter would make a statement which, without reserve, he would accept on behalf of the prosecution, and upon this statement he would ask permission to withdraw the summonses.

Mr. Walter pointed out that it was never intended, in issuing the advertisement complained of, that it should lead the public to believe that the article in question was the invention of Dr. von Welsbach or the manufacture of the Auer Co., and they did not intend to repeat any such advertisement, although they would continue to mark their own lamps with the words "Welsbach," their own name, and with their trade-mark, the word "Aur."

Mr. Bros thought the parties had acted very wisely. The proceedings were naturally very expensive, with the calling of experts and engagement of professional gentlemen. And this would have been but a preliminary skirmish to another and more protracted and expensive inquiry. The time had not been wasted, however, if it had resulted in the parties coming to an agreement without the intervention of the Court. It was a great satisfaction to know that the case was going to be withdrawn.

Thus all proceedings were formally withdrawn, and the matter ended.

EDUCATIONAL.

KING'S COLLEGE (UNIVERSITY OF LONDON).

In the faculty of engineering during the session 1909-1910 there will be a special course of advanced lectures and demonstrations on single-phase electrical traction, given by Professor Ernest Wilson, M.I.E.E., and Mr. Francis Lydall, B.A., B.Sc., commencing on Monday, January 17, 1910, at 5.30 p.m. The first five lectures, accompanied by demonstrations, will be given by Prof. Wilson, and will deal with the fundamental principles involved. The second five lectures, given by Mr. Lydall, will deal with practical considerations with special reference to the Rotterdam Hague Single-phase Railway and the electrification on the Midland Railway. The syllabus is a most interesting one, and is as follows:—*Lecture* 1. The three elements comprising an electric railway system—power supply—train equipment—link between power supply and train—each element as affected by choice of system. Three alternative systems, direct current, three phase, single phase—each system dependent primarily upon the motor—advantages and disadvantages inherent in each system. Preliminary consideration of the single-phase railway motor. *Lecture* 2. The single-phase railway motor—distinguishing features—effect of transformer voltage—two types of single-phase motor—series and compensated repulsion—characteristics of series motor—speed—pull—efficiency—power-factor. Commutation poles for neutralising transformer voltage and their effect on the electrical and mechanical characteristics. *Lecture* 3. The compensated repulsion motor—electrical characteristics—speed—pull—efficiency—power-factor—range of sparkless operation. Control of single-phase railway motors—facility of adapting voltage control without rheostatic losses—various methods of obtaining variation of voltage. *Lecture* 4. Different arrangements of preventive coils and resistances for voltage variation—voltage stops required for uniform start—number of stops required for any given starting conditions—typical wiring diagrams for multiple unit control—single-phase contactors—electric—electro pneumatic. *Lecture* 5. Transmission system for single-phase railways—mechanical properties—necessity for catenary construction—electrical properties—voltage drop as compared with direct current—transmission drop in overhead line and rails—the use of sucking transformers—interference with telegraphs and telephones. *Lecture* 6. Single-phase overhead line—requirements of ideal system—different methods of meeting these requirements—material employed in the various systems—insulators—catenary wire—contact wire—droppers—clips—pull-offs—poles and supports. *Lecture* 7. Section insulation—automatic tightening devices—arrangement of overhead line for special conditions—under bridges—in tunnels—in stations—feeder system—erection methods. *Lecture* 8. Car equipment—high tension apparatus—current collector—requirements to be met—description of different types—connection from collector to high tension chamber—contents of high tension chamber—connection from high tension chamber to transformer. *Lecture* 9. Car equipment—low tension apparatus—transformer—control apparatus—car wiring—auxiliary apparatus—brake equipment—lighting and heating equipment—car to car connections—motors—forced ventilation—constructional details. *Lecture* 10. General consideration of railway electrification. Graduates of the University of London will be admitted at half fees, but Undergraduates will only be admitted by special arrangement on the nomination of the Dean of Faculty of their College.

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PATENTS.

Dynamos or Electrical Motors.

14391.—1909. J. GARTY, Glasgow. The object is to simplify and cheapen the construction of dynamos and motors. The magnetic field and yoke parts are a series of stamped metal plates with one or more pairs of poles, with holes to receive bolts supporting the end plates. These are of stamped metal and the requisite key-ways to take the bars constituting the feet. Fig. 1 is a side view showing the yoke and the end plates in section of a dynamo or

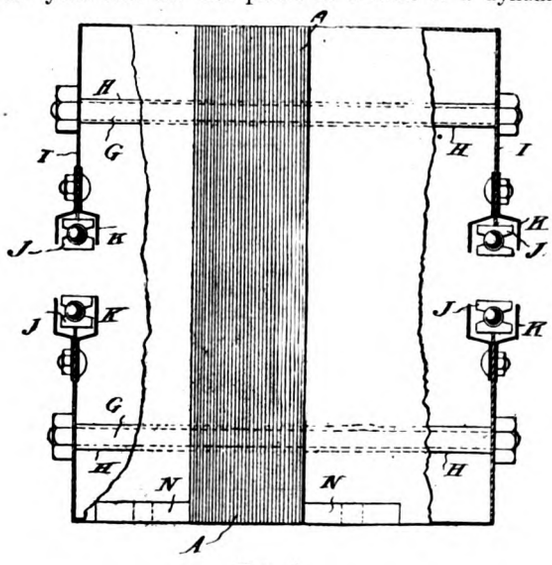

FIG. 1.

electrical motor. Fig. 2 is a half plan of the end plate, and a half plan of the yoke showing one pole and the bolts. The yoke and magnetic field portion A, which is composed of a series of stamped metal plates of square section outside is provided with one or more pair of poles. Holes F are formed for the reception of the bolts G. These have fitted on them the tubular distance pieces H for bracing together

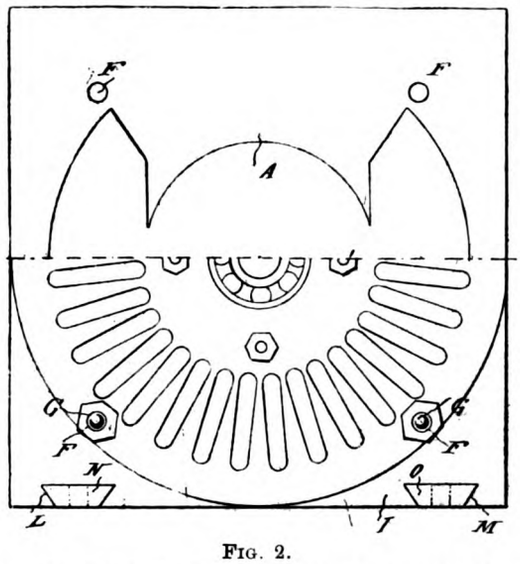

FIG. 2.

the end plates I, I, which carry the bearing S, J, J, for the spindle of the dynamo or motor. Shields K envelope the bearings. The stamped metal plates composing the yoke and magnetic field A are provided with the dove-tail key-ways L, M, designed for the bars N, O, which constitute feet for enabling the dynamo or motor to be bolted down to the place required.

Electrodes for Electric Furnaces.

4175.—1909. M. RUTHENBURG, London, E.C. Electrodes are often burned away and thinned at the sides owing to the action of the hot gas rising up from the arc, and thus it is necessary to renew them much more frequently than would be the case were the consumption confined to the end of the electrode, where the arc is actually produced. To obviate this disadvantage it has been proposed to surround the electrode with a water jacket; but in practice this is found to be inconvenient as the electrode frequently breaks and an arc is set up between the upper portion of the electrode and the jacket which burns away the jacket and allows the liquid circulating therein to enter the furnace. In this improvement the electrode is provided not merely with a water jacket but with a lining of insulating and refractory material between the jacket and the electrode. This lining might be made of fire-clay or of a mixture of fire-clay and asbestos. Fig. 1 is a vertical section and Fig. 2 a cross section of one construction of lined water-jacket for an electrode. The jacket consists of an inner tube A of cast iron, and an outer tube B connected by distance pieces C. The extremities of the inner tube A are screw threaded and engage with the threaded

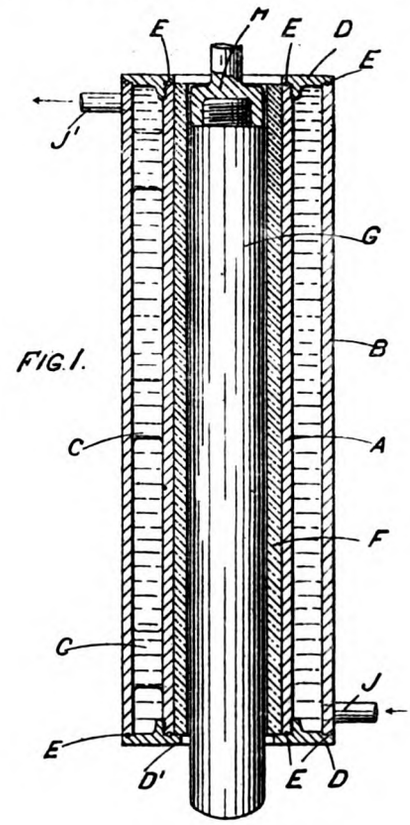

FIG. 1.

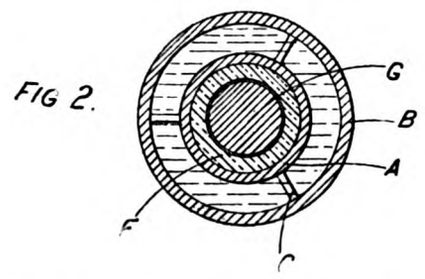

FIG 2.

portion of caps D, made of wrought iron. Between the ends of the tubes A and B and the caps D are gaskets E of round copper wire to ensure water tight joints. The cap D at the bottom of the jacket has a flange D extending within the space enclosed by the inner tube A and forming a ledge upon which rests a lining tube F made of non-conducting and refractory material. This lining is inserted from the top and through it passes the electrode G. The holder H for this electrode is made of the same diameter as the electrode itself, in order that it may easily pass through the lining, and the end of the electrode is reduced in diameter where it is attached to the holder. Any convenient arrangement may be employed for the circulation of water in the space between the tubes A and B, and Fig. 1 shows an inlet opening J and an outlet J. It will be apparent that if the electrode G should break at any portion of its length within the jacket the arc set up is kept from damaging the inner wall A of the water jacket by the insulating and refractory lining F.

Metal Filament Electric Lamps.

667.—1909. J. MESZAROS, London, S.W. This lamp has a hollow internally coated cylindrical or a conical reflector of comparatively large size supported on a rod rigidly connected at its upper end to the base of the bulb and steadied by a spring at the lower end. Solid as well as tubular central reflectors of various forms have been fitted with a steadying spring and are either freely suspended from the base of the lamp or firmly held between the base and pip of the bulb. In another arrangement the leading in wires hold a suspended star-shaped carbon filament carrier at a distance below the base of the bulb, this carrier being connected with a depending rod fast, in the pip of the bulb to hold between the carrier and the lower cross-arms of the carbon filaments either a tubular or solid externally coated reflector. In this new lamp

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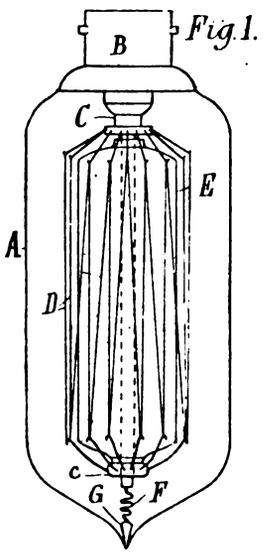
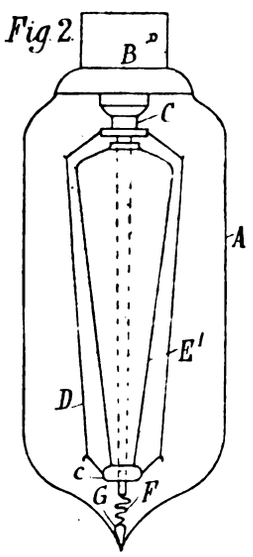
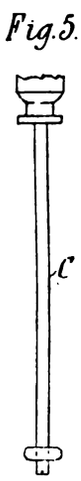
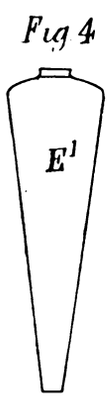
firmly secured in the cap of the lamp, is a depending rigid rod, the lower end of which is resiliently attached to a small glass plug fused in the pip of the bulb in a usual manner. The rod is fixed direct in the cap of the lamp, and has a collar to receive the radial arms for retaining the metal filaments. On the rod is mounted a hollow central cylindrical or conical reflector of comparatively large size, which is formed with end portions having each a central or axial orifice adapted to fit the rod and to be supported on it by a lower collar. The lower supporting collar is fitted with radial arms having hooks for the retention of the sections of the filaments. Fig. 1 is an elevation of an electric filament









lamp provided with a central cylindrical reflector and carrier rod within the continuous filament cluster. Fig. 2 is a similar view of a lamp provided with a hollow conical reflector and its carrier rod. Figs. 3 and 4 are separate elevations of the reflectors. Fig. 5 is an elevation of the supporting rod. The bulb A is fitted with the cap B, which carries the rod C to which are secured the filaments D. On the rod C is mounted a hollow reflector E or E, which is supported at its lower end upon a collar c. The vibrations of the rod C are checked by a spring F attached with one end to such rod and with its outer end to a glass plug G fixed in the pip of the bulb.

Telephonic Apparatus.

21002.—1909. E. A. GRAHAM, Brockley. The apparatus comprises a water-tight casing in which a transmitter is mounted and which contains a telephonic receiver. The receiver is mounted on arms articulated to the casing and adapted when moved into position for use to operate both the switch and the carbon granule agitating device of the microphonic transmitter.

Receivers for Wireless Telegraphy.

4125.—1909. G. MARCONI, Westminster. Two rectifying detectors are connected to the secondaries of two oscillation transformers the primaries of which are joined to the receiving serial conductor. A condenser is inserted in the circuit of each of the secondaries and are so arranged that one of them is in resonance with the electrical waves which it is desired to receive, while the other has a period differing slightly from that of the waves. The valves are so connected to an induction coil that the rectified currents which they generate in consequence of the received oscillations are opposed to each other in polarity.

Electric Switches.

4111.—1909. A. H. CURTIS, Bedford. The slow continuous movement of the levers moving over series of contacts in electric switches is transformed into one in which there is a quick movement between the steps and a period of rest on each step. This is effected by an improvement in the worm gear and cam, and also the provision of a spring for controlling their movement.

Wireless Signallin g.

18430.—1909. R. A. FESSENDEN, Brant Rock, U.S.A. In order to provide for more efficient production of high frequency oscillations and electro-magnetic waves the armature winding is mounted asymmetrically in the aid gap of the magnetic circuit and is axially adjustable in the space between the fixed and rotary elements of the magnetic system. The armature is made of boxwood in numerous sections, clamped together and supported so as to allow the sections to expand independently.

Wireless Signalling.

20466.—1908. R. A. FESSENDEN, Brant Rock, U.S.A. In this system the indications produced by locally sustained impulses are normally annulled or modified by received impulses continuously emitted from another station. Signalling is effected by interrupting these impulses at the sending station so that the locally produced indications become effective.

Electrical Wiring.

23413.—1908. A. E. LAMKIN, Croydon. The ends of tubular line conductors are connected by means of solid coupling pieces on to the ends of which they are forced. The conductors are arranged within insulating material surrounded by a casing.

Incandescent Electric Lamps.

24212. 1908. SOCIETE FRANCAISE D'INCANDESCENCE PAR LE GAZ, Paris. The support for the lamp filaments consists of a central rod of insulating refractory material to which fusible metal stems are fixed so as to form a helix. The free ends of the stems are provided with hooks of very refractory material is suspended from the hooks and is wound in a single or double helix around the support.

Boosters.

16473.—1908. W. STANSFIELD & J. J. HATT, Manchester. In order to maintain a constant pressure across the mains which supply the lamps, the booster has differentially arranged shunt field windings in series with a resistance, the magnitude of which varies with the variation of temperature due to the variation of current.

Electrically Heating Liquids.

24038.—1908. J. A. ABBOTT, Dublin. A coil or other resistance is inserted into the liquid. The lowering of the resistance connects the electric current and causes the resistance to become heated, thereby heating the current. When the resistance is withdrawn the electric current is disconnected.

Controllers for Electric Motors.

28188.—1908. BRITISH THOMSON-HOUSTON CO., London. In controllers provided with a sliding cam to operate the emergency device a handle is arranged to rotate with the operating shaft. This handle is pivoted so as to have a limited rotary movement in a vertical plane against the action of a spring. The handle may be operatively connected with the emergency devices so that a rotary movement of the handle under the downward pressure of the operator's hand moves the cam out of operative engagement with the emergency device.

Electric Switch.

25819.—1908. CARDWELL, BOWMAN, FORD-LLOYD, LTD., London. This improved switch comprises a standard to which a blade is pivoted for rapidly making and breaking contact. An arm is rigidly connected to the blade and carries springs which control the blade and maintain the switch in an open or closed position.

Tramway Points.

23546.—1908. G. H. BUTTERWORTH, Great Crosby. Instead of conveying the energising current from the car to the point actuating and releasing mechanisms through rubbing contact pieces on the trolley head and corresponding contact strips carried by the trolley wire, a series of surface contact studs are buried in the roadway and a series of conducting contact wheels are carried by a frame under the car body.

Cooling Rotor Windings.

19599.—1909. SIEMENS SCHICKERTWERKE, G.m.b.H., Berlin. Metal blades are fitted to the opposite end of the machine to the commutator. These blades project from end connections and drive the cooling air in a radial direction after the manner of a fan, and in this manner being themselves cooled, draw off heat from the conductors.

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NOTES.

FUTURE OF ELECTRICITY.

At the annual dinner of the Newcastle Local Section of the Institution of Electrical Engineers the right note of optimism was struck. As Professor R. L. Weighton pointed out in proposing the toast of the evening, electricity in its varied manifestations surrounds us on all sides, and has had an enormous effect upon the older branches of engineering, upon constructive engineering generally. He was quite safe in prophesying that the miracles of the future were with the engineer, and more particularly with the electrical engineer. Professor Kapp, in reply, said that electricians owed a great deal to the mechanical engineer, and that, after all, electricity was only mechanical engineering with a little bit of electricity grafted on. Making allowances for the permissible after-dinner exaggeration, this states a truth which too many young electricians are apt to overlook. As an engineering writer stated recently, he had a well-educated, bright young electrician under him, capable, yet who floundered hopelessly when asked to calculate whether certain floor beams could carry a generator proposed to be erected thereon. Of course, such limitation handicapped him severely. As Mr. Mordey put it tersely enough when addressing the students of the Crystal Palace School of Practical Engineering, nothing helped a man so much in engineering work as to be able to take his coat off and do the job himself. Now, if this is applied to electrical engineering, it presupposes more than a cursory knowledge of mechanical and civil engineering. We must specialise, of course, but only after possessing ourselves of a sufficient all-round experience.

CHEAP ELECTRICITY.

By the way, Professor Kapp rather startled some of his auditors when on congratulating the local engineers and shipbuilders on having electricity as cheap as twopence per unit, he pointed out that in Italy the price ranged from eightpence to ninepence per unit. It is true that whilst in Italy there are some very big concerns using electricity, in England there are far more establishments, great and small, who depend upon it for industrial purposes.

PROFITABLE ELECTRICITY.

Of course there is such a thing as having goods or service too cheap, and there are not wanting those connected with the electrical industries who hold that electric current is sold at too low a rate. On the other hand such a return as is included in Part III. of the Home Office report on Municipal Trading, which has only recently been issued, proves that cheap electricity pays. We see this if we take the following instances of the latest returns available at the Home Office:—Birmingham, electricity department, £7,677 profit, trams (worked by the council) profit £4,353; Brighton, tramways department, profit £1,616, telephones £464 (though here there was a loss in the electricity department of £976); Croydon, electricity department, profit £4,190, tramways profit £973; East Ham, electricity department, profit £637 (plus £1,750 towards rates adjustment), tramways £4,580 (plus £5,250 to rates adjustment); West Ham, electricity department, profit £2,523, tramways profit £16,920; Derby, electricity department, profit £969, tramways £6,808; Leicester, electricity department, profit £6,882, tramways profit £13,110; Norwich, electricity department, profit £5,603; Nottingham, electricity department, profit £13,514, tramways profit £20,177; Wolverhampton, electricity department, profit £3,474, tramways profit £6,419. Which is not a bad showing.

GERMAN PATENT LAWS.

Vigorous efforts are being made in Germany to find some way to modify the rigours of the British Patent Laws, as regards the working clauses. Manufacturers desire to have the law so altered as to enable Germany to make reprisals against England, Austria Hungary and France, or to negotiate treaties for the mutual relinquishment of compulsory working clauses, on the understanding that effective working in any of the contracting countries should satisfy the others. So far no official steps have been taken.

MISPLACED ELECTRIC LAMPS.

It appears that the Hamburg Theatre managers are somewhat worried as to the result of the too great popularity of portable electric lamps. It seems that theatre goers use their pocket electric lamps for the purpose of reading their programmes when the lights are turned low. We can well understand that at the thrilling moment when for scenic reasons the auditorium is left in darkness, it must be awkward to see flashes popping about the audience like will o' the wisps or fire-flies. Besides spoiling effects, such sudden flashes might well give rise to panic. But the interesting point is the evidence of the popularity of the portable lamp. All, however, who know how gruesomely dark the cavernous common stairs of great blocks of flats become after midnight in most continental cities, will sympathise with the Hamburgers.

GROWING DEMAND FOR POWER.

Mr. W. W. Lackie, City Electrical Engineer of Glasgow, has been taking the citizens into his confidence. He predicts a good time coming, not only for the electricity works, but for the consumers of light and power. It is largely on the steady growth of demand for power that he pins his faith to the progressive profitableness of the undertaking and the cheapening of supply. He declares that ever since 1898 it has become increasingly apparent that the supply of electrical energy for power purposes is to be a ruling element in the development of the electrical industry. The relative growth of the supply for lighting and power purposes is very remarkable. In 1898 the h.p. required for lighting was 7,899, for motors 301, this rose respectively thus: 1900, 13,806, 1,894; 1904, 32,634, 9,366; 1906, 36,695, 19,805; 1908, 36,495, 29,505.

THE NATURE OF THE DEMAND.

Mr. Lackie goes on to say that the demand began in quite a small way, being principally made for working hoists and fans in large tenements of offices, and later for a few cranes in engineering works. Next followed the application of the electric motor to the driving of printing machinery. The development of power supply has continued, until now there is hardly an industry in the city which has not an increasing proportion of its operations dependent upon a continuous supply of electricity from the Corporation mains. Last year in Glasgow there were 112 different trades, representing 3,600 consumers, using electricity for power purposes. The power demand goes on summer and winter alike, and is on the whole steady. Large power consumers are found remote from the source of supply as well as in the densely populated parts of the city. Altogether the energetic engineer contrives to draw a very lively and convincing picture.

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"WIRELESS" EFFICIENCY.

In connection with the discussion on Professor Fleming's paper on quantitative measurement in connection with radio-telegraphy, Mr. B. Davies has sent a lengthy written commentory. One point he raises touches upon an aspect of the question to which we alluded last week in these columns. He says: "The efficiency of transmission mentioned at the end of the paper is also interesting. The figures given for the power issued by the sending antenna, and the power caught by the receiving antenna, reveal an enormous attenuation of the strength of the signal with distance. Thus, of the 18,000,000 ergs emitted from the battleship *Henry IV.* only 320 ergs could be picked up at a distance of 1 kilometre or ·63 mile. This represents a 'power attenuation constant' of 20 per mile. Compared with the same 'constant' for submarine cables, this is a very large figure. A cable working at top speed gives a power attenuation of the order of ·01 per mile. The wireless attenuation is thus 2,000 times as great as that of a submarine cable. This exhibits well the great sensibility of the coherer."

THE I.E.E. AND ELECTRICITY IN MINES.

In another column there will be found an official intimation from the Institution of Electrical Engineers that the Council are preparing to tender evidence to the Home Office Departmental Committee on the Use of Electricity in Mines. The Secretary writes that he will be glad to receive any observations on the subject from electrical engineers. Although the Home Office enquiry is extremely limited in its scope, it is important that the evidence tendered should be as complete as possible, and so we would urge upon our readers the advisability of considering the matter at once and communicating with the Secretary as soon as possible. It should be remembered that the finding of the Committee may have considerable influence for some time to follow, both as regards Home Office regulations and future legislation.

COPPER.

Messrs. Bolling & Lowe, in their trade report for the past year, state that 1909 in the copper market has been a remarkable year by reason of the enormous speculative dealing for the rise, which has resulted in a remarkably steady market notwithstanding the constant deterioration apparent in the statistical position. High water-mark in prices was touched last January at £64 3s. 9d., and low water-mark was reached in March at £54 10s. The prices during the greater part of the year moved between £58 and £62, and it was round about this range that the bulk of the huge speculative commitments was opened up. These operations were based upon a belief in, or a fore-knowledge of an impending consolidation of leading interests in North America headed by the Amalgamated Copper Co. and those at the back of the operations have kept continuously to their holdings through good report and evil. The negotiations, which have been very protracted, resulted in a basis of agreement being reached, but the plans formulated for carrying it into effect have been disturbed by the now historic declaration that the Standard Oil Co. is an illegal Corporation, and pending the discovery of some means of evading the law, as at present interpreted, the proposed copper merger, following the lines of the oil trust, has been postponed. There is no doubt that in some form or other the consolidation will take effect, in which case the interests concerned will control probably 50% of the North American output of copper, the chief parties to it being the Amalgamated, Guggenheim and Cole-Ryan Groups. Already, as a result of the negotiations and of the better feeling existing between all United States copper producers, steps are being taken to control production by 10%, and this if put into effect should wipe out the overplus of output seen this year.

Messrs. Morris & Hawkins, Ltd., 30, St. Mary Axe, E.C., and Dagenham, Essex, write in reference to the winding up of the Morris-Hawkins Electrical Co., Ltd., that as in some quarters this has been taken as referring to their company, they wish to point out that Morris-Hawkins, Ltd., have no connection whatever with the Morris-Hawkins Electrical Co., Ltd.

TRAMWAYS—INCOME TAX AND DEPRECIATION.

In view of the great importance of the subject of income tax assessment and depreciation allowances, as recently shown in our columns, a brief abstract from the London County Council's Finance Committee concerning the Tramways undertaking, should be of interest. Mr. Goldie states in his report that negotiations have for some time been proceeding with the chief inspector of taxes with a view to a determination of the liability of the Council and a settlement has now been arrived at. Before giving the amounts payable under the settlement, it would be well to deal with some special points to which attention was devoted during the course of the negotiations.

As regards allowances for depreciation of permanent way (conduit traction), figures were prepared for the Council, which showed that the average cost of renewal of conduit lines was £5,450 a single mile of track, and this figure has now been accepted by the chief inspector of taxes. Taking the average life at 10 years the annual allowance is £545. The following items have also been allowed, in accordance with a scheme adopted by the Inland Revenue, viz., £315 a single mile of track for permanent way (overhead traction), 7% on written-down copital cost of cars, 3% on written-down capital cost of cables and 5% on written-down capital cost of general plant and machinery. The total allowances for depreciation for each of the five years, 1904–5 to 1908–9, are as follows:—1904–5, £36,202; 1905–6, £52,308; 1906–7, £77,878; 1907–8, £122,680; 1903–9, £160,900.

A claim was also made on behalf of the Council under section 101 of the Income Tax Act, 1842, to set off against the "profit" on the tramways the loss on the steamboats during the three years in which a service was run. This claim has been admitted, and the total amount which has been allowed is £88,171, made up as follows:—1905–6, £36,454 (loss on working £29,543, wear and tear £6,911); 1906–7, £26,885 (loss on working £18,416, wear and tear £8,469); 1907–8, £24,832 (loss on working £16,363, wear and tear £8,469). The allowance for wear and tear in each year represents 4% on capital expenditure on boats.

A claim was also made for an allowance of £3,725 a mile in respect of horse lines reconstructed for electric traction and which were wholly worn out at the time of reconstruction. The Council will remember that originally an allowance in respect of horse lines partly worn out was claimed, but on appeal to the High Court against the disallowance of this claim by the District Commissioners, the Council was unsuccessful. The present position is that the Council has been allowed £3,725 a mile in respect of about 71¼ miles (single line)—of which 5 miles were allowed in 1903-4—wholly worn out, and nothing in respect of about 50 miles not wholly worn out at the time of reconstruction. On March 31, 1909, there were about 69 miles not reconstructed, and the Council will no doubt be able to claim allowances for the greater part of these. The amounts allowed each year for the 5 years now in question were as follows:—1904–5, £12,436; 1905–6, £17,135; 1906–7, £104,747; 1907–8, £82,829; 1908–9, £29,688.

For the year 1908-9 the net amount on which tax is payable is £126,759, after allowing for the fact that in accounting to the Inland Revenue for the tax deducted by the Council from interest on its consolidated stock, the Council is allowed to retain tax on interest paid out of income already taxed. Interest upon the money borrowed for the tramways undertaking is not allowed as a deduction in arriving at the amount of tramways "profits" liable to tax, and inasmuch as such interest is payable out of taxed tramways profits the Inland Revenue would get tax twice over on the same income if the deduction and retention of tax on the interest were not allowed. Shortly stated, the net amount on which the Council pays income tax on its tramways is the net surplus of the year, plus items of expenditure not allowed by the Inland Revenue to be taken into account in arriving at the assessable "profits," plus repayment of debt but deducting allowance for depreciation.

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ELECTRICALLY HEATED HOUSEHOLD APPLIANCES.*

By A. G. JONES.

The load factor of the central station is a subject which materially affects the financial success of the station. Therefore, progressive managers throughout the entire country have turned their attentions towards making the ratio above referred to as high as possible. The cost of managing the system and distributing the electrical energy is not merely the operating expense of the station but includes the depreciation on the equipment and interest on the money invested. The operating expense may be divided into two classes, one class dependent on the load, and the other class independent of the load. It is, therefore, evident that a station with a large k.w. output will have a cheaper operating cost per kilowatt-hour than will a similar station of smaller kilowatt-hour output. It has been found by experience that it is almost as economical from an operating standpoint to deliver two k.w.h. as it is to deliver one kilowatt-hour, assuming, of course, that the plant is of sufficient capacity to take care of the large load. It will, therefore, be seen that a high load factor, meaning a high k.w. output, would considerably lower the cost of operation of a given station. Medium and large size stations consider a load factor of thirty-five per cent. to be very good, indeed, and a load factor of fifty per cent. to be excellent.

The daylight load is secured by the installation of motors and heating devices. How many central managers are there who walk down their brilliantly lighted thoroughfares in a blaze of light from electric signs, which have been placed on the system by the strenuous efforts of canvassers? The electric sign business is undoubtedly profitable to the central stations, but if you will stop a moment and consider the effect which would be obtained if electric signs were in use during the morning, the noon and the evening meal hours, you will find an incentive in instituting a vigorous campaign in behalf of electrically heated devices. In other words, suppose that you had an equivalent connected load of heating devices in service during the morning, noon and evening meal hours, do you not agree that the load factor would be materially improved, and the cost of generation per kilowatt-hour materially reduced? The experience of companies that have extensively exploited electric heating devices will confirm the truth of such arguments. Think of the energy lost while operating a large generating plant at the reduced efficiency ensuing from a small load. Suppose that the central station in which you are interested had connected to its lines fifty or one hundred cooking outfits, and that the average loads of such outfits were represented by the values given in the table below.

Taking data from actual experience, which may be considered as being a fair rate for a family consisting of three to four persons, it was found that the average weekly consumption of current for cooking and heating purposes was as follows:—Breakfast hour (6.30 to 8) 5½ k.w. h.; baking time (8 to 11), 7 k.w. h.; ironing (7 to 11), 2½ k.w. h.; mid-day meal time (11.30 to 1), 9 k.w. h.; general consumption between 1 and 4.30, 2 k.w. h.; supper time (4.30 to 8), 3 k.w. h.; night load, 2 k.w. h.; that is, a total for cooking and heating of 31 k.w. h., *day load*. The lighting load (4.30 to midnight) was only 10 k.w. h. for the week.

In the particular case above referred to, the consumer used current during the previous year to the amount of $35 for light, and after the installation of the heating and cooking devices, his bill was increased to approximately $110 per year, showing an increased income to the central station amounting to over 150% for this particular residence. This case illustrates what can be done, and what should be done, in exploiting the electric heating business. Notwithstanding the great increase in revenue to the central station, the consumer's bill was approximately the same as it had previously been when using gas and coal for cooking purposes.

In introducing heating and cooking devices, public demonstrations are of great value, but under no condition should the demonstration be in the hands of a person incompetent and unfamiliar with the details of the devices. A great amount of interest is always shown in displays and demonstrations of electric heating and cooking devices. Besides the attractive appearance of the goods, they seem to have a fascination which cannot be easily explained. They are clean, sanitary, quick in operation, and ornamental, reasons which undoubtedly appeal to the most critical housewife.

The layman usually has a more or less vague idea as to the meaning of the watts rating as will be found on the nameplate of heating devices, and, perhaps, the simplest way to make such a rating comprehensive to the public is to reduce the rating in watts to an equivalent number of 16 c.p., 110 volt, carbon lamps. The standard 110 volt, 16 c.p. carbon lamp consumes about fifty-six watts; therefore, if the watt rating on the nameplate of the heating device be divided by fifty-six, the "lamp equivalent" will be obtained. If the consumer will, therefore, compare the lamp equivalent of the heating device which he proposes to use, he will have a very good general idea of what he might expect the operation of the heating device will cost, by comparison with previous lighting bills. If electric cooking and heating is employed extensively in any given house, it is desirable to have the entire circut separate from the lighting circuit, and metered by an independent meter. In this way the consumer can obtain definite figures as to the actual cost of cooking or heating by electricity. Often the installing of a curve-drawing wattmeter for a short time will prove instructive both to the customer and the lighting company.

The importance of heating-device displays in the exhibit rooms or offices of central stations will not be questioned by the most sceptical manager, and in order that such a display may be most effective and interesting to prospective customers, the articles chosen should be representative and few in quantity, rather than simply a miscellaneous collection of a complete line. To be most attractive, they should be surrounded by articles in keeping with their use. For instance, a chafing-dish on a well-finished table with a few dainty dishes and some silverware will catch the eye of an apparently disinterested person much quicker than would a general conglomeration of heating devices. The coffee percolator and the toaster, when in operation, make a very attractive display. In other words, the more ornamental the appearance of the general display, the more effective it will be.

The heating units in various electric appliances vary materially with different manufacturers and with the particular article in question. The units may, however, be divided into three general classes, known as: (1) Flat unit; (2) the well-known cartridge unit; (3) a unit composed of resistance wire wound on mandrels of various shapes.

A typical flat unit consists of a stamping of the desired shape made from a solid sheet of specially prepared resistance metal of very thin cross section. This is placed between thin sheets of amber mica, and securely clamped in position, which brings the resistance material in close thermal contact with the surface to be heated. Such a unit is ideal for flatirons, percolators, small disc stoves, and other appliances where an even temperature is required over the entire surface.

The cartridge unit consists of a spiral of suitable resistance wire wound on edge, each layer being insulated by a powdered material resembling porcelain. The spiral is then encased in a metal cartridge, after which it is baked to a very high temperature. This type of unit is eminently well suited for instantaneous water heaters, and other devices which do not require uniform heating of a flat surface. The cartridge unit is also used with great success in flatirons, since the metal composing the iron can be shaped in such a manner as to produce an even temperature on the smoothing surface of the iron. This is accomplished by putting a great amount of metal in the proper place, and also by forming an air space directly beneath the cartridge unit, that is, between the unit and the surface of the iron, thus preventing the centre of the iron from becoming too hot and insuring a uniform heat on the working surface. The cartridge unit has the advantage of being very easily renewable, and also has a remarkably long life.

* Abstract of paper read at Joint Convention N.W. Electric Light and Power Association, 1909.

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The various heating units constructed from ordinary round resistance wire wound on suitable mandrels have many applications, but broadly speaking do not admit of the most efficient utilisation of heat.

Great care should be exercised by the agent or solicitor in selling heating devices to be certain as to the voltage of the circuit upon which the device is to be used. A large percentage of the trouble with heating devices is due to using such devices on circuits of voltages varying widely from that for which the unit is designed. In order to get the maximum efficiency from a heating unit, it must be designed rather closely to its voltage limit, and for this reason heating devices should not be used on circuits varying more than 5% from the rated nameplate voltage. An excessive voltage, of course, results in short life, and low voltage results in dissatisfaction caused by the great length of time taken for the unit to come to a working temperature.

The application of heating and cooking devices is very broad. The table given below, being taken from the "Solicitor's Handbook of the National Electric Light Association," gives a very complete outline of the most useful devices. The table gives the name of the material, the energy consumed and the cost of operation per hour at five cents per kilowatt-hour :—

Apparatus.	Watts.	Cents per Hour.
Broilers, 3 ht.	300 to 1,200	1·5 to 6
Chafing dishes, 3 ht.	200 to 500	1 to 2·5
Cigar lighters	75	0·375
Coffee percolators for 6 in. stove	100 to 440	0·5 to 2·2
Coil heaters	110 to 440	0·5 to 2·2
Corn poppers	300	1·5
Curling-iron heaters	60	0·3
Double boilers for 6 in., 3 ht. stove	100 to 440	0·5 to 2·2
Flatiron (domestic size), 3 lb.	275	1
Flatiron (domestic size), 5 lb.	400	2
Flatiron (domestic size), 9 lb.	610	3·05
Foot warmers	50 to 400	0·25 to 2
Frying kettles, 8 in. diameter	825	4·125
Griddle-cake cookers, 9 by 12 in., 3 ht.	330 to 880	1·7 to 4·4
Griddle-cake cookers, 12 by 18 in., 3 ht.	500 to 1,500	2.5 to 7·5
Heating pads	50	0·25
Instantaneous flow water heaters	2,000	10
Kitchenettes (complete), average	1,500	7·5
Nursery milk warmers	450	2·25
Ornamental stoves	250 to 500	1·25 to 2·5
Ovens	1,200 to 1,500	6 to 7·5
Plate warmers	300	1·5
Radiators	700 to 6,000	3·5 to 30
Ranges, three heats, 4 to 6 people	1,000 to 4,515	5 to 22
Ranges, three heats, 6 to 12 people	1,100 to 5,250	5·5 to 26
Ranges, three heats, 12 to 20 people	2,000 to 7,200	10 to 36
Shaving mugs	150 to	·75
Stoves (plain), 4·5 in., 3 ht.	50 to 220	0·25 to 1·1
Stoves (plain), 6 in., 3 ht.	100 to 440	0·5 to 2·2
Stoves (plain), 7 in., 3 ht.	120 to 600	0·6 to 3
Stoves (plain), 8 in., 3 ht.	165 to 825	0·75 to 4·12½
Stoves (plain), 10 in., 3 ht.	275 to 1,100	1·3 to 5·5
Stoves (plain), 12 in., 3 ht.	325 to 1,300	1·6 to 6·5
Stove, traveller's	200	1
Toasters, 9 in. by 12 in., 3 ht.	330 to 880	1·6 to 4·4
Toasters, 12 in. by 18 in., 3 ht.	500 to 1,500	2·5 to 7·5
Urns, 1-gal., 3 ht.	110 to 440	0·5 to 2·2
Urns, 5-gal., 3 ht.	440 to 1,700	2 to 8·5

In addition to the above table of household heating and cooking utensils, there are a number of other useful devices, such as glue pots, soldering irons, leather-finishing tools, drying tables for use in printeries and binderies, etc.

Heat energy is derived from electric energy by passing the current through a resistance of suitable dimensions. The amount of heat energy dissipated will depend absolutely on the product of the resistance into the square of the current. From this it will be seen that the actual number of heat units can be accurately predetermined, the efficiency of the heating unit depending upon the design of the unit itself, and the design of the device in which it is used. We, therefore, have to look to the ingenious engineer to give us heating devices of high efficiency. The short life of heating units can be often traced to poor design, inasmuch as the resistor has to work at a temperature considerably above that which would be necessary if the design of the appliance in which it is used were such as to utilise the maximum amount of heat produced.

The majority of heating devices, such as the tea-kettles, combination cookers, water heaters, and stewpans, usually require from ten to fifteen minutes to reach the boiling point, whereas, with the grids, hot plates, and such devices as require rapid heating, they take only from two to six minutes to reach an operating temperature, assuming, of course, that the surrounding temperature is normal.

The electric coffee percolator is especially representative of the rapid strides which have been made in the art of design and manufacture of heating devices within the past several years. Actual tests on a one-and-one-half-pint size of percolator prove that water drawn from a hydrant, direct, at a temperature of eighteen degrees centigrade, required only forty-five seconds to start to percolate, and only one minute and forty seconds in the three-pint size. In either case the percolation proceeds very rapidly, and the coffee is finished in ten minutes or less. Such results are due to the improvement in the design of the heating unit, and also to the improvement in the design of the "pump" in the latter designs.

WIRELESS TELEGRAPHY.

By GUGLIELMO MARCONI, D.Sc., LL.D.

(*Continued from page 846*).

In January, 1901, some successful experiments were carried out between two points on the South Coast of England, 186 miles apart, *i.e.*, St. Catherine's Point (Isle of Wight) and The Lizard, in Cornwall.* The total height of these stations above sea level did not exceed 100 meters, whereas to clear the curvature of the earth a height of more than 1,600 meters at each end would have been necessary. The results obtained from these tests, which at the time constituted a record distance, seemed to indicate that electric waves produced in the manner I had adopted would most probably be able to make their way round the curvature of the earth, and that, therefore, even at great distances, such as those dividing America from Europe, the factor of the earth's curvature would not constitute an insurmountable barrier to the extension of telegraphy through space.

The belief that the curvature of the earth would not stop the propagation of the waves, and the success obtained by syntonic methods in preventing mutual interference, led me in 1900 to decide to attempt the experiment of testing whether or not it would be possible to detect electric waves over a distance of 4,000 kilometers, which, if successful, would immediately prove the possibiltiy of telegraphing without wires between Europe and America.

The experiment was, in my opinion, of great importance from a scientific point of view, and I was convinced that the discovery of the possibility to transmit electric waves across the Atlantic Ocean, and the exact knowledge of the real conditions under which telegraphy over such distances could be carried out, would do much to improve our understanding of the phenomena connected with wireless transmission. The transmitter erected at Poldhu, on the coast of Cornwall, was similar in principle to the one I have already referred to, but on a very much larger scale than anything previously attempted.† The power of the generating plant was about 25 kw.

Numerous difficulties were encountered in producing and controlling for the first time electrical oscillations of such power. In much of the work I obtained valuable assistance from Professor J. A. Fleming, Mr. R. N. Vyvyan, and Mr. W. S. Entwistle.

My previous tests had convinced me that when endeavouring to extend the distance of communication, it was not merely sufficient to augment the power of the electrical energy of the sender, but that it was also necessary to increase the area or height of the transmitting and receiving elevated conductors.

As it would have been too expensive to employ vertical wires of great height, I decided to increase their number and capacity, which seemed likely to make possible the efficient utilization of large amounts of energy.

The arrangement of transmitting antennæ, which was used at Poldhu, consisted of a fan-like arrangement of wires supported by an insulated stay between masts only 48 meters high and 60 meters apart. These wires converged

* See "Journal of the Society of Arts, London." Vol. XLIX, page 512, 1901.

† Royal Institution of Great Britain. Lecture by G. Marconi, June 13, 1902.

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together at the lower end, and were connected to the transmitting apparatus contained in a building. For the purpose of the test a powerful station had been erected at Cape Cod, near New York, but the completion of the arrangements at that station were delayed in consequence of a storm which destroyed the masts and antennæ.

I, therefore, decided to try the experiments by means of a temporary receiving station erected in Newfoundland, to which country I proceeded with two assistants about the end of November, 1901.

The tests were commenced early in December, 1901, and on the 12th of that month the signals transmitted from England were clearly and distinctly received at the temporary station at St. John's in Newfoundland.

Confirmatory tests were carried out in February, 1902, between Poldhu and a receiving station on the s.s. *Philadelphia*, of the American Line. On board this ship readable messages were received by means of a recording instrument up to a distance of 1,551 miles, and test letters as far as 2,099 miles from Poldhu. The tape records obtained on the *Philadelphia* at the various distances were exceedingly clear and distinct, as can be seen by the specimens exhibited.

These results, although achieved with imperfect apparatus, were sufficient to convince me and my co-workers that by means of permanent stations and the employment of sufficient power it would be possible to transmit messages across the Atlantic Ocean in the same way as they were sent over much shorter distances. The tests could not be continued in Newfoundland owing to the hostility of a cable company, which claimed all rights for telegraphy, whether wireless or otherwise, in that colony.

A result of scientific interest which I first noticed during the tests on s.s. *Philadelphia*, and which is a most important factor in long-distance radio-telegraphy, was the very marked and detrimental effect of daylight on the propagation of electric waves at great distances; the range by night being usually more than double that attainable during daytime.‡

I do not think that this effect has yet been satisfactorily investigated or explained. At the time I carried out the tests I was of opinion that it might be due to the loss of energy at the transmitter, caused by the dis-electrification of the highly-charged transmitting elevated conductor under the influence of sunlight.

I am now inclined to believe that the absorption of electric waves during the daytime is due to the ionization of the gaseous molecules of the air affected by ultra violet light, and as the ultra-violet rays, which emanate from the sun, are largely absorbed in the upper atmosphere of the earth, it is probable that the portion of the earth's atmosphere which is facing the sun will contain more ions or electrons than that portion which is in darkness, and, therefore, as Sir J. J. Thomson has shown,§ this illuminated and ionized air will absorb some of the energy of the electric waves.

Apparently the length of wave and amplitude of the electrical oscillations have much to do with this interesting phenomenon, long waves and small amplitudes being subject to the effect of daylight to a much lesser degree than short waves and large amplitudes.

According to Professor Fleming, the daylight effect should be more marked on long waves, but this has not been my experience. Indeed, in some very recent experiments in which waves about 8,000 meters long were used, the energy received by day was usually greater than at night.

The fact remains, however, that for comparatively short waves, such as are used for ship communication, clear sunlight and blue skies, though transparent to light, act as a kind of fog to these waves. Hence the weather conditions prevailing in England, and perhaps in this country, are usually suitable for wireless telegraphy.

During the year 1902 I carried out some further tests between the station at Poldhu and a receiving installation erected on the Italian cruiser *Carlo Alberto*, kindly placed at my disposal by H.H. the King of Italy.* During these experiments the interesting fact was observed that, even when using wakes as short as 1,000 ft., intervening ranges of mountains, such as the Alps or Pyrenees, did not, during the night time, bring about any considerable reduction in the distance over which it was possible to communicate. During daytime, unless much longer waves and more power were used, intervening mountains greatly reduced the apparent range of the transmitter.

Messages and Press despatches of considerable length were received from Poldhu at the positions marked on the map, which map is a copy on a reduced scale of the one accompanying the official report of the experiments.

With the active encouragement and financial assistance of the Canadian Government, a high power station was constructed at Glace Bay, Nova Scotia, in order that I should be able to continue my long-distance tests, with a view to establishing radiotelegraphic communication on a commercial basis between England and America.†

On December 16, 1902, the first official messages were exchanged at night across the Atlantic, between the stations at Poldhu and Glace Bay.

Further tests were shortly afterwards carried out with another long-distance station at Cape Cod, in the United States of America; and under favourable circumstances it was found possible to transmit messages to Poldhu, 3,000 miles away, with an expenditure of electrical energy of only about 10 kw.

In the spring of 1903 the transmission of Press messages by radiotelegraphy from America to Europe was attempted, and for a time the London *Times* published, during the latter part of March and the early part of April of that year, news messages from its New York correspondent, sent across the Atlantic without the aid of cables.

A breakdown in the insulation of the apparatus at Glace Bay made it necessary, however, to suspend the service, and, unfortunately, further accidents made the transmission of messages uncertain and unreliable.

As a result of the data and experience gained by these and other tests, which I carried out for the British Government, between England and Gibraltar, I was able to erect a new station at Clifden in Ireland, and enlarge the one at Glace Bay in Canada, so as to enable me to initiate, in October, 1907, communication for commercial purposes across the Atlantic between England and Canada.

Although the stations at Clifden and Glace Bay had to be put into operation before they were altogether complete, nevertheless communication across the Atlantic by radiotelegraphy never suffered any serious interruption during nearly two years, until, in consequence of a fire at Glace Bay this autumn, it has had to be suspended for three or four months.

This suspension has not, however, been altogether an unmitigated evil, as it has given me the opportunity of installing more efficient and up-to-date machinery. The aerial used consisted of a nearly vertical portion in the middle, 220 ft. high, supported by four towers, and attached at the top to nearly horizontal wires, 200 in number and each 1,000 long, extending radially all round, and supported at a height of 180 ft. from the ground by an inner circle of 8, and an outer circle of 16, masts. The natural period of oscillation of this aerial system gave a wave-length of 12,000 ft. Experiments were made with this arrangement in 1905; and with a wave-length of 12,000 ft., signals, although very weak, could be received across the Atlantic by day as well as by night.

The system of aerial I finally adopted for the long-distance stations in England and Canada not only makes it possible to efficiently radiate and receive waves of any desired length, but it also tends to confine the main portion of the radiation to a given direction. The limitation of transmission to one direction is not very sharply defined, but the results obtained with this type of aerial are nevertheless exceedingly useful.

Many suggestions respecting methods for limiting the direction of radiation have been made by various workers, notably by Professor F. Braun, Professor Artom, and Messrs. Bellini and Tosi.

‡ See proceedings of the Royal Society, Vol. LXX, "A Note on the Effect of Daylight upon the Propagation of Electro-magnetic Impulses." G. Marconi, June 12, 1902.

§ See *Philosophical Magazine*, August, 1902, Ser. VI., Vol. IV., page 253. J. J. Thomson. "On Some Consequences," etc.

* See Rivista Marittima, Rome, October, 1902.

† See paper read before the Royal Institution of GreatBritain by G. Marconi, March 3, 1905.

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In a paper read before the Royal Society in London in March, 1906,|| I showed how it was possible by means of horizontal aerials to confine the emitted radiations mainly to the direction of their vertical plane, pointing away from their earthed end. In a similar manner it is possible to locate the bearing or direction of a sending station. The transmitting circuits at the long-distance stations are arranged in accordance with a comparatively recent system for producing continuous or slightly damped oscillations, which I referred to in a lecture before the Royal Institution of Great Britain on March 13, 1908.

An insulated metal disc A is caused to rotate at a high rate of speed by means of an electric motor or steam turbine. Adjacent to this disc, which I will call the middle disc, are placed two other discs (C′ and C″), which may be called polar discs, and which are also revolved. These polar discs have their peripheries very close to the surface or edges of the middle disc. The two polar discs are connected by rubbing contacts to the outer ends of two condensers K, joined in series, and these condensers are also connected through suitable brushes to the terminals of a generator, which should be a high tension continuous current generator.

On the middle disc a suitable brush or rubbing contact is provided, and between this contact and the middle point of the two condensers an oscillating circuit is inserted, consisting of a condenser E in series with an inductance, which last is inductively connected with the radiating antennæ. The apparatus works probably in the following manner: The generator charges the double condenser, making the potential of the discs, say C′ positive and C″ negative. The potential, if high enough, will cause a discharge to pass across one of the gaps, say, between C′ and A. This charges the condenser E through the inductance F, and starts oscillations in the circuit. The charge of F in swinging back will jump from A to C″, the potential of which is of opposite sign to A, the dielectric strength between C′ and A having meanwhile been restored by the rapid motion of the disc, driving away the ionized air. The condenser, E, therefore, discharges and recharges alternately in reverse directions, the same process going on so long as energy is supplied to the condensers K by the generator H. It is clear that the discharges between C′ and C″ and A are never simultaneous, as otherwise the centre electrode would not be alternatively positive and negative.

The best results have, however, been obtained by an arrangement in which the active surface of the middle disc is not smooth, but consists of a number of regularly spaced copper knobs or pegs, at the ends of which the discharges take place at regular intervals.

In this way it is possible to cause the groups of oscillations radiated to reproduce a high and clear musical note in a receiver, and thereby it is easier to differentiate between the signals emanating from the sending station and noises caused by atmospheric electrical discharges. By this method very efficient resonance can be also obtained in appropriately designed receivers.

With regard to the receivers employed, important changes have taken place. By far the larger portion of electric wave telegraphy was, until a few years ago, conducted by means of some form or other of coherer, or variable contact either requiring tapping or else self-restoring.

At the present day, however, I may say that at all the stations controlled by my company, my magnetic receiver is almost exclusively employed.§ This receiver is based on the decrease of agnetic hysterises, which occurs in iron when under certain conditions this metal is subjected to the effects of electrical waves of high frequency. It has recently been found possible to increase the sensitiveness of these receivers, and to employ them in connection with a high speed relay, so as to record messages at great speed.

A remarkable fact, not generally known, in regard to transmitters is, that none of the arrangements employing condensers exceed in efficiency the plain, elevated aerial or vertical wire discharging to earth through a spark gap, as used in my first experiments.

|| "On Methods whereby the Radiation of Electric Waves may be mainly confined," etc. Proceedings of the Royal Society. A. Vol. LXXVII., 1906.

§ Proceedings of the Royal Society. "Note on a Magnetic Detector of Electric Waves." G. Marconi. Vol. LXX., 1902, page 341.

I have recently been able to confirm the statement made by Professor Fleming in his book, "The Principles of Electric Wave Telegraphy" (1906, page 555), that with a power of 8 watts in the aerial it is possible to communicate to distances of over 100 miles.

I have also found that by this method it is possible to send signals 2,000 miles across the Atlantic, with a smaller expenditure of energy than by any other method known to myself.

The only drawback to this arrangement is, that unless very large aerials are used, the amount of energy which can be efficiently employed is limited by the potential beyond which brush discharges and the resistances of the spark gap begin to have a deleterious effect.

By means of spark gaps in compressed air, and the addition of inductance coils placed between the aerial and earth, the system can be made to radiate very pure and slightly damped waves, eminently suitable for sharp tuning.

In regard to the general working of wireless telegraphy, the widespread application of the system and the multiplicity of the stations have greatly facilitated the observation of facts not easily explainable.

Thus it has been observed that an ordinary ship station utilising about half a kilowatt of electrical energy, the normal range of which is not greater than 200 miles, will occasionally transmit messages across a distance of over 1,200 miles. It often occurs that a ship fails to communicate with a nearby station, but can correspond with perfect ease with a distant one.

On many occasions last winter the s.s. *Caronia*, of the Cunard Line, carrying a station utilising about half a kilowatt, when in the Mediterranean, off the coast of Sicily, failed to obtain communication with the Italian Stations, but had no difficulty whatsoever in transmitting and receiving messages to and from the coasts of England and Holland, although these latter stations were considerably more than 1,000 miles away, and a large part of the continent of Europe and the Alps lay between them and the ship.

Although high-power stations are now used for communicating across the Atlantic, and messages can be sent by day as well as by night, there still exist short periods of daily occurence, during which transmission from England to America, or *vice versa*, is difficult. Thus in the morning and evening, when in consequence of the difference in longitude, daylight or darkness extends only part of the way across the ocean, the received signals are weak and sometimes cease altogether. It would almost appear as if electric waves in passing from dark space to illuminated space, and *vice versa*, were reflected in such a manner as to be diverted from their normal path.

It is probable that these difficulties would not be experienced in telegraphing over equal distances north and south, on about the same meridian, as in this case the passage from daylight to darkness would occur almost simultaneously over the whole distance between the two points.

Another curious result, on which hundreds of observations continued for years leave no further doubt, is that regularly, for short periods, at sunrise and sunset, and occasionally at other times, a shorter wave can be detected across the Atlantic in preference to the longer wave normally employed.

Thus at Clifden and Glace Bay, when sending on an ordinary coupled circuit arranged so as to simultaneously radiate two waves, one 12,500 ft. and the other 14,700 ft., although the longer wave is the one usually received at the other side of the ocean, regularly, about three hours after sunset at Clifden, and three hours before sunrise at Glace Bay, the shorter wave alone was received with remarkable strength, for a period of about one hour. This effect occurred so regularly that the operators tunded their receivers to the shorter wave at the times mentioned, as a matter of ordinary routine. With regard to the utility of Wireless Telegraphy there is no doubt that its use has become a necessity for the safety of shipping, all the principal liners and warships being already equipped, its extension to less important ships being only a matter of time, in view of the assistance it has provided in cases of danger.

Its application is also increasing as a means of communicating between outlying islands, and also for the

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ordinary purposes of telegraphic communication between villages and towns, especially in the Colonies and in newly developed countries.

However great may be the importance of Wireless Telegraphy to ships and shipping, I believe it is destined to an equal position of importance in furnishing efficient and economical communication between distant parts of the world, and in connecting European countries with their Colonies and with America. As a matter of fact, I am at the present time erecting a very large power-station for the Italian Government at Coltano, for the purpose of communicating with the Italian Colonies in East Africa, and with South America.

Whatever may be its present shortcomings and defects there can be no doubt that Wireless Telegraphy, even over great distances, has come to stay, and will not only stay, but continue to advance.

If it should become possible to transmit waves right round the world, it may be found that the electrical energy travelling round all parts of the globe may be made to concentrate at the antipodes of the sending station. In this way it may some day be possible for messages to be sent to such distant lands by means of a very small amount of electrical energy, and, therefore, at a correspondingly small expense.

But I am leaving the regions of fact, and entering the regions of speculation, which, however, with the knowledge we have gradually gained on the subject, promise results both useful and instructive.

QUANTITATIVE MEASUREMENTS IN RADIO-TELEGRAPHY.

Dr. J. A. Fleming has sent a written reply covering the whole field of the discussion on his paper on the above subject, read before the Institution of Electrical Engineers on December 16.

He says :—Mr. Taylor throws doubt on the accuracy of the high frequency resistance measurements, but he offers no sufficient reasons for objecting to the scientific principles involved. The discrepancy in the case of the No. 14 copper wire to which he draws attention is capable of a simple explanation. The accuracy of the measurements of the high frequency resistance by the differential thermometer described depends as stated entirely on the possession of ammeters capable of reading correctly large high frequency currents. Such ammeters are, however, as mentioned in the paper, not yet purchasable in the market, and hence at the beginning of the experiments we had to employ the results of tests made with the differential thermometer to guide us in the construction of a satisfactory form of high frequency ammeter.

Also it was not until some experience had been gained in the use of this differential instrument that difficulties with it were finally overcome. The figures in the Table I. which are given are the actual unadulterated results of observations, and although it was evident that the measured high frequency resistance of the No. 14 wire varied in the wrong direction with frequency, the observations were not excluded merely on that account, but attention was directed to improving the high frequency ammeter. The results with the No. 16 copper wire are in excellent agreement with them, and these last results were obtained with the finally used form of ammeter. It would, of course, have been easy to reject all results not in good accordance with them, but one object of including them was to afford an opportunity of pointing out the sources of error.

There is certainly no incorrect scientific principle violated in this method of measuring high frequency resistance, but the accuracy which is obtainable depends on the precautions taken by the observer to make his final reading of currents early after the temperatures of the wires have reached a stationary condition, also on the employment of correct ammeters and on the use of the method of double weighing.

The chief purpose served by the experiments, and even by the discrepancies in the results, has been to indicate the lines on which a correct reading high frequency ammeter can be constructed.

With respect to Mr. Taylor's objections to the accuracy of the measurement of the power radiated from the antenna on the ground that earth resistance is not included, Mr. Taylor furnishes no figures or data in support of his opinions, nothing, in fact, but a surmise.

It is perfectly true that there may be energy losses due to earth resistance if the said earth connection is faulty, but these losses are generally largely under control. The mere measurement with direct currents of the so-called earth resistance will not furnish any reliable data for their predetermination. They can, however, be determined by bending down the antenna so as to form a feebly radiative or non-radiative current whilst leaving the earth connection intact, but attracting the free end of the antenna to a capacity plate so as to have the same current in it. The radiation of energy is then stopped, but the dissipation of energy by resistance in the wire and earth connection remains the same as before. As regards losses by induction one is not necessarily obliged to place antennæ near pipes or other conductors so that these other sources of loss mentioned by Mr. Taylor are hypothetical and not essential. The object of the paper was to show how such energy radiation could be measured by difference, but in any case something must be left to the intelligence of the observer.

There is no difficulty in measuring the earth connection losses if they exist, and they must then be taken into account. Dr. Erskine Murray seems to think that the difference between the small high frequency resistance with damped and undamped oscillations in some way invalidates my results. This, however, is not the case. My apparatus can be used for measuring the resistance under either kind of oscillation, but the difference in the results is not nearly so great as he appears to think. Prof. Barton's additions to Lord Rayleigh's formula are perfectly well known, but they have nothing to do with the matter in question. My experiments were made with damped oscillations because I was for the moment concerned only with spark telegraphy. As regards his remarks that better spark photographs have been taken by Rühmer and Majorana he is entirely incorrect. No such spark photographs as have just been shown to you have been published by these experimentalists. The phenomena of multiple spark discharges has been, of course, well known, but many of the diagrams given in Dr. Erskine Murray's translation of Rühmer's book on wireless telegraphy seem to be rather the product of the imagination than the record of actual observations by photography.

I totally disagree with Dr. Murray's explanation of the short spark phenomenon. I am glad to hear Prof. Wilson express the opinion that in licences for wireless telegraphy the permissible radiated energy should be defined. If the definition is based on the power given to the apparatus in the form of direct or alternating current, then no one will be able to know what he may do or what he may not do, and experimental research work in radio-telegraphy outside Government establishments will be practically interdicted. In conclusion, I should like to say that I am glad to find that the results of measurements on the efficiency of radio-telegraphic apparatus made by Dr. Eccles and Mr. Makeower agree so well, broadly speaking, with my own, a certain type of spark apparatus. I have long been of the opinion that exaggerated claims were being made for the efficiency of certain types of apparatus in this respect. Even if the results of experience is to show that certain other sources of loss must be taken into account, such as the brush discharge from the summit of the antenna, which may, however, be prevented by proper terminal apparatus, the methods explained to-night will have no doubt cleared the way for more complete scientific knowledge of the efficiency of radiotelegraphic apparatus.

CHANGE OF ADDRESS.

Messrs. Horne & Co. announce that in consequence of the demolition of their offices at No. 8, Delahay-street, under the Public Offices Sites (Extension) Act, 1908, they have removed to 35, Old Queen-street, Westminster, S.W.

Messrs. Babcock & Wilcox, Ltd., have removed their Manchester office from 14, Deansgate, to more commodious premises at 30, Cross-street. The telephone number remains as before, No. 3112 City, and the telegraphic address, "Babcock, Manchester."

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ELECTRICAL APPARATUS AND PREVENTION OF ACCIDENTS.*

By FRANK E. LAW, M.E., and W. SEWELL, AB., M.E.

When operating at a potential in excess of 550 volts, dynamo and motor-frames and bedplates, ladders, and other metallic parts, should be jointly and efficiently grounded. It is even better to ground all parts whenever the potential is in excess of 250 volts, as there are persons to whom a higher potential is dangerous. Grounding at a less potential than 550 volts is, however, against the rules of the National Board of Fire Underwriters. Whenever machines operated at a less potential than 550 volts are grounded, a permit should be obtained from the Fire Underwriters.

Dynamo and motor frames may be insulated from the ground when operating at a potential of less than 550 volts. Better still is a limit of 250 volts within which the machines may be insulated. But if a limit of 250 volts is adopted, care should be taken to get the permission of the Fire Underwriters, as noted in the preceding paragraph. The rail-fencing about dynamos and motors should be made of some non-conducting material, such as wood. In addition, a high-potential machine should be surrounded by an insulated platform. This may be made of wood mounted on insulating supports, and so arranged that a man must always stand upon it in order to touch any part of the machine. The platform should be covered by a rubber mat, preferably perforated so that oil and water accidentally dropped will not remain on the surface. The terminals, brushes, connectors, and other parts of high-voltage dynamos, motors, and transformers, should be so arranged or boxed that no person can accidentally establish connection between two parts at a high-potential difference, with his body, clothing, or conducting tool. Belts in exposed positions where a person's clothing is liable to be caught should be railed or boxed off. Ragged edges of belts should be removed, to minimize the chances of clothing catching.

When a belted dynamo or motor must be set close to a wall, the pulley side should always be next to the wall if possible. This will locate the belt out of the way, as well as make the commutator and brushes easily accessible. Tools and pieces of iron and steel should be kept away from dynamos and motors while running, as they may be drawn in by magnetism, and perhaps get between the armature and pole-pieces and ruin the machine. Therefore zinc, brass, or copper oil-cans should be used, never iron or "tin" (tinned iron). Before starting work on any machine not in service, a man should always satisfy himself that the machine is disconnected from the switchboard or circuit.

In oiling, cleaning, or adjusting any part of a dynamo, motor, or transformer in service, the attendant should wear rubber gloves, first examining them to see that they are in good condition. In making adjustments, especially on high voltage machines, it is well in addition to stand on an insulated board and never touch opposite sides of the circuit at the same time. The attendant should use one hand only wherever possible. A safe rule is, "Keep one hand in your pocket," in order to be sure not to use it. He should also be careful not to allow any portion of his clothing to get caught in the machinery or belting. The handles of oil-cans, and wipers and cleaners, should be insulated so that they cannot act as a conductor between the hand and the thing touched.

Rubber mats or other equally efficient insulating material, kept in a dry and efficient state, should be placed wherever it is possible for an attendant to make an accidental dangerous connection with any conductors, or to be grounded by contact with gas, water, or waste pipes.

Switchboards should invariably have rubber mats or insulated wooden platforms placed in front of them. All switchboards should have at the back a clear space of at least four feet which should never be used for storage, or otherwise obstructed. This space should be kept closed off, except when making adjustments or repair.

As far as possible, all work should be done using only one hand at a time. It is best to keep the other hand behind the back, the most dangerous shocks being those from hand to hand. Before touching any portion of a switchboard or its conductors or connections, if the voltage is over 15, the attendant should put on rubber gloves, first satisfying himself that the gloves are in good condition.

In case a circuit-breaker "opens," the attendant should open switch immediately before touching the "breaker," and should see that both are in good condition before making "circuit" again, first setting "breaker," then throwing in switch. It is very bad practice to close a circuit by resetting the "breaker." Any circuit on which the "breaker" opens at short intervals should be investigated, and the trouble located and remedied. The following simple precautions should also be carefully observed: Never place any switches in the factory over wet floors or iron floor-plates, or behind running belts. Screen off "live" sections of high-pressure switch-boards from "dead" sections, when working or cleaning has to be done on "dead" portions.

Standard enclosed fuses should always be used wherever possible. If there is anything amiss, or any fault upon the circuit, the fuses will generally blow at the moment of switching on the current. If the fuses are of the open type, the operator is likely then to receive the full benefit of the explosion of molten metal and the heat of the arc on his hand or in his face. For instance, a fuse may have blown from a short circuit on the line. In attempting to renew this fuse (if an open one), a flash will occur should the short circuit have not been remedied, and burn the operator. Bare metal fuses had best not be used at all, but if used, should be so protected that when they come into operation the fused metal cannot be scattered. In any event, switches and fuses should not be fixed to the same base in such a way that in switching on, the operator's knuckles will touch the bare fuse-metal. The advantages of using enclosed fuses cannot be over-emphasised.

All transformer-cases should be effectually and permanently grounded, and so constructed that in the event of "running to frame," the earth connection will not be broken by the removal of the fuse-box or other part of the case. Transformer-cases, iron ladders, and all permanent metallic parts contained within the transformer-chamber and not forming part of the electric circuit, should be metallically connected. All holes in transformer-cases through which high-voltage conductors pass, should be bushed with effective non-conducting material. All high-voltage connections within a transformer-chamber should be so protected with insulating material that it is impossible to touch them. Switches for cutting off both the high and low-voltage connections of transformers should be operated as far as possible from the outside. All transformers should be periodically inspected. Leads exposed for long periods to the weather are likely to become bare of insulation and come into contact with the case, thus connecting the primary and secondary windings.

Overhead cables and wires in factories should be insulated all over, and so supported that there is no possibility of anyone coming into contact with them. The use of exposed or moulded wiring in basements, especially in damp basements, or about rooms having grounded surfaces, such as baths, toilets, and the like, should be avoided. Very many serious and fatal accidents have been caused by the use of brass-shell key-sockets and flexible cords, accessible to persons from baths, sinks, metal or damp floors, gas, water, or waste-pipes, and the like. The use of porcelain sockets in such cases is strongly recommended, provided such use does not constitute a violation of the "Fire Underwriters' Rules." These state that "porcelain-shell sockets being subject to breakage, and constituting a fire hazard when broken, will not be accepted in places where they will be exposed to hard usage." All dangerous apparatus and cables should be painted *bright red*, and large-type notices prohibiting any unauthorized person going within 6 ft. of them should be fixed in a conspicuous position. All dangerous parts should be protected against accidental contact, as far as is consistent with convenient operation. Rubber gloves should be provided by the employer and used on both hands in the handling of cables and wires, whether the parts are "live" or not. The workman should satisfy himself before beginning work that the gloves are in good condition. Working on "live" circuits,

* Abstract from pamphlet of Fidelity and Casualty Co., New York, Sept., 1909.

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especially alternating current, should be avoided as far as is practicable. A man should not work on wire or conductors of any kind with sleeves rolled up or arms exposed, nor should wires ever be handled while standing or sitting in a wet place, without extra precaution to obtain insulation from the ground. In handling any circuit over 115 volts known to be "live," it is best, if possible, to use only one hand. Keep the other in the pocket or behind the back. If the power has been cut off by opening a switch located some distance from where the work is being done, a sign should always be placed on the switch stating that men are working on the line. No examinations, repairs, or alterations, necessitating the handling of cables, wires machines, or other apparatus under high voltage, should be made if it is possible to avoid so doing. In any case such work should be done only by a trained electrician.

The neutral wire of either direct or alternating-current three-wire systems and one side of an alternating-current two-wire circuit should be grounded, provided (*a*) that such circuits are so arranged that under normal conditions of service there will be no passage of current over the ground wire, and (*b*) that the maximum difference of potential between the grounded point and any other point in the circuit does not exceed 250 volts. The "Fire Underwriters" do not permit grounding of a two-wire direct-current system having no accessible neutral point. If alternating-current secondary systems are not grounded, a dangerous, and possibly fatal, shock may be received by anyone touching the secondary wiring if a ground should exist on the high-tension system.

Serious, and even fatal, shocks have been caused by the use of faultily-constructed hand-lamps. A portable lamp intended for use in places where the person holding it is in contact with earth, such as damp ground, metal plates, or inside steam boilers or metal tanks, should be specially insulated. The two most important points to be observed are: (1) that there shall be no metallic connection between the lamp-holder and any other metal part of the fitting, and (2) that the flexible wires in passing from the lamp-holder shall not be led through a metal tube or otherwise touch any metal part of the fitting.

Emergency outfits for immediate assistance in cases of electric shock should be provided, and it should be made the duty of some competent person to see that they are kept in good condition.

The outfits should contain the following articles:

(*a*) A bottle of aromatic spirits of ammonia.
(*b*) A bottle of ordinary ammonia with sponge attachment.
(*c*) A package of bi-carbonate of soda (ordinary baking
(*d*) A tin cup. (soda).
(*e*) A pair of tongue-pliers.
(*f*) A towel.
(*g*) A package of antiseptic cotton.
(*h*) A roll of antiseptic bandaging.
(*i*) A roll of adhesive tape.

All engineers, electricians, etc., should be familiar with "first aid" treatment for shock, in order to be able to render prompt assistance pending the arrival of a physician. The following precautions and rules for procedure should be borne in mind:

In cases of accident due to contact with a "live" cable or wire, the injured person may retain his grasp on it. If possible, the current should be shut off immediately. If this cannot be done, it is dangerous to seize any part of the victim or his clothes with bare hands. The rescuer should protect his hands whenever possible with rubber gloves, and if the wire is lying on top of the victim, it should be flipped off with a *dry* stick. Where gloves are not available, a coat or other garment, if made into a thick pad, or a thick layer of rags or paper, may be used to pull the victim away from the wire. It is much safer to take hold *only* of his *clothes* rather than to grasp or touch his body. After rescuing him, he should be carried immediately out into the fresh air and placed on his back on a flat surface, with a coat rolled (not folded) under his shoulders and neck in such a way as to allow his head to fall backward far enough to straighten the windpipe. A physician should be summoned at once. The patient's clothing should be loosened, and if breathing is irregular or suspended, artificial respiration should be proceeded with. Burns caused by electricity should be treated the same as burns from fire.

CARDIFF TRAMWAYS FINANCE.

Mr. John Allcock, treasurer of the City of Cardiff, has drawn up an important report on depreciation funds in connection with the tramways and electric lighting undertakings. The report was issued last week.

The city treasurer states:—The importance of this question will be quite apparent from the fact that the capital expenditure on the 31st of March, 1909, reached £768,088, an expenditure, having regard to the mileage, greatly in excess of any similar undertaking in the United Kingdom. In order to form an opinion upon this point, I have ascertained from the accounts of 67 undertakings that the capital expended per mile of single track works out at an average of £12,583, whereas in Cardiff this outlay reaches £24,138 per mile of single track.

It is only necessary to set aside depreciation funds in respect of those portions of the undertaking having lives shorter than the periods granted for the loans, or where such improvements have been made as to render it advisable to reject obsolete machinery and to replace such by machines of a more up-to-date and economical character. This feature is well illustrated in connection with the permanent way or track. The loan period, therefore, extends to 30 years, and the city engineer has already advised that the average life cannot be considered to be more than about fifteen years, and this advice has been strengthened by the fact that the Inland Revenue authorities have recently fixed periods ranging from twelve to sixteen years as a basis for the allowance of depreciation in assessing electric tramways for income-tax purposes.

In my original report on this question of depreciation, as already explained to the council, I did not allow for any earnings on the investment of the depreciation fund, and although a portion of such fund might be invested temporarily and interest earned thereby, still the recent report of the city engineer, in which he states that he will require the sum of £89,320 on account of renewal of track during the ensuing period ending with March, 1917, proves that it would be incorrect to assume that the depreciation fund would earn interest in the same way as a loans sinking fund, inasmuch as the latter is left undisturbed for a long period of years—in fact, until it accumulates to the amount required for the extinction of the loan.

There is at present a tramways depreciation fund of £19,004 5s. 5d., and a tramways reserve fund of £9,952 8s., making a combined total of £28,966 13s. 5d. These funds would be used as a nucleus towards making provision for the £89,320 which will be required by the city engineer on account of track renewals, viz., £7,160 in 1912, £35,320 in 1914, and £46,840 in 1917.

It will be seen from the appended table that it is imperative that the sum of £6,604 10s. shall be set aside annually during the next eight years for track renewals up to the year 1917.

On further reference to the table on tramway track depreciation in the city engineer's report, it will also be seen that Mr. Harpur contemplates spending additional moneys to the extent of £127,360, as follows:—£14,000 in 1920, £19,320 in 1922, £35,320 in 1926, and £58,720 in 1932.

Now, with regard to the latter amount, viz., £58,720, I do not think it is necessary to provide for this expenditure by accumulating a depreciation fund, inasmuch as at the time this particular money is required the original loan will have been repaid, and it would be quite in order for the council to ask the Government department in 1932 for sanction to re-borrow for this work, and I have no reason to think that such sanction would be refused.

Taking, however, the whole of the city engineer's requirements, less the £58,720 already mentioned, I find that it would be necessary to set aside during the period ending March, 1926, an annual sum of £6,946 10s., which, together with the present funds in hand and compound interest at 2½% per annum, will provide the moneys as required, and as shown in the city engineer's report.

The foregoing annual requirements are exclusive of the outlay which will be necessary from year to year on repairs of the track (as distinct from renewals), which, of course, has been and always will be chargeable to revenue account.

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In connection with my previous reports the city electrical engineer and manager supplied me with a series of rates of depreciation, which I understood at the time were based upon the conditions of the plant and machinery under his control. Subsequently, however, after a further and more detailed examination, Mr. Ellis felt he could with safety modify those rates so as to call for a smaller annual sum for the purposes of depreciation.

Now I am informed that, in his opinion, a depreciation fund is not necessary, except for the tramway track, and, after conferring with the electrical engineer and manager in reference to the great importance of the matter under review, it is with Mr. Ellis's concurrence that I present the following extracts from two of his letters on this subject of depreciation.

Mr. Ellis states: We have no plant in use at the present moment which can be considered obsolete. I do not think that we have any plant . . . . which will not last fully the life given to them as represented by the various periods during which loans upon the same must be repaid. . . . My opinion is that the finance committee should only make provision, so far as depreciation is concerned, for what is actually necessary and for what cannot be provided each year by way of repairs and maintenance. I refer to track. Track is an item of expenditure different to almost every other item, and track cannot be maintained in a condition equal to new, so far as the rails themselves are concerned, but must wait unti, the whole of it has been worn out, and must then be entirely re-constructed. It naturally follows that if the life of the track is only fifteen years—as against 30 years allowed—then at the end of fifteen years a certain sum of money must be raised somehow to cover the cost of re-construction, but with other items of expenditure this is different, because they can all be repaired and maintained week by week, and worn parts replaced out of stock and paid for out of revenue account. Take, for instance, cars. On the cars we are allowed fifteen years for the repayment of principal. Can you reasonably argue that the cars will not last the fifteen years, or, in fact, double this time? We are, as a matter of fact, turning out of our dep't every week of the year one car in a condition equal to new—all worn parts having been replaced by new parts, such as wheels, axles, motors, trolleys, etc. A glance at the cars themselves in the streets is sufficient proof that whilst they have already run nearly eight years, they are not by any means used up to the extent of 50%.

"The same thing applies also to overhead construction. What wear and tear is there on underground cables and earthenware conduits, which are laid solid in concrete? And, lastly, a personal examination of the plant at our power station—which has also been in operation nearly eight years—will show you that it is not by any means worn out to the extent of 30%, the time allowed for the repayment of the same being, I believe, 25 years. With regard to the track this is an entirely different matter, and must be faced, and is simply a question as to how much it is necessary to put aside each year to form a fund from which can be drawn the amounts at certain periods, as given in the city engineer's report. I do not think the corporation need have any fear as far as obsolescence is concerned. . . .

Having regard to the foregoing express opinion of the city electrical engineer and manager, limiting as it does the question of depreciation to track only, I feel that this is the all-important point on which the committee should express their views, for if the committee should be in agreement with the electrical engineer, the present report will probably satisfy all needs; but if in their judgment there are certain items of plant and machinery which would not live as long as the loan period, then it will be necessary for the engineer to give specifically the rates which should be applied to the different classes of machinery.

The fear that the rates of the city might be called upon to assist in building up depreciation funds has on several occasions been discussed by the council, but, perhaps, I may be allowed to submit that the source from which the money is derived does not operate upon the abstract question of depreciation. It is either a fact that the wear and tear of the machinery, etc., is greater than that represented by the amounts set aside for sinking funds—in which case extra provision should of necessity be made—or it is not a fact, and until this question is definitely agreed upon and settled it will, I think, be quite clear to the committee that I cannot complete my report.

The latter part of the foregoing report on tramways can be read as also applicable to the electric lighting undertaking. It is, therefore, not necessary for me to trouble the committee at the present time with any further detailed remarks on this part of the subject.

THE BRADFORD ELECTRICAL ENGINEERING COMPANY.

At a meeting of the creditors of the Bradford Electrical Engineering Co., Ltd., held at Leeds, Mr. J. Herbert Haley, incorporated accountant of Bradford, one of the liquidators, said the meeting took place in pursuance of Section 188 of the Companies (Consolidation) Act, and the purpose of that section was to enable creditors to determine the necessity or otherwise of making an application to Court for the appointment of a liquidator in the place of, or to act jointly with, the liquidator appointed by the company, or for the appointment of a committee of inspection. About the middle of last month the larger creditors were invited to confer with the directors on the position of the company. The two Messrs. Cassé, the former proprietors of the business, having resigned their position as managers, a scheme was proposed for the establishment of the business on a proper basis, whereby the creditors would have received 20s. in the pound, and the business would have been continued. The payment of 20s. in the pound would have covered a period of fifteen months. Certain creditors, however, thought it advisable to wind up the business, and the proposed scheme fell through. It was decided that he (Mr. Haley) and Mr. George Edgar Corfield should act as joint liquidators, and that the company should be wound up voluntarily. The company was incorporated on October 30, 1907, with a nominal capital of £3,000, divided into 3,000 £1 shares. Of these 1,182 were issued, 732 against cash to outside shareholders, and 450 to the vendors —Messrs. C. J. and H. H. Cassé—against the purchase account as part consideration. Since the company was formed trade had not been profitable. The directors were dissatisfied with the management, and Messrs. Cassé's connection with the company ceased on October 31 last. The shareholders' capital being subsequently finished, the directors, as already stated, met the principal creditors.

The statement of affairs, said Mr. Haley, showed 33 unsecured creditors for over £10, and 95 for sums under £10, the total owing to unsecured creditors being £1,238 7s. The total liabilities were £1,309 7s. The assets were composed of £819 14s. 11d. worth of book-debts, estimated to produce £650; furniture, fixtures, and plant, valued at £55 12s. 3d.; stock-in-trade and work in progress, £341 13s. 4d.; and cash in the bank, £14 6s. 4d. From the total there was to be deducted £100 due to debenture-holders and £37 9s. 5d. preferential claims; the total assets thus being £924 2s. 6d., leaving a deficiency of £385 4s. 6d.

It was decided that no application be made to the Court, but that the appointment of the present liquidators be confirmed. An advisory committee to act with the liquidators was appointed as follows:—A representative of Messrs. Scattergood & Johnson, Leeds; Mr. Dowthwaite, of C. A. Muller, Bradford; and Mr. Barclay, of the Tudor Accumulator Co., Ltd.

PERSONAL.

Mr. Lionel B. Hogarth, Assistant Engineer, Bermondsey Electric Supply Works, has been appointed Resident Borough Electrical to the Morecambe Corporation.

Mr. Cragg has been promoted to Mr. Hogarth's post, and Mr. Ingram (Junior Assistant Engineer) has been promoted to Mr. Cragg's post.

Mr. Ferdinand Saunders, of Johannesburg, has been appointed consulting engineer to the Municipal Electricity Scheme of Potchefstroom. This flourishing town, by the way, already possesses a private company supplying electric light to the business community.

Mr. A. H. Seabrook, chief engineer and general manager, has accepted the presidency of the Marylebone Electricity Department Sick Club, which, under the fostering care of its hon. treasurer, Mr. E. J. Jennings, is prospering amazingly.

Mr. H. T. Wilkinson has resigned his position as assistant manager of the Chloride Electrical Storage Co., Ltd., and has joined the Wardle Engineering Co., Ltd., of Manchester, as managing director, conjointly with Mr. C. H. K. Chamen.

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CONTENTS.

	PAGE
Notes	871
Tramways—Income Tax and Depreciation ..	872
Electrically Heated Household Appliances ..	873
Wireless Telegraphy ..	874
Quantitative Measurements in Radio-Telegraphy	877
Electrical Apparatus and Prevention of Accidents	878
The Bradford Electrical Engineering Co. ..	880
Personal	880
The Institution and its Mission	881
Use of Electricity in Mines	882
Correspondence	882
Methods and Practice in the German Electrical Industry	883
Year Books and Calendars	884
Educational	884
Electricity from the Wind	885
The Rotasphere	886
Social and Recreative ..	886
Electric Patents Action ..	886
Technical Problems, with Solutions by Practical Men	887
Bishop's Stortford Scheme	889
Tyneside Notes	890
Midland Notes	890
Lancashire Notes	891
American Notes	892
German Notes	893
Publications	894
Lighting & General Notes	895
Traction Notes	896
Companies' Meetings and Reports	896
Contracts Open	897
Tenders Accepted	897
Catalogues and Lists ..	897
Standard Works on Electrical Subjects	898
Institution of Mining Electrical Engineers ..	899
Patents	900

THE INSTITUTION AND ITS MISSION.

A matter of vital importance has been raised in connection with the aims and guiding policy of the Institution of Electrical Engineers. In the course of a discussion at the Institution's meeting, on the night of the 9th, Mr. Garcke gave utterance to certain remarks which the President deprecated as savouring of politics. Now, both Dr. Kapp and Mr. Garcke have long held such a high and well-established position in the electrical world, that their respective opinions must necessarily call for very careful consideration. The point of difference is this: Mr. Garcke wants the Institution to be a fighting professional organisation, a kind of upper class Trades' Union, something on the same lines as, say, the purely professionally selfish British Medical Association, while Dr. Kapp and, presumably the majority of the Council, wishes it to be essentially a scientific society, above politics and the commercial side of professional pre-occupations. The difference of view revealed, therefore, is very great, and it arose in this way. Mr. Garcke complained that the Institution had neglected to deal adequately with the Electric Lighting Bill of this year, more particularly as regards the draft Audit Clause and the draft Clauses touching upon competition between Local Authorities and Companies. In reply to these strictures, Mr. Mordey, past-President of the Institution, declared that a Special Committee had been appointed to consider the Bill, and had made representations to the Board of Trade on the subject, but in doing so the Committee recognised that it was the duty of the Institution to look at these matters not from the point of view of the industry alone, or of any particular section thereof, but specially from the point of view of the consumers and the general interests of the community. To this attitude Mr. Garcke apparently entirely demurs, for in his communication to the Secretary he says that, as representing very important and considerable interests in the industry (and,

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he feels, there are other representative members who agree with him), he unhesitatingly declares that in his opinion this view of the province of the Institution ought not to prevail. He thinks that the exalted functions assumed by the Council really appertain to Legislative and Government Departments. He, in fact, sides with what he thinks is the large proportion of electrical men hold should be the case, that the Institution should recognise and undertake the responsibility of safeguarding the interests of the electrical industry in the battle of life. No doubt the majority will be quite in sympathy when he declares that the present position of the electrical industry in its legislative and industrial aspects is unsatisfactory. But it is probably not everyone who will follow him so far as to say that the Institution should descend into the political and economic arena and take sides. That would, surely, alienate many sympathies from a splendid society, which at present stands so high, and of which all may be proud. In standing aloof from such debatable questions as those alluded to by Mr. Garcke, the Institution at once takes a dignified attitude, and by declaring itself a learned society attracts men of all ways of thinking who are interested on broad lines in the progress of electricity. It at once places itself on a level with the other learned societies, and by gaining public confidence enlists an interest in the science that conduces to the permanent welfare and advancement of electricity and those professionally engaged therein. There is a need for such a Institution, and good work for it to do. But, in saying this, we do not in the least call in question the equal urgency for the narrower professional and economic interests to have collective representation. This, however, could be secured outside the Institution, and, as a matter of fact, quite satisfactory organisations representing different sections of the electrical industry already exist, and can, as occasion arises, become effectively vocal. It may be that good would come if some inter-society Emergency Committee was formed, a kind of Council representative of all branches of electrical industry, which could be called together when matters of vital interest had to be considered and measures of protection adopted. Such an arrangement would provide the collective wisdom and delegatory force required, while leaving the Institution, free from the more selfish preoccupations, to fulfil its own particular high and useful mission.

USE OF ELECTRICITY IN MINES.

The Council of the Institution of Electrical Engineers are considering the evidence to be submitted to the Home Office in connection with the enquiry on the use of electricity in mines. The Secretary of the Institution will be glad to receive in writing, on or before January 10, next, any observations which members may wish to make on the Special Rules of the Home Office for the Installation and use of Electricity (Coal Mines Regulation Act, 1889), now in force.

BOOKS RECEIVED.

Directory of the Royal Society of Arts. Edited by Sir Henry Trueman Wood. London: George Bell & Sons. Price 2s.

Waterproofing. By M. H. Lewis, C.E. London: Constable & Co., Ltd. Price 2s. net.

CORRESPONDENCE.

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

ELECTRIC PROPULSION OF SHIPS.

Sir,—The article in your valued paper from the pen of Mr. E. Kilburn Scott, on the above subject, is of great service as a strong incentive to action on the part of the Admiralty.

The aim of all these suggestions and discussions is clearly to reduce the fuel consumption, for a given distance covered by the vessel, by means of the increased efficiency of the power generating and distributing plant. At this juncture in the discussion, whilst not venturing to criticise the action and object of the electrical section of the schemes advocated in this matter, it may not be considered irrelevant to the subject if the present writer directs attention to the matter of reduced cost of fuel.

In quoting the figures given by Mr. Mavor as the result of close reckoning for a cargo boat requiring 770 shaft h.p., it is shown that the steam-driven vessel of this power has a fuel consumption of 260 tons, whereas the sister vessel with gas power plant and electric distribution gives a coal consumption of 100 tons. Your correspondent, Mr. E. K. Scott, states: "It frequently happens that a *tramp* steamer arrives at a coaling station when either the prices asked, or the quantity in stock, prevents the captain from taking coal on board."

He further points out that under such conditions it sometimes pays to move on "to the next coaling station at half speed, and this condition must be met before owners will look into the subject."

Now, it comes to be a question of saving money on the coal bill, and the consideration arises as to whether the amount of capital spent is justified by the economies gained.

In connection with the figures above quoted, it appears very desirable to have stated for us the relative costs of the fuels used, because if the tons of coal, multiplied by the price in the first case, is equal by the product of the same factors, in the other case, the capital outlay on the gas and electric plant is not justified on these grounds alone, although the writer is quite aware that other considerations are also of importance. It is hence clear that if a 770 shaft h.p. cargo boat is to be fitted out with a composite gas and electric plant, the gas plant to be able to compete with steam must run on the same quality of coal, so that the owner of such vessel and the nation in turn can get their share of the benefit to be derived from the reduction of the fuel consumption to the lower point rendered available by the gas plant.

My object in writing on this subject is a desire to make clear the fact that it is now possible to generate a tar free gas from bituminous coal of ordinary quality, or even from cheaper quality than is used in the case of the steam-driven plant, so that in making comparison it may safely be asserted that it is now possible to equip an electrically propelled vessel with gas-driven plant, using bituminous fuel, while retaining practically all the advantages of the simple suction gas plant employing the high-priced anthracite fuel.

It seems to the writer that if the pioneers in this movement can arrange to secure all the economies claimed for the electric propulsion system, and can fortify their position by the introduction of such a plant that the writer knows to be now available, then it is clear that the combination is such as will at once appeal to the ship owners with overwhelming force of fact, and "we should continue to lead the nations" at any rate in matters of national economy, if not "in naval matters."—Yours, etc.,

JOHN STEWART.
(STEWARTS' GAS PRODUCERS CO.)
141, Bath-street, Glasgow,
December 15, 1909.

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WELSBACH LITIGATION.

Sir,—The attention of our clients, the Welsbach Incandescent Gas Light Co., Ltd., of 344–354, Gray's Inn-road, has been drawn to your reference to the hearing of this case in your impression of the 18th inst., which is calculated to convey an erroneous impression, which we must ask you to correct in your next issue.

What counsel for the Company stated when the prosecutors, the G.E.C., intimated that they wished to withdraw the prosecution, was that it was never their intention to mislead by the particular advertisement complained of, which would not be repeated, but the Company would continue to use the word "Welsbach," their own name, and the trade mark "Aur."

There was never any question of remodelling advertisements, other than the particular advertisement above referred to, nor, as we advised, had the Merchandise Marks Act anything to do with the question of advertisements, as it deals in this respect merely with actually applying trade marks or trade descriptions to goods which cannot as a matter of law be done by advertisements.

Yours, etc.,

MICHAEL ABRAHAMS, SONS & Co.

5, Tokenhouse-yard, Lothbury, London, E.C.

December 20, 1909.

METHODS AND PRACTICE IN THE GERMAN ELECTRICAL INDUSTRY.

By L. J. LEPINE and A. R. STELLING, Dipl. Ing., Students.

(*Continued from page 860*).

Rotor by Firm A.—The rotor is cylindrical with a distributed winding. The hub or core is one solid forging with the shaft, to which the teeth are attached as follows. The teeth are built up of stampings in packets of about 6 in. length, so arranged that there is a clear space through from top to bottom on the middle 2 in. The packets are riveted together, and after being ground to size the rivet heads project about ¼ in. outside the packet, so that when the packets are placed together on the core a vent space of about ½ in. is formed. The excitation coils are former wound, and while subjected to pressure each coil is enclosed in a metal casing which is soldered up, thus rendering the coils watertight (*i.e.*, non-hygroscopic) and affording excellent mechanical protection. The coils are laid on the core and the teeth packets slid into position on either side of the coils. These teeth slide in grooves milled out along the core, the grooves being deep enough to permit a current of air to pass under the teeth to the vent spaces. The coil ends are bound down to the core body by means of banding wire wound on by a special machine under tension. Over the first banding comes a bronze sleeve, and another banding on top of that. Copper wedges are driven over the windings in the slots and steel wedges are arranged in the empty slots to take up lateral pressure. These wedges when driven in, press down the coils into the core with a pressure greater than the maximum pull due to centrifugal force, and they also press the teeth packets against the grooves in the core so as to form good magnetic contact. The bronze sleeve short circuits the copper wedges which form amortisseurs.

Rotor by Firm B.—The core of this rotor is built up of steel plates with the slots already punched in. These slots are unequal in width and unequally spaced, the spacing being so arranged as to give the desired flux distribution curve without having any empty slots. In cases of large outputs the whole rotor is forged out of the solid and the slots milled out. In this case the slot is very deep, with a shoulder half-way down on which a metal lining rests to support the winding. The lower half of the slot thus forms an air channel directly under the winding. The coils are wound on the rotor, each coil being separated from the following one by aluminium packing pieces. Pressspahn slot insulation is used, and the coil in one slot is wound in layers, the layers being kept separate by a special compound put on hot. In addition to the aluminium packing, there are L-shaped steel plates, the lower limb of the L fitting in grooves turned in the rotor hub. The interstices are all fitted with compound, and a bronze ring is shrunk on over all.

Rotor by Firm C.—This firm adopt salient-pole rotors from four-pole upwards. They are usually built up of steel slabs (forged) approximately 3 in. thick, with forged steel pole-piece slabs dovetailed into the hub. The windings are of copper strip wound on edge and insulated with press-spahn. Bronze angle pieces hold the ends of the winding, and V-shaped packing pieces hold the coils in place laterally. The ventilation is through holes drilled in the slabs. All rotors are dynamically balanced at a speed of about 50% above normal. Exciters are specially designed, and in almost every case their armatures are carried by the extension of the rotor shaft without there being any additional bearings. Steel slip-rings shrunk on over mica are used in conjunction with one carbon and two copper brushes to each ring. Standard practice is to arrange one ring at each end.

Turbo-generators for Direct Current.—There is much less demand for this type of machine, and the principle variations from English practice which we observed are in the ventilation of the armature. Here, again, the axial ducts are used, as many as three rows being arranged concentrically. Field frames are usually built up of stampings. To avoid the use of very long commutators, these are now made in two halves and connected together.

SCIENTIFIC EXPERIMENTAL WORK.

Referring to the development of engineering since 1872, when Germany began her career as a great power, one finds that time and time again the Germans have taken up some design of an English engineer, and after a thorough investigation have devised important improvements. It is this thorough system of scientific investigation and experimental work that has enabled German firms to attain otherwise inaccessible eminence in certain branches. There are several striking examples of this, perhaps the best known is the experimental high-speed railway, near Berlin, between Marienfeld and Zossen, which has been fully described in the technical press. Another example, well known to members of the Institute, is the important series of investigations carried out on mining motors, a series with far-reaching results. Less well known is the important test of the effect of heat and age on insulating materials carried out by one of the large firms. Samples of all kinds of insulation were kept at a constant temperature of nearly 100° C. for one year, some being kept under pressure. This experiment was of the utmost value to the firm concerned, but no results have yet been made public. A considerable amount of plant has been laid down for experimental and special testing purposes, among the most recent being a water brake of 8,000 h.p. for testing steamship turbines at one works, and a wireless telegraph station at another works.

As an example of the application of scientific methods to works practice may be cited the dynamic balancing of all rotors and armatures of high or extra high peripheral speeds, as well as of all large size rotating parts while in the building-up stage. Of course, capital is required for these experiments, but as the German engineers are so well trained theoretically, and the German firms willing to employ them, the capital is rarely expended without some tangible profit. It is due also to these experiments that they are able to cope with special circumstances, and are also able to train the experts referred to in the earlier portion of the paper. They have proved to the satisfaction of their financial supporters that money spent on careful experiments in the hands of capable well-trained men is capital well invested, and we would like here to insert a plea for the further recognition and better payment of the specialist in our own country.

Conclusion.—We have carefully avoided mentioning, as far as possible, anything relating to the other important branches of the electrical industry in Germany, since a separate paper could be easily written on the management, manufacture, and design in each individual branch. The majority of our general remarks, however, apply equally well to other branches, viz., switchgear, instruments, lamp and cable manufacture. It has been attempted in this paper to give a brief survey of the German industry in the manufacture of dynamo electric machinery with the idea of investigating the factors of German makers' success, both in the German and the open market. Summarised briefly, we have, first of all, their commercial enterprise,

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including good general management, close study given to any scheme or undertaking, and the judging of each one on its own merits; secondly, their large capital and the backing up given them financially by the all-important banks. The large capital at their disposal assists them in their own country, and obtains for them good credit in foreign markets. Coming to the manufacturing side of the industry, we consider the two-shift system, together with cheap labour, and the thorough system of specialising the most important factors in competition. In design, England is in no way behind, in fact, in several cases the English designers are more far-seeing, and their designs more practical than those of their German competitors. If the English financiers and commercial leaders of the electrical industry were as enterprising and as successful as their German rivals, English manufacturers, supported as they are by the superiority of their productions, would not have to fear German competition in the open market.

YEAR BOOKS AND CALENDARS.

We have become so accustomed to Messrs. A. and C. Black's quartette of annuals that it is difficult to realise what busy people would do without their "Who's Who," "Who's Who Year-Book," "The Writers' and Artists' Year-Book," and "The Englishwoman's Year-Book and Directory." Happily all four are now on our desk, and very prosperous they look, for they grow in portliness each succeeding year.

"Who's Who" (10s. net) now gives some 23,000 biographies in its 2,200 pages. Turning over the leaves we find most of the notabilities of the world represented by useful and often entertaining notes. Such omissions as we do note concern mostly men of science, whose labours and personalities are less before the public than those of soldiers, sailors, and miscellaneous worthies. We should be glad to see so good a friend and stand-by as this reference book strengthened in the direction indicated.

"Who's Who Year-Book" (price 1s. net) contains a great variety of information, generally in compact tabular form, which makes it an indispensable companion to the first-named.

As we are all, in these days, interested in the Press in one or other of its many phases, "The Writers' and Artists' Year-Book" (price 1s. net) has a wide appeal. It gives lists and particulars of all the leading periodicals published in the English language, and many other useful details.

"The Englishwoman's Year Book" (price 2s. 6d. net) affords a good index of steadily widening range of woman's interests. It is an admirably edited work, which should appeal to everybody concerned with social progress.

The "Mechanical World" Electrical Pocket Book for 1910. (Manchester: Emmott & Co. Price, 6d. net). Like its companion volume, "The Mechanical World Pocket Diary and Year Book," this is an extremely handy and useful little book, the tables and short articles being carefully selected to meet the needs of those requiring a book of ready reference. This edition has undergone considerable extension and rearrangement, and now covers a wide field. It will be found of daily service by students and the wiring contractor.

Messrs. the Simplex Conduits, Ltd., have issued a handsome pocket book (6 in. × 4 in.), bound in flexible leather, with gilt edges, and containing diary and squared paper for notes and diagrams, and a mass of valuable data. Apart from the usual matter found in such books, such as postal information, discount and wages tables, ready reckoner, etc., we find notes on electrical units, formulæ concerning dynamos, motors, accumulators and copper conductors, details as to wiring, switchboards, cost of heating and cooking, and a great variety of other subjects. From this brief notice it will be gathered that this "Simplex" pocket book is well worth possessing.

The United States Metallic Packing Co., Ltd., of Bradford, have issued a handsome calendar for 1910. It is adorned with a bas-relief in white on a dark green card, of the celebrated equestrian sculpture group, "The Lion Killer," now in the Berlin Museum. It is a fine piece of artistic work, the idea of marble sculpture being well suggested.

The Motor Manual, 12th edition (London: The Temple Press, Ltd., price 1s. 6d.), is quite the most popular of books for the motorist. Its 272 pages are adorned with 260 excellent diagrams and full of practical hints to the man who wishes to understand his machine, and how to avoid or remedy mishaps. The electrical information given is adequate for the needs of motor proprietors and chauffeurs.

From Siemens Bros. & Co., Ltd., and Siemens Bros. Dynamo Works, Ltd., comes a neat, morocco bound, little Self-Opening Pocket Diary (4½ in. × 3½ in.), which also contains some tables and data which busy men constantly require, such as legal standard wire gauge, British standard table of conductors, diameters of wires fused by a given current, and so on.

The Yorkshire Boiler Co., Ltd., are issuing a comic Christmas card, in which we see the Yorkshire Boiler challenging the Lancashire Boiler to a game of billiards. This is *apropos* of a recent comparative test, when a "Yorkshire" 24 ft. evaporated 16·8 % more water than a "Lancashire" of 30 ft.

The Western Electric Co.'s season's greeting card is in the form of a serviceable tear-off monthly calendar.

"The Practical Engineer" Electrical Pocket Book and Diary for 1910 (London: The Technical Publishing Co., Ltd.), is issued in two forms, in soft leather binding with gilt edges at 1s. 6d. net, and in cloth at 1s. net. It contains 566 pages of closely printed matter, and among the new articles or sections are: Storage batteries, design of motor starting resistances, outer resistances for testing purposes, the "international candle," transformation of currents for power purposes, types of underground boxes, modern wiring systems, metallic filament lamps, etc. *The old* information appears to have been carefully brought up-to-date, and what with its many letters and illustrations, forms a most creditable and useful compilation.

The General Electric Co., Ltd., have brought out for their friends a large blotting pad and wallet, bound in soft black leather, with inside pockets lined with crimson watered silk. It is an excellent thing for the business man, on his travels, or the consulting engineer when preparing his reports. In either case one of the pockets should certainly be reserved for the company's catalogue.

EDUCATIONAL.

CRYSTAL PALACE SCHOOL OF ENGINEERING.

At the 111th award of certificates (marking the close of the 37th year) in connection with the Crystal Palace Co.'s School of Practical Engineering, in the unavoidable absence of Colonel R. E. B. Crompton, C.B., R.E., member of the Council of the Institution of Civil Engineers, the chair was taken by Mr. W. M. Mordey, M.Inst.C.E., past president of the Institution of Electrical Engineers. The examiners presented their report, which showed that in the first year's course of mechanical engineering 28 students were eligible for examination and 20 passed. In the Electrical Section, A. C. S. Bowman, R. B. Culbertson, H. E. Startin, and W. J. Startin came out first. Others who took primier honours were A. Bridge, E. C. Coke, and H. E. Rapsey.

The Chairman, in an address to the students, pointed to how enormously important it was that engineers should be able to work as mechanics. Nothing, he said, helped a man so much in engineering work as to be able to take his coat off and do the job himself. There was nothing that would give him so much respect among the men who worked under him as to be able to show that he was the master, that he was not only able to do the work by theory, but also by practice. Another piece of advice he would give the students was that no matter how eminent they might become in their profession they should always keep up the ability to do the detail work, as they were then in the best position to tell others how it should be done. He advised them to aim at being underpaid, because the man who was not underpaid never had a chance of getting a rise. On the whole he thought that British engineers were more to be relied upon than the engineers of any other country. Uprightness and high professional conduct were of the greatest importance to engineers, and these qualities had placed many British men in charge of work not only in our Colonies but in all parts of the world.

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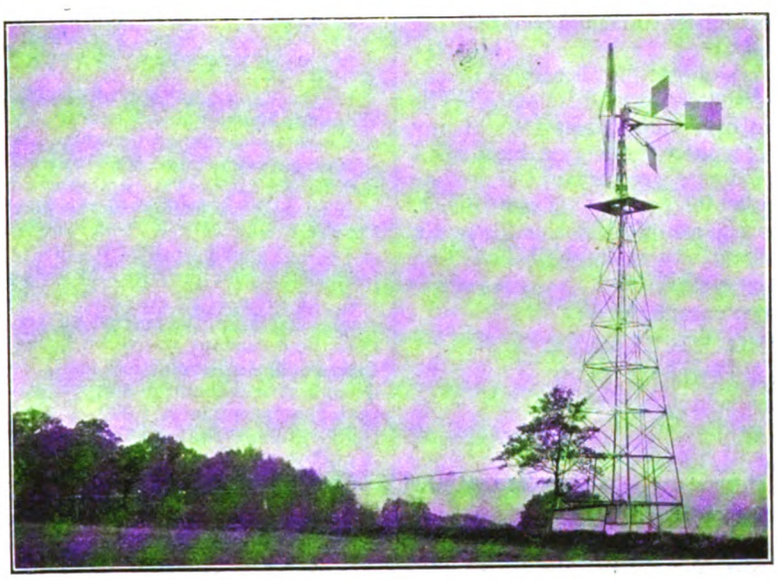
PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

Electricity from the Wind.

We have from time to time given particulars in these columns of various more or less unusual methods of obtaining power for the generation of electricity. Some months ago we gave details of the wind turbines constructed by Messrs. J. G. Childs & Co., Ltd., electric and hydraulic engineers, and we have also pointed out that wind appliances are very suitable for driving small plant, especially where topographical peculiarities conduce to a fairly steady morning or evening breeze.

An excellent example of a country house installation, for which Messrs. Childs are responsible, is illustrated herewith. The plant, it may be mentioned, is one of their standard wind turbines for electric driving. It is 24 ft. in diameter, and mounted upon a steel tower 75 ft. high. This tower is placed some 435 yards from the house (where the battery is situated), about 90 ft. above the level of the ground round the house. The generator is placed in a small house at the foot of the tower, and the battery and switchboard are in one of the outbuildings of the house.



The current is conveyed from the generator to the battery by means of bare solid overhead copper cables, carried on porcelain insulators mounted on poles, in connection with which lightning arrestors are fixed. The poles and the cross arms are placed about 30 ft. apart, and were supplied from the plantation on the estate.

The generator is of a special design, with a speed variation of 400 to 1,600 r.p.m., and runs with the armature in a vertical position. It is carried on ball bearings, and is driven by a 5 in. belt from the vertical shaft of the wind turbine, the belt being on its edge. The generator is of 4 kw. capacity, with a normal voltage of about 70.

As it was desirable to have the whole of the control arrangements in the battery room, where the switchboard is placed, a separate field wire was carried up to the battery along with the other conductors. This also is a bare copper wire carried on insulators.

The battery consists of 28 cells by Messrs. Pritchett & Gold, having a discharge capacity of 46 a. for 10 hours. The battery is divided into two equal groups, either of which can be used for the lighting circuit, which is at 25 v., using Osram metallic filament lamps. Arrangements are made for using 50 v. for power, as the plant, in addition to running the lights in the house (about 100 in all) also drives a 50 v. motor for running a chaff cutter, circular saw, and root pulping machine. This motor is placed in a shed about 80 yards from the house, and is connected to the battery by means of an armoured lead covered cable laid in the ground. The chaff-cutting required for the homestead is easily dealt with by this machine, and also a considerable amount of firewood, etc., is sawn. The motor is belted direct to the various machines, and, of course, only runs one at a time.

The plant has been running for some months, and, we understand, behaves admirably. It is entirely automatic, being fitted with our patent tail-gear, giving very accurate adjustment to the wind. This arrangement consists of 3 tails, two of which stand out at about 20 degrees with the wheel. Two of these are connected together, so that when the wheel is required to stop, these have only to be pulled down into a horizontal position, and the wheel immediately comes up into the wind and stops running. In the same way, the tails are so balanced, that when the wind reached a predetermined velocity, the tails tend to take the horizontal position, and so bring the wheel more or less out of the wind as the strength of the wind varies.

All the main bearings carrying load are ball bearings, and the gear is enclosed in a cast iron oil bath, so that if the plant were left for 12 months no harm would result from want of lubrication.

As the wind turbine is placed on ground somewhat higher than the house, and out of sight behind a wood, there is often a good wind blowing at the turbine, when none is felt down at the house. The plant is guaranteed to produce 3,000 units a year, but in practice it produces at a much faster rate than this. There is a record that in 12 hours the plant produced 14 units, with wind averaging 15 miles an hour.

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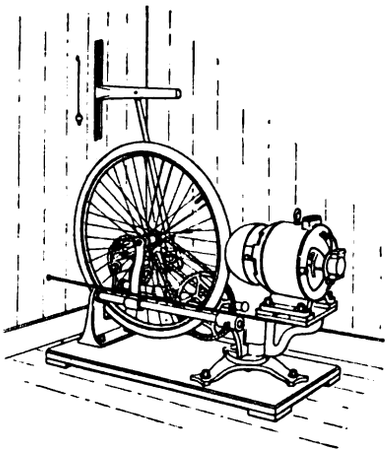
THE ROTASPHERE.

The "Rotasphere" is an invention for blowing organs by electrical power, possessing several notable features.

The drive from the electric motor is by friction between a hemisphere of aluminium and an ordinary pneumatic bicycle tyre. We believe that this is the first time that a pneumatic tyre has ever been used for such a purpose, its resilience forming an ideal member for a frictional-couple.

The automatic control is also highly ingenious, and it is obtained by swivelling the motor and hemisphere, by means of power derived from the rising and falling of the organ bellows itself, so that a greater or less arc of the hemisphere is in contact with the tyre. By this means a bevel gear of infinite pitch is obtained. As there is no "scrubbing"



action on the rubber, the tyre lasts a long time. The motor, being shunt-wound, runs at a constant speed, and the speed of the driven member is reduced by means of chains and sprocket wheels, while a crank finally transmits reciprocating motion to the bellows handle.

In practice, the machine is so silent that it may be placed on the floor, by the side of the organ, and its efficiency is extraordinarily high, being over three times that of any rotary fan blower. A "Rotasphere" operated by a small ½ b.h.p. motor will blow a moderate-sized organ, and provide an ample supply of wind for the full power of the instrument.

It is a capital contrivance, and one which is likely to come into wide use. It is manufactured by the Kinetic Co., Ltd., organ blowing specialists, of Linclon.

SOCIAL AND RECREATIVE.

ORDNANCE ATHLETIC CLUB.

A smoking concert was held last week at *The King Edward VII.*, New Corporation-street, Birmingham, in connection with the Football Section--Second Division—Works League, between three and four hundred of the staff and workpeople being present.

The Chairman, Mr. J. R. Garner (Works Manager) read a letter of apology from the Superintendent of Works, and President of the "Ordnance" A.C. (Mr. F. E. Hinton), who regretted his inability to preside, but informed the assembly that he wished the club every success, and stated that he would do his best to promote its interests at all times, being strongly in favour of sports. He considered they were most essential to workers shut up in a factory all day long, and he trusted during the forthcoming season that the cup put up for competition by Messrs. Vickers, Sons & Maxim, Ltd., Sheffield, the parent company, wonld again come back to Birmingham. This cup was won the first year of competition, 1908, by the Ordnance Athletic Club, against teams from the works of Vickers, Sons & Maxim, at Barrow, Sheffield and Erith, and the Wolseley Motor Car Works, Birmingham.

The Chairman heartily confirmed the President's sentiments, and stated that a firm who had a first-class Athletic Club, were invariably a successful business concern. A good player was usually a good worker.

Mr. Morrison, the secretary and commercial manager of the company, was in the vice-chair, and stated that he had every sympathy with the movement, and was very glad to be asked to take the vice-ehair. He was himself a player, and had taken part in a football match between the heads of departments and foremen some years ago.

A very enjoyable programme was given, and the meeting was concluded with cheers for the chairman.

ARC WORKS VOLUNTARY SICK BENEFIT SOCIETY.

At the annual meeting, held in the Recreation-room at the Arc Works, Chelmsford, Mr. A. J. Hodgson presided, supported by Mr. Claud Crompton.—The Secretary (Mr. W. G. Bickmore) reported receipts by contributions to the general fund, £285 0s. 8d.; donations from Messrs. Crompton & Co., Ltd., for additional sick pay, £75 13s. 2d.; balance of dividend, £3 3s. 8d.; making, with 13s. 9d. for fines, a total of £365 11s. 3d. The sick pay amounted to £196 10s. 11d., making, with the £74 12s. 10d. added by Messrs. Crompton & Co., a total of £271 3s. 9d. Compensation for loss of time through contagious disease prevailing at home or lodgings amounted to £1 1s. The management expenses, including printing, stationery, postage, and officers' salaries, came to £19 5s. 4d. The society lost one member through death, and the funeral levy realised £24 17s. 6d. The total receipts were £390 8s. 9d., and the total expenses £316 7s. 7d., leaving a balance for distribution of £74 1s. 2d. The reserve fund showed a balance at the bank of £100 17s. 8d. —The report and balance-sheet were unanimously adopted. A vote of thanks was accorded the retiring officers, and they were all re-elected. The meeting then resolved into the annual general meeting of the subscribers to the Arc Works Voluntary Infirmary and Dispensary Fund.—The hon. secretary, Mr. W. G. Bickmore, reported that the amount received by subscriptions of one penny per month totalled £26 9s. 8d., and 16s. 11d. was brought forward from the previous year. The expenditure was: Subscriptions to the Essex and Chelmsford Hospital Fund, £9 9s., and to the Chelmsford Dispensary Fund, £17 17s., leaving a balance in hand of 7d.—The report and accounts were adopted, and the hon. secretary, who was re-elected, received a hearty vote of thanks for his past services.—A unanimous vote of thanks was also accorded the directors of Messrs. Crompton & Co., Ltd., for their generous support, and for the kindly interest they take in all the various institutions of the Arc Works.—A vote of thanks to the chairman for presiding was most cordially received and carried.

ELECTRIC PATENTS ACTION.

In the Court of Appeal, before Lords Justices Vaughan Williams, Buckley and Kennedy, the hearing was concluded of the case of Gould *v.* Lehwess, upon the defendant's appeal against a judgment of Mr. Justice Phillimore in favour of the plaintiff for £2,528. The action was brought upon an agreement claimed to have been made between the plaintiff, Commander Charles Gould, of New York, and the defendant, Dr. Lehwess, of London, dated April 28, 1908, whereby the defendant, as the plaintiff alleged, promised to secure that the Electrobus Co., Ltd., or some other company would purchase certain electric storage batteries, the property of the plaintiff; and failing that, that the defendant was to be liable to pay for them subject to their passing a satisfactory test. Plaintiff also alleged that the defendant had made a misrepresentation as to all the shares, with the exception of 4,000, of an English company called the Gould Storage Battery Co., being issued for cash. Defendant denied these allegations.

Lord Justice Vaughan Williams, giving judgment, said they were all of opinion that in this case there ought to be a new trial. It was not usual where a new trial was ordered for the Court to go into matters that had been discussed before them on appeal, because if they went into them it was almost impossible to avoid making observations which might be calculated to prejudice the new trial. He, however, wished to indicate for himself the broad grounds on which he thought generally why a new trial should be ordered. First, as to the question of damages, he was clearly of opinion that the damages should have been assessed otherwise than they had been. But apart from any measure of damages applicable in the case, he thought that there was not sufficient ground for leaving out of consideration certain portions of the evidence that had been given. He hesitated to make any observations as to the conclusions he had come to upon a great many matters which ought to have been dealt with in the light of that evidence. He felt every mo ent he was approaching nearer the border at which he had resolved to stop, so as not in any way to prejudice the new trial, so he contented himself by saying that he thought the order of the Court should be to direct a new trial upon the usual terms that the costs would abide the result.

Lord Justice Buckley and Lord Justice Kennedy also agreed, while regretting that the parties should be put to the expense of a new trial.

The judgment of the Court below was accordingly set aside and a new trial ordered, the costs to abide the result of the rehearing. Should, however, the plaintiff decide to go to the House of Lords, then it was ordered that the costs of the appeal should be the defendant's.

An application for a stay in regard to costs in the event of an appeal to the House of Lords was refused.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

Owing to our steadily increasing circulation and the ever widening interest taken in these Technical Problems, it has been found necessary to revise the old regulations.

The new Rules have been framed in order to encourage fresh talent to enter the field; at the same time it is hoped that the progressive lines adopted will meet with the cordial approval and support of our old and valued correspondents.

It is to be noted that these Rules only apply to Questions 1213 and onward. The first replies under the new conditions will appear in our issue of January 7, 1910.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

QUESTIONS.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

WEEKLY PRIZES FOR SOLUTIONS.—For the best solution of any question we offer a cash prize of *seven shillings and sixpence*.

For the second best solution (if published) we offer a prize of *five shillings*.

For the third best solution (if published) we offer a prize of *two shillings and sixpence*.

QUARTERLY PRIZES.—No competitor will be awarded more than three third prizes, two second prizes, or one first prize during any one quarter. But, in adjudicating upon the merits of the various solutions, marks will be allotted to the four best solutions to each question, and at the end of each quarter extra prizes will be awarded to those competitors receiving the highest aggregate number of marks.

These prizes will be awarded in kind, the winners being at liberty to choose any book advertised or reviewed in our columns, or any instrument or appliance manufactured by any advertiser in our pages. These quarterly prizes will be of the value of *one guinea*, *half-a-guinea* and *five shillings*. Winners may, if they should so desire, order through us books or appliances of a higher value than their prizes, by forwarding to us the difference in price.

MSS. AND SKETCHES.—All answers to problems must be sent in within fourteen days of the question appearing in our columns. Replies should be concise and ought not to exceed one thousand words in length.

Quarto paper (10 in. by 8 in.) should be used, only one side being used, a margin 1½ in. wide being provided on the left side of each sheet. The number *only* of each question should be written legibly at the top left-hand corner of each solution. The solution should be signed with initials or pseudonym, and the name and full address of the contributor must be appended. Any formula should be set out on a line by itself; all letters and symbols in the text should be clearly written, to make them conspicuous.

Loose sketches should bear the *number* of the question and the author's name and pseudonym, and should be pinned to the MS.

Sketches must be drawn in ink, with good solid lines. Squared paper may be used, but as the faint blue lines are not reproduced by the photographic process, all horizontal or vertical lines to appear must be inked in with heavy, full dotted or chain dotted lines as required. Column width blocks are preferred, so it is well to draw sketches 6½ in. wide, for reduction to one-half.

Copyright of all solutions awarded prizes becomes the property of The Electrical Engineer, Ltd.

QUESTIONS.

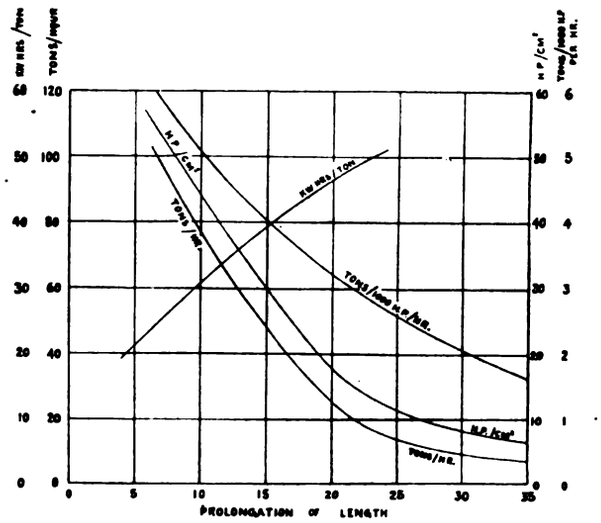
Question No. 1210.—What are the advantages of electric motors over steam engines for driving rolling mills? Please give some idea of the power required for rolling stated sections and of the extent to which electric motors have replaced steam engines in this service. Is the *replacement* justifiable, or are electric motors only commercially practicable in *new installations*

Answer to Question 1210 (*awarded* 10*s*.)– The advantages of electric over steam drive for rolling mills are manifold. The most important are as follows:—

Ease of Reversibility.—Reversible mills are used for rolling all sections that are too heavy to be dealt with by "3-high" rolls. The rapidity of reversal of the rolls and all the moving parts connected to them is of the utmost importance, since the period of reversal directly controls the possible output of the mill. By the proper use of fly-wheel storage systems, reversal is effected much more rapidly in electric than in steam mills. The torque in the latter case is definitely limited by the steam pressure and the piston area; the electrically-driven mill can, however, draw on the immense reserve of energy in the fly-wheel, and may thus temporarily operate at two or three times its normal h.p.

Actual examples are: An electrically-driven mill was reversed from + 60 r.p.m. to 60 r.p.m. in the opposite direction in 1½ sec., the rolling cycle being completed 28 times per min.; another mill reversed = 120 r.p.m. in 6 sec.

By the substitution of electric drive for steam drive from 20–50%, increase in the output of a mill has been repeatedly obtained; the process of operating the mill and handling the sections rolled is much simplified, and fewer men are required to work an electric mill. The accelerated output is an enormous advantage. Where shorter shifts rather than higher output has been the aim, it has been found possible to abolish night shifts in several instances. Where electrically-driven mills are used, all accessory apparatus should also be electrically operated, coal only being burnt in the metal heating furnaces and in the electric generating stations. The overload capacity of electric motors is much superior to that of steam or gas engines, for the reasons already stated (regarding reserve power).



The above advantages are not obtained at the cost of reduced efficiency, for in this respect also the electric motor is superior. The "light" losses of an electrical mill-driving set are high on account, mainly, of the converter losses and the windage losses on the large, high speed fly-wheel required; but the condensation and similar losses in large steam engines are, in general, heavier. The engine or motor, as the case may be, must of necessity be fitted in a somewhat exposed locality, and electric motors are less affected by this condition than are steam engines. The space occupied by an electrical installation is much less than is required for the equivalent steam equipment; as a result more mills can be installed in a given size of mill yard, and the efficiency of working and the output of the whole plant is much increased. Ease of extension of plant, flexibility of operating conditions, reliability, and proven less risk of breakdown are further attributes, making electric motors so suitable for rolling mill service. Centralisation of the energy supply results in well-known economies; further, the case with which the energy consumed can be measured in electrically-driven mills enables investigation into the conditions resulting in the maximum efficiency of working.

Probably the only objection to the electrical driving of rolling mills lies in the high capital cost of the equipment requirement. In many cases this objection is very serious, particularly when the *conversion* of a steam mill is under consideration. In the case of a completely new mill there is little doubt that electrical operation is preferable. This view is now generally accepted on the Continent, in England, and in America; an increasing percentage of new rolling mills are laid down for electrical driving. The scrapping of a steam plant, which, among steam plants, has hitherto been regarded as satisfactory, and its replacement by electrical apparatus has always proved justifiable by subsequent results. It must not be assumed, however, that such heavy capital expenditure would always be wise.

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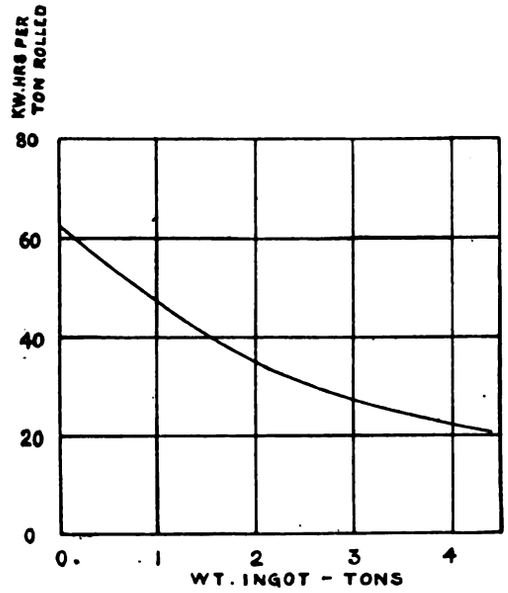
Those instances in which conversion has been carried out have been subjected to the most careful consideration before this course was decided on; in these cases subsequent justification of the conversion simply amounted to realised anticipations; it is not always commercially possible to replace steam drive by electric motors. As in the case of colliery winding, the only objection to such a scheme is the capital cost, and whether or no the latter is justified can only be determined definitely by consideration of every case on its own merits. In general, conversion will ultimately pay, and in a time dependent upon the extent to which the demand on the works enables a full utilisation of the greater capacity of the electric mill. Notable instances in which steam plant has been replaced by electric drive in England are: (1) A 3,000 h.p. reversing mill at Middlesbrough, and (2) a 8,000–12,000 h.p. mill in the Bilston works. As regards the extent to which electric drive for rolling mills is now employed: In April, 1908, 230 electrically-driven rolling mills in Europe totalled, according to Hooghwinkel, 190,000 h.p. (normal), the maximum h.p. being 410,000. The average normal h.p. per mill, therefore = 830 h.p., the mean overload capacity being 2·15 : 1. The Bilston equipment is the largest in England, while on the Continent the Rombacher-Hütte has probably still the largest installation, viz., two 7,500 h.p. motors, both coupled to one mill shaft.

Power required to Roll Various Sections.—The energy expended in a rolling mill—expressed as kw. hrs. per ton of metal rolled—is naturally very variable. It is dependent chiefly on the temperature at which the metal is rolled, on the ratio of the length of the initial billet to that of the final "section," and on the general rapidity with which the rolling is conducted. Subject to certain restrictions, the heavier a billet, the less the expenditure of energy per ton in rolling it. This statement is well illustrated by the curve of Fig. 1, and is subject to the restriction that the use of the heavier billets must not necessitate a great increase in the number of prolongations of the billet during rolling $\left(= \frac{\text{final length}}{\text{original length}}\right)$. If the number of prolongations be unduly high, the exposed surface of the metal per ton weight becomes proportionately high, hence the metal cools rapidly and the energy per ton rolled rapidly increases. For this reason, also, the initial temperature of the billet should be as high as is consistent with not damaging the metal, and the rolling should be completed as rapidly as possible. These points are illustrated by Fig. 2. Sections such as channels and light rails are specially subject to rapid cooling, and to a further useless expenditure of energy, which in such cases assumes great importance, viz., the frictional loss between rolls and section. Though the curve of Fig. 1 gives good average figures for the energy expenditure in rolling mills, more discriminative data from actual tests is given in Table I.

On such a large subject much more might be written; indeed, it is difficult to compress even its most salient features into the space here available. However, the above authentic information will, I think, cover "C. T.'s" requirements.—W. M.

TABLE I.

Rolling :—				kw. hours per ton.
Flanged Mine Rails (Koettgen)	28 lbs. per yard.	Total weight, 885 lbs.; 94½ft. lengths		3·75
	18 ,,	,, 683 ,, ; 112½ ,,		4·75
	8 ,,	,, 353 ,, ; 126 ,,		5·40
Billets (Graubner)	82 mm. square :	weight, 2·854 tons : prolongation, 5·3 : tons per hour, 9·47		2·21
	60 ,, ,, :	,, 2·762 ,, : ,, 9·86 : ,, ,, 7·61		3·01
	50 ,, ,, :	,, 1·33 ,, : ,, 11·50 : ,, ,, 6·12		3·60
Billets (Crowe)	4 in. square : 15 passes :	from ingots, 15¾ in. square		2·54
	2 in. ,, : 17 ,, :	,, ,, 15¾ in. ,,		3·80
Joists	11″ × 6″ : 19 ,, :	,, ,, 17″ × 18″		5·00

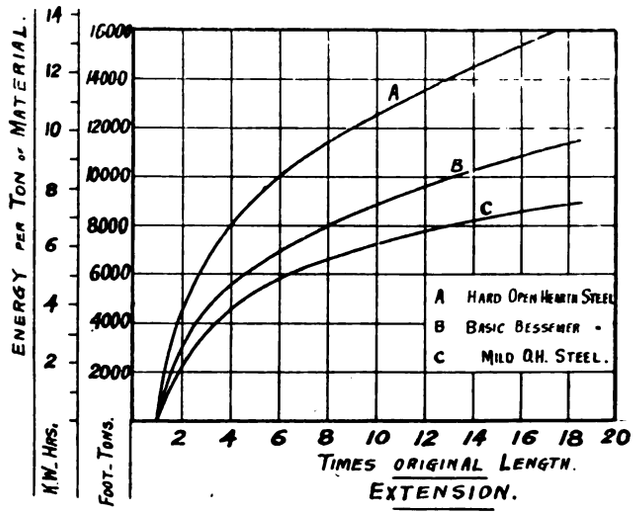


Answer to Question 1210 (*awarded* 5*s.*)—Many good papers have been read on the subject of "Electric Driving of Rolling Mills" within the last few years, a few of which are given later. The following article contains information chiefly gathered from these sources.

The advantages and disadvantages of the use of electric motors for rolling mills are chiefly :—

Advantages :

1. Constant and regular torque.
2. More reliable, less breakages of couplings, pinions, etc.
3. Less room required, on account of reduction in necessary boiler capacity, piping, etc.
4. Easy adaption to mill, direct drive being possible in very many cases.
5. Easy and simple handling.
6. Easy distribution by cables (instead of steam pipes or gas pipes in other systems).
7. Possibility of centralising the power.
8. Less labour.



9. Lower fuel costs in most cases.
10. Less oil and other stores.
11. Use of gas engines of medium size in power station (referring chiefly to blast furnace gas power).
12. Increased output due to higher speeds.

Disadvantages :

1. Less efficient for whole plant, and wasteful speed regulation.
2. Influence of the power fluctuations on generating stations.
3. Electric motors overload themselves until circuit breaks.
4. Higher fuel costs than direct gas engine drive.
5. High capital outlay, since a load-equalising set, such as the Ilgner, is usually essential.

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TABLE II

Works.	Product of Mill.					Tons Capacity per Hour.	Mill Motor.				Primary Power at Power Station.
	Finished Product.	Tons Weight.	Original Section.	Elongation.	Number of Passes.		Coupling to Rolls.	Armatures in Series.	Speeds at Maximum & Minim'm	Maximum Load in H.P.	
Hildegarde	70 lb. Rails. 18″ Girders.	2	15″ × 15″	Times. 43	23	15	Direct	3	110-140	9,000	Steam Turbine.
Resicca .. 1	2″ × 2″ Bars.	3·5	24″ × 20″	4,75	19	33	Gear 2 : 1	2	110-150	9,000	Gas Engine.
Resicca .. 2	6 mm. Plates.	3·5	16″ × 32″	19	29	30	Gear 2 : 1	2	110-150	9,000	Gas Engine.
Rombach ..	2″ × 2″ Bars.	2·1	9″ × 7″	16	13	65	Direct	2	120-160	12,500	1. S. Turbine ; 2. Gas Engines.
Dorman Long & Co.	6″ Girders, Angles, and T Sections.	0·35	6″ × 6″	24	—	10	Direct	1	110-160	3,000	Power Supply Co. and S. Turbine.
Grille Funke & Co.	Tubes.						Gear 5 : 1	1	250-	800	Power Supply Co.
Georg Tugmayer & Sons ..	Billets	3	64″ × 6″	—	80	3	Gear 5 : 1	1	120-	900	Water Turbine.

A most important feature in mill driving is the necessity for quick acceleration and retardation, in order to save time between the passes of the ingots.

Electric drive has been found to compete very favourably, in this, with steam and gas drive. The high speed of the armature and consequent high inertia has in some cases necessitated the division into two or three smaller units, arranged with armatures in series, giving less inertia.

The maximum load on the motors may be three times their normal rating. This maximum load is given below for a few cases of European mills, which have been installed.

An estimate of the power required at the rolls can also be made from the following curves, which are based on experiments (with a steam-driven plant) by Herr Köttgen at Oberhausen.

Another set of results from "Stahl and Eisen" is given below, indicating the power per ton of finished material.

53 lb. rails from 1·4 ingots require 70 kw. per ton.
72 lb. ,, ,, 1·5 ,, ,, 60 ,,
41 lb. joists ,, 1·8 ,, ,, 56 ,,
86 lb. ,, ,, 1·85 ,, ,, 53 ,,
4″ = 4″ billets ,, 1·45 ,, ,, 29 ,,
2″ × 2″ ,, ,, 1·35 ,, ,, 52 ,,

The power required per ton varies considerably with the rate of working; thus for 1 ton of 4″ × 4″ billets the consumption is (for same mill):—

29 kw. at a rate of 17 tons per hour.
33 kw. ,, 14 ,, ,,

As to whether the replacement of existing steam plant by electric motors is expedient depends on the several individual conditions of the case under considerations: such as the possibility of using existing engines to drive generators; the probable cost of energy per unit; quality of work produced as against that expected, etc. Suffice it now to say, that in many cases the change has proved efficacious. More instances of this occur in Germany than Great Britain, mainly because of the lower cost of coal in Britain; and also greater economy in use of blast furnace gases for power in Germany. For future development greatest economies in production will be probably obtained with complete blast furnace and rolling mill plants intended for working on the continuous system (as against reversing mills), the gases from the furnace being utilised for gas engines coupled to generators.

The advisability of replacement depends on the conditions outlined above, but doubtless the questioner will obtain better information from some of the following authors of papers on this subject.

G. M. Brown, Rugby Eng. Society, Jan. 10, 1907.
D. Selby Bigg, Iron and Steel Institute, May, 1907.
G. Hooghwinkel, Sheffield Society of Engineers, Jan., 1908.
H. Crowe, Cleveland Institute of Engineers, April 6, 1908.
C. Köettgen and C. Ablett, Iron and Steel Institute, Oct., 1908.
C. Ablett, Birmingham Association of Mech. Eng., Nov. 7, 1908.—"H. K. W."

BISHOP'S STORTFORD SCHEME.

The Urban District Council of Bishop's Stortford have printed and issued the report of Messrs. May & Hawes, consulting electrical engineers, on the proposal to establish an electrical undertaking. The document is a most interesting one, the whole question being discussed from all points of view. It is only possible here to give a few of the most salient particulars. Messrs. May & Hawes's estimate for capital expenditure is as follows:—

Generating Works: (*a*) Buildings of plain structure, comprising engine room, accumulator room, offices and stores, with overhead travelling crane, £1,670. (*b*) Electrical and mechanical equipment, comprising two 75 kw. combined oil engines and dynamos, oil storage tanks, oil and water pipes, switchgear and cable connections, cable ducts, tank wagon, pump and hose, battery of accumulators, reversible booster and regulators, £4,630, making £6,300.

Electric Supply Mains: (*a*) Two-feeder cables, comprising 1,800 yards ·3 triple concentric armoured cables with pilot wires, 7,558 yards of three-core armoured low pressure distributing cables of various sizes, all laid direct in the ground, two-feeder pillars and all necessary disconnecting and terminal end boxes, trenching and reinstatement, mains and meter testing apparatus, £4,250. (*b*) 200 house services, comprising cable, house service and fuse boxes, trenching and reinstatement, £600, making £4,850. House Meters: 200 meters of various sizes, £300. Public Lamps: 104 single, three double and four triple lamps, including standards and brackets, electrical fittings, metal filament lamps, switches and cable connections, £500. General: Provision for general expenses and contingencies, £800. Or a grand total of £12,750.

On the basis of the foregoing, the financial results work out as follows:—Revenue: From private supply, 69,000 units at 5¾d. per unit, £1,650; from public lighting, 122 lamps at £3 10s. 6d., £430 (less cleaning, maintenance, attendance and renewals, £112), £318. From meter rents, £80. Total £2,048.

Working Expenses: Fuel, stores, wages, repairs, maintenance, rates, taxes, management expenses, salaries, insurance and administration expenses at 2·45d. per unit sold, £1,020. Gross profit, £1,028. Loan Charges: Interest and repayment charges at 7·2% on £12,750, £918, leaving a surplus of £110.

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ELECTRICAL PROGRESS AT HOME & ABROAD

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TYNESIDE NOTES.

NEWCASTLE-ON-TYNE.

One of the most pleasing indications of the return of prosperity to Tyneside is the fact that at the present time a considerable number of new buildings are being erected in the city, chiefly for business purposes. One of the latest and most important of these is a block of buildings which is being constructed for the Alliance Assurance Co. at the corner of Mosley-street and Pilgrim-street. This not only includes the Companies own suite of offices, but also a considerable number of other suites to let for the use of other businesses. It is probable that when they are completely finished these buildings will be one of the most tasteful and best finished blocks of property in the city. The architect is Mr. W. L. Newcombe, and in dealing with the electric lighting of these offices, a very carefully thought-out scheme has been evolved by Messrs. Falconer Cross & Co., electrical engineers of this city. This special scheme provides for a pipe system, for about 120 lights in the Company's own offices, together with a minimum of 50 lights on each of the three upper floors of the building. It is designed to be a pure draw-in and a pure distribution system, so arranged that in the event of new tenants entering any of the offices a service can be run in and the wiring arrangements effected without the slightest inconvenience to neighbouring tenants or to the offices overhead or beneath. As this marks a decided advance upon many of the systems of wiring of large office blocks at present in use, it is worthy of especial attention.

Mining Conference.

For some little time there has been in Newcastle a Conference between representatives of the colliery owners and the miners in order to determine the most favourable conditions under which the eight hours Act for mines can be applied to the needs of this area. The two parties are now practically in agreement, and at the present time it appears as if in a good many cases three shifts will be adopted, more particularly in collieries having wide seams. This will increase the value of the best collieries, the great trouble being in some instances of finding an adequate number of putters. Under such an arrangement it is expected that the masters will have considerable powers as regards the hours in which they draw coal out of the pit. If the masters get double shifts they will desire to avail themselves of this extra time in order to get the coal to bank and the problem resolves itself into a question of drawing the coal, as far as practicable, electrically. There is, therefore, every reason to believe that electricity will be used to a considerably greater extent than before, both for haulages and winding gear, and the effect of this fact will probably be as regards the electrical mining industry to offset the depressing effect of the recent troubles in Scotland and at West Stanley.

Messrs. Scott and Mountain, Ltd.

The importance of the present time to mining electrical engineers is further emphasised by the exhibition of electrical mining machinery which was held by Messrs. Ernest Scott & Mountain, Ltd., at their Close Works, Gateshead-on-Tyne, on Saturday, the 18th inst. They had on view a large amount of the plant which was described in my previous week's notes, and in addition to this there were on view a large number of new portable haulage gears which Messrs. Scott & Mountain have designed in order to meet the provisions of the Eight Hours' Act, and which they are now carrying in stock. Some of these designs are of the portable tandem haulage type, which are calculated to very largely increase the haulage facilities of collieries inasmuch as they can be placed at any point in the mine in order to assist where the natural incline will not carry the tubs at a sufficiently high speed. There were also a considerable number of trunk type pump and electrical motor sets, which are very useful for dip working, being capable of being mounted on trucks and running on the ordinary rails in the mine roads. A considerable number of mining engineers inspected the plant, and the effect of such an exhibition should be of great value.

Flicker Photometry.

One effect of the condensation of papers read before the Institution of Electrical Engineers Local Section into a printed form much shorter than the actual paper for the purpose of publication is, that a good many valuable points are missed, which, although they are subsidiary, are yet in themselves of considerable practical importance. Readers of the official published accounts of the paper read by Mr. H. Morris-Airey, M.Sc., F.R.A.S., before the Local Section, will not have an adequate conception of the excellent way in which this lecture was illustrated by means of optical and other experiments of great beauty. The conclusion reached by Mr. Airey was that the flicker photometer is not capable of accurately comparing intensities of lights of different colours, and he obtained this by reference to Stewart's work in 1888 upon the growth of the stimulus upon the eye of the different coloured components of white light. In the resulting discussion Professors Stroud and Thornton, of Armstrong College, appeared to *support this* view, while Mr. C. Faraday Proctor, of Messrs. Edison & Swan, referred to the extreme practical difficulty experienced in getting the girl testers of metallic filament lamps to obtain uniform standard in their readings.

Newcastle Local Section Dinner.

On Wednesday, the 15th inst., the annual dinner of the Newcastle Local Section of the Institution of Electrical Engineers was held, Dr. H. Stroud being in the chair. About 80 members and guests were present, and the President of the Institution gave a very interesting speech, the chief subject of interest being his suggestion that the Local Section should endeavour to obtain a formal standardisation of voltages for ship lighting and power work, more especially in view of the importance of the metallic filament lamp. Other speakers were Mr. Gerald Stoney, Mr. C. S. Vesey-Brown, Mr. J. F. C. Snell, formerly of Sunderland, Principal W. H. Hadow, of Armstrong College; Mr. D. Balfour, junr., representing the Local Section of the Institution of Civil Engineers; Dr. P. P. Bedson, who spoke of the electro chemical developments on Tyneside; and Professor J. J. Welch, the head of one of the two Naval Architectural Schools in the Kingdom, which are not under Admiralty control.

MIDLAND NOTES.

BIRMINGHAM.

Electrical matters have figured very prominently in the Greater Birmingham Inquiry, which occupied five days' hearing at the Council House, Birmingham, last week, and seems likely to go on for weeks longer. All the local authorities concerned have electrical undertakings of one sort or another. The Greater Birmingham movement, in the estimation of many people, would not have been initiated but for the undoubted inconveniences experienced in the tramway working arrangements for carrying passengers to the outside districts, owing to the presence of two or three different authorities. Most of the fighting has ranged round the tramway question. The Handsworth District Council were able just prior to the inquiry to put an end to a serious difficulty through which passengers in the Perry Barr district had to change cars, although the line was continuous, before being able to reach their destination, and both sides have made the most of this fact in their public contest.

Yardley and Handsworth Tramways.

The rivalry between the different local authorities has come out in a variety of ways. Mr. Baker, the tramways

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manager, on Saturday gave a significant example with regard to Yardley, where the length of line within the boundary is 3,641 yards, and on the Yardley side, outside the boundary, 2,216 yards. The outside company wished to have an equal division of fares, but to this the city would not consent, being, as Mr. Baker explained, indisposed to hand over anything belonging to themselves to the company. Similarly, Mr. Baker criticised the agreement made by Handsworth and already sanctioned for through running, on the ground that Handsworth had made an excessive concession to the company. Once more the battle-ground reverted to the much-criticised prospective management by Handsworth of the cable line from Hockley Brook to the New Inns terminus, on which several estimates, mostly contradictory, have been given. Mr. Baker added an estimate of his own, which differs in some respects from its predecessors. He pointed that to begin with there were £72,000 to pay to the British Electric Traction Co. in respect of award for the depôt and cars, and £5,000, the cost of the arbitration. Handsworth would require a capital of £120,000 before they could run their cars, and towards this he gave them credit for £20,000, in respect of the scrap value of the old undertaking. The line of route was about three miles, and that meant a cost of £33,000 per mile. This he compared with the average cost of undertakings throughout the country, which is between £17,000 and £18,000 a mile. As the receipts per car mile for Handsworth amounted to 8·74d., while in the city they were 12·49d., he thought it impossible for the Handsworth section ever to pay its way on a capital of such dimensions. Of course, the answer to these representations has yet to come from the Handsworth side, and a stiff fight therefore is in prospect.

Necessity for Undivided Control.

Mr. Baker's views were strongly supported by Alderman Beale, who was very decided as to the urgent necessity for an undivided control of the whole of the trams running into the city. One of the lines projected for the service of Warwick-road could not be introduced, because the various interests could not agree as to the electric supply. Incidentally, Mr. Baker gave some interesting facts about the Birmingham tramways system. Up to March of this year, after five years' operation of the Tramway Committee, there were 66 miles and 18 chains in Birmingham, and the total outlay was £1,020,599. Some lines were not yet constructed. The value of the rolling stock was £197,585, the cars numbering 300, including a number used on lines outside the city. The result of the services were extremely satisfactory, as after paying all working expenses, interest and sinking fund, and making ample provision for depreciation in the first two years, the sum of £64,000 was handed over in relief of the rates.

Electric Hire-Purchase at Handsworth.

An important step has been taken by the Handsworth District Council, the object of which is to supply electric light to ratepayers who cannot afford to pay cash for the wiring of their houses. The difficulty is to be met by the introduction of a hiring and hire-purchase scheme. Councillor Homer remarked at the Council meeting that "however incapable they were in Handsworth, according to Birmingham, in managing the electric supply of the district, they were now able to give the residents advantages that the city of Birmingham were not in a position to do."

Electric-Motor Shunting.

An application of electricity to railway purposes, which seems likely to be followed up extensively, is just being made at the new Moor-street station of the Great Western Railway Co. in Birmingham. The platform is a terminal one, and the trains run up on each side. For taking the trains out again, bank engines were kept at the station but a new plan is now being adopted. On each side of the platform a traverse or transporter is being put in, so that the engine may be shifted on to another line of rails and so proceed to the front of the train. The plan of the traverse is similar to that adopted in tramcar sheds, a section of the roadway built on an iron structure being made to move transversely so as to bring the engine into the position required for the change. It is a case in which an electric motor is particularly serviceable. The motor taking up little room, lies snugly under the moving roadway, and can be actuated by a switch from the platform, so that to the unsophisticated beholder the engine seems to glide almost as if by magic across the line. The traversers are being put in by Mr. S. H. Heywood, of Reddish, who has had considerable experience of this sort of work in connection with tramways. The motors are supplied by the Lancashire Dynamo & Motor Co. There are two of them, one on each side the platform, each of 18 h.p., 700 r.p.m., 110-volts, three-phase, 25 periods per second, 94·5 amperes half-hour rating. The mains and switches and other connections are provided and put in by Callender's Cable & Construction Co., Ltd., of London and Erith, who are also carrying out other work in connection with the Great Western Railway extensions in Birmingham.

LANCASHIRE NOTES.

MANCHESTER.

The improvement in the state of the electrical trade here has been well maintained during the week. Although there are no very large contracts, still the number of smaller orders received as the result of quotations some time ago is very encouraging. There is every reason to believe that as soon as the present crisis in the cotton trade is over, and it has regained its usual prosperity, enormous developments in the use of electrical power will take place. Although in certain quarters there does undoubtedly still exist that strange prejudice against the electric drive, most mill owners are already convinced that electricity, whether taken from a supply authority, or generated on the premises, possesses such advantages as would make its adoption highly desirable, even if its cost was twice as great as for the old steam drive, and they are only waiting for the prospect of more business before making the change. The advantages are, first, more even turning movement, producing a finer and more even thread. These are qualities of no little importance, and, by reason of their superior product, electrically driven mills can obtain a higher price, or, what is of more importance when the market is dull, they get the preference over firms spinning an uneven thread. Secondly, the freedom from sudden changes in speed materially reduces the breakages and resultant loss of time in piecing up, and actual tests recently made by Mr. W. F. Rhodes, of Stockport, show that at least 10% more cotton can be spun with the same machines and attention by the electric drive, than by steam driving. The Lancashire Power Co. have recently published tachograph records taken before and after converting the driving of a doubling frame to the electric drive. When the doubling frame was driven by a belt from the main shaft (driven by a horizontal tandem compound engine of 250 i.h.p. at 73 r.p.m.), the mean speed variation during 2 min. was from -2% to $+1\%$ about normal, but, in addition, there was a variation of about $1\frac{1}{2}$ to 2% every second, about a mean value. The curve taken when the same frame was driven by a three-phase motor direct coupled, was only about $\frac{1}{4}\%$ during 1 min., and the variation during any 5 secs. was very much less.

Very extensive and careful records show that electricity can be generated by the modern mill-power station at as low as ·2d. per unit. This is the figure for the Kearsley Spinning Co.'s mill where there are two 750 kw. turbo-alternator sets. This figure is actually lower than most steam-driven mills can show, and it must be remembered that in the latter, transmission losses are greater.

Electricity in Saw Mills.

On account of its extremely small fire risks, electricity is being employed both for power lighting in cabinet works and saw mills. The wood shops of the Manchester Corporation Tram-car Works are electrically driven, the motors being installed in the basement under the shops, thus efficiently protecting them from the wood dust, and leaving the shop free from all shafting. The telephone cabinet works of the G.C. Co., at Salford, are also electrically driven. At the present moment the Lancashire Dynamo & Motor Co. have in hand four 60 h.p. motors for the Bengal and Nagpur Railway Saw Mills. They will drive the line shafting direct, and are of the pipe ventilated enclosed type, air from outside being brought in ducts through the

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motor, which is thus completely shut off from the dust-laden atmosphere of the shop. Electric driving is also being used for the wood shops at Sheerness Dockyard, and the same company have 12 motors in hand for the work.

Meeting of the Manchester Engineers.

At the last meeting of the Manchester Association of Engineers, a paper was read by Mr. J. S. Peck on the "Distribution and Application of Electric Power." Although there was formerly much discussion as to the relative merits of two and three-phase machines, three-phase was being adopted for nearly all new plants. He also pointed out the need for heavily bracing the end connections on large turbo-generators, so as to withstand the enormous strains produced by shots or mis-phases. In the case of a 5,000 kw., 6,600-volt, three-phase machine, the current at the instant of short circuit would be 20 to 30 times the full load, resulting in stresses 400 to 600 times as great as at full load.

By the use of interpoles, satisfactory operation of motors over a speed range of four or even six to one was quite possible without materially affecting the cost of the motor. Their use on large rotary motors was attended with marked improvement in commutator and brush wear. He also discussed the advantages of high voltages for transmission work, and the value of single-phase motor for railway work.

AMERICAN NOTES.

NEW YORK.

The Telephone situation continues to present many points of interest. A large congress of independent telephone companies is taking up an attitude hostile to the Bell policy and is gaining strong support from all sources. Mr. D. A. Wilson, of this city, who is prominently identified with the independent interests, declares that the disposition on the part of the Bell Company is to annihilate the independent companies all over the country, and, consequently, the National Association of Independent companies has created a fund of $100,000 to fight the Bell people wherever they try to wipe out competition. The theory of the representatives of companies with 4,000,000 subscribers is that formal protest should be made at Washington against restraint of trade which they fear will be effected by the absorption of the telegraph interest by the Bell system. The independent forces are also appealing to the Attorney-General of each of the States in which the Bell Company is pushing its scheme of merger and suits to prevent the Bell policy have been made in St. Louis and in Cleveland with reference to systems built up in Ohio, Indiana, Missouri and Michigan.

"Who Would Be Free——"

A curious and instructive point in connection with this lively dispute is the fact that the independent companies are themselves compelled to form a merger of their own interests in order to fight the Bell interests. The more effectually to achieve their purpose they are preparing, it is announced, to build a trunk line system between the Atlantic and the Missouri River for the benefit of independent exchanges as well as for general telegraph business, the pledge being that they will not seek to kill independent competition but to foster it in that way. It is announced that $50,000,000 has been subscribed to that plan. The independent telephone men declare that exorbitant rates and poor service were offered by the Bell people when they had control through patent rights, but as the patents expired and the independent movement began, the new policy of merger was adopted to restore the old grip of monopoly. Meanwhile President E. H. Moulton, of the Independent Telephone Association, says: "We feel that we owe a moral as well as a business obligation to our stockholders, who have placed $400,000,000 of their earnings in home telephone plants built to protect themselves from monopoly. We shall exert ourselves in every way to show that the Government has an equal obligation to protect investors as well as the 20,000,000 patrons in the independent systems. We shall not stop our fight under any consideration, but shall push it to the highest courts." Altogether things look pretty lively.

The Chicago Electrification.

Opposition to the proposed electrification of railway terminals in Chicago is taking the form of mass meetings of railway employees. These have formulated and adopted certain resolutions which manifest an unexpected vein of humour and deserve a niche of their own in the history of railway electrification. "Smoke," so runs one of the subsections of this quaint and humorous document, "Smoke is at the present time an absolutely essential feature of industry, of work and the advancement of civilization. Before smoke is suppressed by law it must be proved that this can be done without injury to work that smoke now accomplishes. The railroads of this city produce less than one-fifth of its smoke. Yet the railroads are made to suffer nearly all the abuse and the penalty. The railroads in turn punish the employees. The latter do not make the smoke. It is the coal that smokes. The horse is whipped before he is untied from the post. An ordinance is pending in the council making the electrification of railroads in the city compulsory. We submit that this measure is not only manifestly unfair and unjust, but that it would be unconstitutional. Granting that the city has power to suppress a nuisance, and granting for a moment that smoke is a nuisance, the city may have a right to stop the smoke. But we submit that it clearly is beyond its statutory powers to dictate what method shall be adopted. Various other kinds of motive power might be used, all more feasible, less expensive, and more practical than electricity. So long as the so-called nuisance is abated in a proper manner, there the city's jurisdiction ends."

A Mysterious Force.

After this terrific castigation of the proposals of the City Council, the opponents of Alderman Snow's policy might have rested on their oars without incurring condemnation for lack of earnestness. But they have *still more* weapons in their armoury. "If it were necessary," the document continues, "to go further in details, it could be shown that electricity is a mysterious force, still in its infancy, about which little is yet known, that it is very dangerous, unreliable and not practical for general railroad and switching purposes. It has been estimated that the wholesale electrification of railroads in Chicago would cost $600,000,000. This is many times the cost of any other motive power. As the supply of electric power in this city is controlled by a monopoly, the loud clamour for electrification, in view of all the facts, is highly suspicious." It seems a thousand pities that the framers of this instructive resolution could not be persuaded to go into those details to which they refer in so tantalising a fashion. The dangers of this mysterious force really ought to be shown up without delay.

Electrical Terminology.

The Bulletin of the National Electric Light Association makes the following announcement regarding the work of the terminology committee: "With respect to the work of the committee on terminology, the understanding is that this committee was appointed to draw up definitions of various terms used in the central-station business, and regarding which there may be some present confusion; and, if necessary, even to devise new terms. It is intended that the scope of the work of the committee cover the physical and technical departments of the business as well as the commercial end. Therefore, types of apparatus will be defined, as well as such items as 'load factors,' and various rates and methods of charging." The members of the committee on terminology are at present engaged in preparing as comprehensive lists as they each individually can, of such items or terms as seem to require definitions, and the Chairman, Mr. W. H. Gardiner, asks those who are interested in this work to co-operate by forwarding to him lists of such terms as, in their judgment, may require definition. A complete composite list will be made up from all such lists, and will then receive the attention of the committee for individual definitions of each of its items.

Cheap Electricity.

A correspondent at Los Angelos, California, announces that the Pasadena Council has established a low-record price for electrical energy, fixing the rate of municipal electricity to users of over 2,000 kilowatt hours a month at three cents for each kilowatt hour. "Although this is the lowest rate in the United States," declared Manager C. W. Koeiner of the municipal-lighting system, "we can make

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money at this figure, pay interest on the bonds, and establish a sinking fund. It is a triumph for municipal ownership of an electric generating plant."

Nikola Tesla's New Wireless.

Mr. Nikola Tesla has announced that as the result of experiments conducted at Shoreham, Long Island, he has perfected a new system of wireless telegraphy and telephony in which the principles of transmission are the direct opposite of Hertzian wave transmission. In the latter, he says, the transmission is effected by rays akin to light, which pass through the air and cannot be transmitted through the ground, while in the former the Hertz waves are practically suppressed and the entire energy of the current is transmitted through the ground exactly as though a big wire. Mr. Tesla adds that in his experiments in Colorado it was shown that a very powerful current developed by the transmitter traversed the entire globe and returned to its origin in an interval of 84 one-thousandths of a second, this journey of 24,000 miles being effected almost without any loss of energy.

Electricity in the Surgery.

Dr. G. Hauer Everhart, of St. Luke's Hospital, Baltimore, Maryland, recently made what is stated to be the first operation in this country of Dr. E. Doyen's method of removing cancer by electricity. The cancerous growth was located in the patient's mouth in this particular case. After the tissues were softened by the application of very hot sterilized air, the electrical currents were applied in such a manner as to kill entirely the growth in a way not possible with the surgeon's knife. Dr. E. Doyen is an eminent French surgeon, and his process of applying electricity in the cure of cancer is designated "fulguration." It is claimed that the new method is an absolute success and that a recurrence of the disease is not possible when a thorough application of "fulguration" has been made.

Electric Railway Developments.

Engineers are at work on the new electric railroad between Fort Erie and Port Colborne, to be a part of the Toronto and Niagara Falls system. The new road will be 22 miles long, and will touch Crystal Beach, Point Abino, Ridgeway and other important points along the lake front.—The Lake View Traction Company, Memphis, Tenn., has awarded contracts for material for the construction of the first section of its extension from Memphis to Lakeview, a distance of about 11 miles.—The Washington Spa Springs and Gretta R. R., Washington, D. C., will be ready in January to take up the work of building the first section of the line.—The Westchester Street Railroad Company, a reorganization by the New Haven road of the former Tarrytown, White Plains & Mamaroneck Railway Company, has filed articles of incorporation with the Secretary of State at Albany, N. Y., with a capital of $1,000,000.—The foundation work has already been completed for the new power house of the New York & North Shore Traction Company at Bayside Meadows, Long Island, and the work of construction will be rushed as rapidly as possible. Contracts for the electrical apparatus have been placed with the Westinghouse Electric & Manufacturing Company, and it is expected to have the station in operation by next February. This equipment consists of two 100 kw. turbine units; two 25 kw. turbine exciters; four 300 kw. rotary converters; four 333 kva. three-phase transformers; one nine-panel and one five-panel switchboard. The surface work on the extension to Whitestone Landing has been done, and the iron poles for supporting trolley wires are being erected.

An Important Project.

It is expected that the first section of the Shore Line Electric Railway from New Haven, Conn., towards Saybrook will be opened for operation early in 1910. The company has ordered 12 cars from the Jewett Car Company, Newark, Ohio. Each will be equipped with four GE-217 600-1,200-volt railway motors of 50 h.p. each and with Sprague-General Electric type M control. The motor and control equipment is arranged to operate on 500-volt and 1,200-volt current. The whole length of line is to be 52 miles, and the railway will be the first line to be put in operation east of the Allegheny Mountains using 1,200-volt direct current. The power station, which is located on the Connecticut River, near Saybrook, will contain two 1,500 kw., 25-cycle, 11,000-volt, three-phase Curtis steam turbo-generators, and provision has been made for installing two additional units of the same size in the future. Power will be transmitted as three-phase current to two sub-stations, each of which will contain three 200 kw. 600-1,200-volt rotary converters. Two machines will be operated in series to supply current to the trolley at 1,200 volts. The third unit will be used as a spare.

Current Items.

The American Union Telephone Company, which controls considerable independent telephone business in Pennsylvania, and the Allegheny Company, of Pittsburg, have been acquired by the new Continental Telephone & Telegraph Company of New York.

Telephone tolls between Manhattan and suburban points in Long Island, New Jersey and other adjacent territory, were cut five cents a call 12 hours in front of a joint State legislative committee to investigate toll questions.

An order has been served upon all street-railroad companies in New York by the Public Service Commission, requiring that all closed electric and horse cars in service up to April 15th shall be equipped with suitable apparatus for heating, and a temperature not less than 40 nor more than 65 degrees above zero must be maintained.

The scout cruiser *Salem* has sailed from Boston on a long cruise for a thorough test of wireless telegraphy under all conditions. The tests will extend over four months, and the specifications call for sending and receiving messages at least 1,000 miles under all conditions, and 3,000 miles under favourable conditions.

The makers of electrical apparatus, rolling stock, rails and other supplies for electric railways in the United States have now on hand, it is announced, orders which will amount to about $47,000,000. It is estimated that the electric railways of the United States have to-day an actual physical valuation of $2,250,000,000, while specifications have been approved for the electrification of about 650 miles of steam railroads.

Plans are being prepared by the Great Northern Railway Company for the construction of a plant in the Lake Chelan country, which will develop about 80,000 h.p. This is in connection with the present plant at Leavenworth, Wash., which has an output of 12,000 h.p. The object is to equip the entire western division of the railroad for electric operation.

The street railway, light, and heat and power companies of Wisconsin show an increased valuation of nearly $3,000,000 compared with a year ago, and the taxes have been doubled by the final assessment of the State Board of Assessment. The sum of $422,015 will be paid in taxes by these Companies.

Contracts have been let for the erection of a new power plant on the main island at the Ellis Island Station. The plant is being constructed by Evans, Almirall & Company, and the contract for the electrical apparatus has been awarded to the General Electric Company. The plant will be equipped with one 300 kw. and two 125 kw. direct-connected horizontal turbine generators and switchboard.

GERMAN NOTES.

BERLIN.

Telephonic communication between Berlin and St. Petersburg has long been desired by the German authorities, but the Russian officials, who are distrustful of communications which do not readily lend themselves to censorship, have hitherto objected. They now are becoming less obdurate, and it is hoped that the telephonic line between the two cities will soon exist.

The Latest "Wireless."

The Germans have erected a wireless telegraph station on the island of Fernando de Noronka, off the most easterly point of South America, for communication with Dakar on the most westerly point of Africa. As the distance is only about 1,200 miles, transmission from station to station will be easy, at least by night. Vessels, too, going from

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Africa to South America, will be in touch with the Fernando de Noronka station during two-thirds of the voyage. The contract has been given to the Compagnie Generale Radiotelegraphique (Carpentier & Gaiffe, of Rochefort). For short distances an energy of 6 h.p. and a wave length of 2,000 yards. The same company is erecting another station at Pernambuco to receive messages from Fernando de Noronka for the mainland. Here the horse-power used is again six, and the wave length 655 yards. The usefulness of the stations will be enhanced by the fact that they coincide with the land ends of a submarine cable from Africa to America.

Carborundum.

Herr R. Geipert has investigated the resistance to heat of small rods formed of carborundum, with just enough kaolin to bind the mass. Exposure to a temperature varying between 1,400 and 1,500° C., had no effect in 24 hours, but in a week covered the rods with a thick glass of pure quartz.

Telephone Cables.

In view of the fact that the telephone lead cables with paper insulation, if they become wet deteriorate rapidly unless dried promptly by the only feasible means, the pumping in of dry air delivered from a compressor at a pressure of about two atmospheres, various experiments have been made. As regards time occupied, it was found that telephone cables containing 50 pairs of wires, and of 220, 440, 650, and 1,100 yards in length, with an air pressure of two atmospheres, all gave the same result, viz., that the time required was nearly proportional to the square of the length of the cable, and inverse to the air pressure. The difference between the observed and the calculated time never exceeded three per cent.

A Novel Rope Railway.

At Boye, a cable carries 30 trucks each weighing 8 cwt., over a deep valley a mile and a half wide. When the descending trucks were braked there was a loss of energy estimated at 20 h.p., but this force is now recovered by means of the following arrangement, designed by the Siemens Schuckertwerke. The main drum drives by means of cog wheels and belts, a 13 kw. continuous current dynamo, 600 r.p.m., and supplying a current of 220 v. It is electrically connected by cable with an ore dressing machine about 300 yards off, in such a way that the latter machine is connected with a 16 h.p. motor of 1,030 r.p.m. When the trucks are going up this motor is worked as a dynamo and supplies current to the continuous current dynamo, which acts as a motor and mills the trucks up the rope. When the empty trucks are to return, the first machine is driven at a higher speed than motor, which is driven as a dynamo by the 80 h.p. steam engine working the ore dressing plant. Thereupon, the first-named works as a generator and drives the second as a motor, so that it helps the steam engine, and the power exerted by the gravity on the descending trucks is thus utilised. The speed of the trucks is regulated with ease, no braking being required.

The Water Power of the Rhine.

Some interesting particulars on this subject were given by Herr Koehn in a lecture delivered at Cologne before the annual meeting of the German Electrotechnical Association. From Schaffhausen to Kehl, 110 miles, the river has a course of 34½ miles in Germany, and 13½ miles in Switzerland. For the remaining 62 miles it is the boundary between the two countries. The maximum fall is 24 ft. in 10,000, and the least being less than 10 in 10,000, just below Breisach. Between that town and Cologne the river could supply at least 30,000 h.p., but the full being so small the expenses would be very high. At the same time the river is much more constant in volume than many other rivers, owing to the fact that it drains an enormous basin and is fed by many lakes. The average flow was 940 cu. metres per sec., and the highest ever observed was 5,900 cu. metres. Nineteen power stations might be erected down to Breisach, and four below the town. The 23 stations could deliver 573,390 h.p., of which 158,274 would go to Switzerland, 273,821 to Baden, and the rest to Alsace Lorraine. There is, however, only one in existence just now at Rheinfelden, but works at Laufenburg and Whylenaugst are being built, and works have been designed at Kembs and Klein Lindau, as well as at Eglisau and Rheinau.

Arc Lamps.

Herr C. Rieder, writing in the *Elektrotechnischer Anziger* remarks that the latest makes of arc lamps show a tendency to progress in a wrong direction. The lamp most puffed now is the lamp dispensing with cog wheels in the regulating appliance, and a survey of the patents will show conclusively that the idea of making such lamps is catching on rapidly. The first forms of arc lamps had no means of preventing the carbons from getting further apart during the use of the lamp, whereby the arc was first weakened and then disappeared. It was not until the electro-magnetic regulating arrangements were invented that the lamp could be made practically useful. These, however, act by means of a clock train, and attempts are made to replace this by mechanism of a very delicate nature, which makes the cleaning of the lamp a very difficult operation. The earlier clockwork lamps certainly laboured under the same difficulty, but lamps have been made for some years now in which the clock wheels are carefully protected and covered in, so that they do not require more cleaning than a watch. This improvement has naturally checked the demand for the other sort of arc lamps, and hence the revival of the puffing of the newer methods of regulation. It must be remembered that the new systems have not the steadiness of the wheel work system, and are therefore suitable only where there is practical freedom from vibration. The wheel work lamp again accommodates itself the more readily to variations in the supply of current. In short the practical advantages of the wheel work are greater than the theoretical advantages of its rival.

A Flourishing Company.

Shareholders will feel no superstitious fear as to the 13% that the General Electric Co., of Berlin, is paying. The general meeting has just been held, and the Chairman announced that the prosperity of the company justified them in the great extensions they had in hand. About 300 acres of land, advantageously placed between Berlin and Stettin, with a water frontage of about a mile, has been purchased. Orders were coming in very rapidly, and to cope with them it is necessary to hurry on the new works as quickly as possible.

PUBLICATIONS.

Messrs. Siemens Brothers & Co., Ltd., have brought out a supplement to their catalogue No. 512, in which there is a complete description, with illustrations of their Frequency Indicators and Vibration Tachometers, both of which are designed on the vibratory reed principle. The tachometer is constructed to indicate the speed of any type of machine.

The Cowper-Coles Engineering Co., Ltd., are sending out Section H of their catalogue, consisting of illustrated price lists of a number of their specialities. These include centrifugal pumps for acids, acid injectors and acid valves, filter atomisers, complete atomising plant, aluminium welding outfit, and motor electric headlights.

The Wardle Engineering Co., Ltd., send a price list of their patent "Streetlite" specialities. These lanterns, which are made in a great variety of patterns, are fitted with a novel system of carrying the lamps to reduce vibrating and strain, and also of ventilation. A separate list is devoted to the "Carlite" electric side and tail lamps for motors, which are spun in one piece and lined with burnished aluminium reflectors.

The A. E. G. Electrical Co., of Caxton House, have among their publications an interesting pamphlet dealing with "Electricity Applied to Printing," also leaflets on "Continuous Current Interpole Railway Motors," "Automatic Starters for Three-Phase Motors," "Switchboard Measuring Instruments," "Electric Ceiling Fans," "Lead Covered Cable Accessories and Branch Joint Boxes." A separate leaflet printed in colours deals with their Metallic Flower lamp shades. These look exceedingly pretty, and should prove popular owing to their combined utility and decorative effect.

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BUSINESS NOTES AND NEWS.

LIGHTING AND GENERAL—Home.

AMBLE.—The Urban District Council are immediately to proceed with the erection and equipment of an electric installation for light and power purposes in the electoral division of Amble.

AYR.—At Ayr Town Council meeting, Mr. William Smith opposed a proposal to extend the use of electric lighting in the streets of the town. He stated that in 1895, before the electricity works were started, the cost of lighting the burgh was £1,500, whereas it was now £4,837. He admitted that the town was better lighted, but contended that it could be lit with incandescent gas light at half the cost. Mr. Smith, however, did not find a supporter, and the recommendations of the Lighting Committee were adopted.

BATH.—The Corporation propose to obtain powers to extend their electric lighting area so as to take in the Rural District's ground. The Rural District Council is to drop its own Order, and to support the Corporation, receiving £100 in part payment of the amount spent in obtaining the Order.

BEXHILL-ON-SEA.—A Local Government Board enquiry has been held into the application of the Urban District Council to borrow £3,058 for electricity rates.

BOURNEMOUTH.—The Bournemouth and Poole Electricity Supply Co., Ltd., made special arrangements for street and shop lighting during the Christmas week, and obtained permission to attach temporary cables and necessary fittings to the tramway standards for the occasion.

CAVERSHAM.—The Highways and Lighting Committee of the Urban District Council reported that they had discussed the application intended to be made to Parliament in the ensuing Session by the Reading Electric Supply Co., Ltd., for an Act for additional powers, including, *inter alia*, the extension of the area of supply by the company for electrical energy in bulk or otherwise, so as to include Caversham, and they recommended that a special committee be appointed to consider what action, if any, should be taken by the council in the matter of the proposed application. The council agreed that the Chairman and Messrs. Dormer and Norris should comprise this committee, and the report was then adopted.

DONCASTER.—The Doncaster Rural District Council have approved of two schemes of sewerage and sewage disposal for the rapidly increasing parishes of Adwick-le-Street, Owston and Skellow. For the parish of Adwick-le-Street it is proposed to lay main and branch sewers and convey the sewage to a pumping station, where it will be automatically lifted by centrifugal pumps driven by electric motors to the Woodlands Sewage Disposal Works, which will be increased in size to meet the extra population to be dealt with. For Owston and Skellow parishes there will be considerable lengths of main and branch sewers to be laid, which will deliver the sewage similarly to a pumping station, where it will be dealt with in like manner and pumped to a site to be treated. It is proposed to construct screening and detritus chambers, liquefying tanks, percolating and sand filters. Application has now to be made to the Local Government Board for sanction to carry out the works which have been designed by Messrs. D. Balfour & Son, of Newcastle-on-Tyne and London.

DUBLIN.—The South Dublin Board of Guardians has requested the Local Board of Ireland to hold an inquiry into the question of lighting the workhouse, as the Lighting Committee was not able to arrive at a decision as to the relative merits of gas and electricity.

EDINBURGH.—As the result of Sir Alexander Kennedy's report of the two Corporation Electricity Works, the Electric Lighting Committee has decided to send a deputation to London and Birmingham in order to investigate new systems and appliances. Sir Alexander suggests that in order to secure economies at the Dewar-place station it will be necessary to erect cooling towers, which cost £18,000 if of brick, and only £12,000 if of steel. For the McDurald-road station he proposes the installation of exhaust turbines and alter fittings. The total capital outlay would be £45,000, but this would enable the output to be increased by not less than three-and-a-half millions of units, at a cost of £6,575, or 0·45d. per unit.

KINGSTON-ON-THAMES.—Mr. J. E. Edgcombe, M.I.Mech.E., M.I.E.E., borough electrical engineer of Kingston-upon-Thames, in submitting his last annual report, states that for the past year a further capital expenditure of £3,086 6s. 11d. was incurred, bringing the total to £103,429 8s. 7d., but during that period a repayment was made to the extent of £3,443 7s. 9d., making a total repayment of £29,453 16s., leaving the net total expenditure at £73,975 12s. 7d., or £357 0s. 10d. less than in the previous year. Of the capital expended, £1,305 18s. 11d. was for machinery, the remainder being chiefly for the extension of mains, erection of transformer kiosks, and for service cables and meters for connecting up new consumers. Portable ventilating fans may be hired from the electricity works at a rental of 2s. 6d. per quarter, and these are said to be of great benefit, whenever it is important that the air should be kept pure, and, as Mr. Edgcombe says, these are greatly appreciated in times of illness and during close and oppressive weather. He also reports a satisfactory increase in the number of radiators, as their many advantages over other artificial methods of heating are becoming generally known. The metal filament lamps in use are giving very satisfactory results.

LONDON: BARNES.—A Local Government Board enquiry has been held into the application of the Urban District Council to borrow £7,100 for electricity works.

LONDON: ST. MARYLEBONE.—The Borough Council have decided to convert to electricity the 1,385 remaining public lamps in the borough, and have accepted a 10 years' contract of their municipal electric undertaking. It will be necessary to lay down 24 miles of mains in certain streets, whereby private consumers can be served; and thus, it is hoped, a good revenue will be obtained.

LONDON: ST. MARYLEBONE.—The Electricity Department is calling the attention of its customers, and the ratepayers generally, to the economy of home production of ice, and for this purpose are offering electric power at a penny per unit.

LONDON: STEPNEY.—The Borough Council decided that the names of Blyth's Wharf and Osborn-street, as applied to the generating stations, be altered to "Limehouse Station" and "Whitechapel Station" respectively. It was also decided to purchase an electric hoist from Messrs. Lambie, Wrigley & Co. at £62 10s., less 2½% monthly account, and the quotation of Messrs. Crow & Sons, West Ham, for 50 tons of moulded pitch, at £75, be accepted.

LOWESTOFT.—Mr. Fry, Chairman of the Electric Committee, in presenting the report of the Electricity Department, said it was the best he had yet presented. They had turned a deficit of £252 into a surplus of £176. But they had yet to battle with the metallic filament lamps, and would be suffering for a time. There were two reasons for the improvement effected—one was a reduction in the cost of generation. They had generated 10,000 more units at a reduced cost of something like £600. They had been able to effect a saving of £500 in coal in consequence of the success of the mechanical stokers installed. They were paying £120 more in rates, and he thought they ought to appeal. They were too highly rated. They could not help increasing their capital outlay, but against that, their private consumers had increased by £700. In this respect, it was the best of their nine years. This year they had made a gross profit of £6,186—an increase of £800—which represented 7%, upon the year. It was a valuable undertaking.

MANCHESTER.—Messrs. James Howden & Co., of Glasgow, supplied a 6,000 kw. Howden (Zoelly type) turbine to work in conjunction with a Siemens turbo-generator at the Stuart-street electricity supply station. This is the largest Zoelly type turbine hitherto built, and has been working admirably since it was erected last September.

MORTLAKE.—A Local Government Board Enquiry has been held into the application of the Council to borrow £7,100 for purposes of the electrical undertakings.

PORTSMOUTH.—The Borough Telephone Committee have decided to allocate £300 out of reserve for the establishment of an electric clock service. Of this, £65 is to be spent on a master clock, and the balance as required. The charge to subscribers will be £1 10s. per annum for the first clock, and on a sliding scale for any others, all agreements to be for three years.

REDDITCH.—The Electricity Committee of the Urban District Council report that the total expenditure on revenue account for the six months ended September 30, 1909, was £2,069 4s. 4d., as compared with £2,369 1s. 6d. for 1908. The total income for 1909 is £2,226 0s. 2d., as against £2,055 18s. 4d. for 1908. The figures give the following results: A surplus of £156 15s. 10d. income over expenditure 1909, against a deficit of £313 3s. 2d. in 1908, being a net improvement in the financial position of the undertaking of £469 19s. during the first six months of the year 1909–10. During the month the sum of £471 3s. 5d. has been collected, and £558 15s. 5d. is outstanding. During the past month applications have been received for the equivalent of 78 eight c.p lamps and 11 h.p. in motors, being an increase in the month equal to 463 eight c.p. lamps and a total connection of 39,464 eight c p. lamps.

SALTCOATS.—The Town Council have agreed to consent to the application by Mr. George Balfour to the Board of Trade for a Provisional Order, under the Electric Lighting Acts, to supply electricity for lighting purposes within an area of supply including the Burgh of Saltcoats. The district mentioned in the order is Ardrossan, Saltcoats and Stevenston.

WEDNESBURY.—Councillor Griffiths reported that since the Electricity Department had ceased taking bulk supply from

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the Midland Power Co., and had generated their own electricity, they had steadily gone ahead. It was necessary to employ further clerical assistance to cope with the work.

LIGHTING AND GENERAL—Overseas.

AUSTRALIA.—The *Commonwealth of Australia Gazette* of October 30 announces that tenders will be received at the office of the Deputy Postmaster-General, Sydney, up to 2.30 p.m. on February 23, 1910, for the supply, delivery and erection at the Telephone Exchange, General Post Office, Sydney, of two junction line sections of common battery switchboard, in accordance with Schedule N.S.W. E.E. 63/09. Preference will be given to tenders complying most closely with the Department's requirements for prompt delivery. Preliminary deposits may be paid at the Commonwealth Offices in London, 72, Victoria-street, S.W.

BRISBANE.—Local electrical engineers are agitating for the repeal of the wiring clause in the Electric Lighting Act of 1892. This clause practically prohibits the use of overhead wires for lighting purposes, and, it is claimed, is responsible for the stagnation in the electrical trade. Only four towns in Queensland have the electric light. The Minister of Public Works has promised to consider the matter, though some time must elapse before any alteration could be looked for.

BUENOS AIRES.—The United River Plate Telephone Co. has entered a protest against the Provincial Government's proposed tax of one dollar a month per telephone connection.

CHRISTCHURCH (New Zealand).—Mr. J. Crosbie Scott, City Electrical Engineer, in his annual report, shows that of the 970,970 units generated 321,912 units were sold for light and 454,214 for power. The gross revenue was £13,045, the gross profit £5,746, and the net profit £1,327.

MENDOZA (Argentine).—The Mendoza Government has given a concession to Mr. Mauro Herlitzka, representing the Compania de Luz y Fuerza de Mendoza to use the waters of the Mendoza at a point above Blanco Escalada near the Transandine Railway, to establish a hydro-electric station. The concession includes the right of supplying electricity for light and motive power to private houses and industrial undertakings, the maximum tariff being stated.

MEXICO.—The *Diario Oficial* publishes the text of a contract between the Mexican Ministry of Fomento and Señor Silvestre C. Díaz, empowering the latter to utilise the waters of the river Arteaga, in the State of Coahuila, to an extent not exceeding 500 litres per second, for the purpose of generating motive power. The contract is for a term of 20 years. The concessionaire engages to commence operations within 24 months, and to complete the work in seven years. The electric energy may be carried overhead by means of aerial wires, or underground by means of insulated conductors. The concessionaire is granted the right to import free of duty, once only, all the machinery and apparatus necessary for executing the work, and is also authorised to construct any bridges, telegraph and telephone lines that may be required. It appears that the Chapala Hydro-Electric and Irrigation Co., headed by Messrs. Fernando Pimentel and Fagoaga, of Mexico City, will shortly carry out a scheme for the transmission of electrical power to the Aguascalientes district from the Santiago river. The company will probably instal a large power plant at Las Juntas, and construct a canal from the Juanacatlan Falls to that place, a distance of 26 kilometres (about 16 miles). At Las Juntas the fall of water would be sufficient for the generation of 90,000 h.p.

OTTOWA.—An application will be made to the Parliament of Canada at its next session for an Act incorporating a company, under the name of the St. Lawrence Power Transmission Co., Ltd., with a capital of $250,000 (about £50,000). The company is to have the right to generate and distribute electrical energy, etc. The head office of the company is to be at Cornwall, Ontario.

ROTORUA (New Zealand).—Mr. Lawrence Birks, B.Sc., A.M.I.C.E., engineer-in-charge, of the Department of Tourist and Health Resorts, in his report on the electric lighting system says the total output and revenue for the year has been as follows:—Private lighting, units, 72,600; revenue, £1,819; street lighting, units, 12,000; revenue, £39; bath buildings, units, 8,000; sanatorium, units, 2,000; tea-house, units, 600; State nursery, units, 800. Valuing the current supplied to the public buildings (11,400 units), at 3½d. per unit, the plant earned £166 from such supplies, making the total earnings £2,024. The working costs during the year have been as follows:—Salaries, £543; wages and materials, £370; proportion of office salaries and expenses, say, £200; total, £1,113, leaving a working profit of £911, or 4½% on a capital expenditure of about £20,000. The plant, which is a hydro-electric one, is being enlarged.

TORONTO.—The Dominion Iron & Steel Co. is about to erect new mills, and also a hydro-electric plant, taking power from the Sydney river, capable of generating 4,000 kw. The erection of furnaces is also contemplated.

TRACTION—Home.

ISLE OF WIGHT.—A conference of the public authorities of the Isle of Wight, convened by the County Council, approved of the proposals by private promoters for the improvement of the island railway system by electrification, but adjourned the consideration of details until the terms of the railway companies are officially ascertained.

LONDON.—The London County Council has decided to apply to Parliament during next Session for authority to construct a subway under the Victoria Embankment.

LOWESTOFT.—The Corporation Tramway Committee reported to the Finance and Rating Committee that the accounts show a deficit on the year's working of £2,685 15s. 4d., £1,200 of which is included in the current borough rate, leaving a net balance to be provided for of £1,485 15s. 4d. The Electric Lighting Committee having considered the request of the Tramways Committee for the reduction of the price of current used for traction to 1¾d. per unit, resolved that from October 1 last to September 30, 1910, the charge shall be 1¾d. per unit, provided that the Tramways Committee agree to take as a minimum consumption the same number of units as last year, and that the price of coal is not increased in the 12 months; should either of these factors be altered to the detriment of the electric lighting undertaking during the term, the charge is to be re-considered. A proposal to appoint a traffic manager has been put forward.

WATFORD.—The Urban District Council has appointed a Committee to consider the railless trolley traction system, and has accepted an invitation of the North Metropolitan Tramway Co. to inspect the existing installation. The local Tradesmen's Association have petitioned against the adoption of the system, mainly on the plea that the cars raise dust, as do motor buses.

TRACTION—Overseas.

BUENOS AIRES.—The first section of the La Plata Tramway is expected to be open for traffic by January 1, and the other four sections at three months' intervals.

CALCUTTA.—The Electrical Department of the East Indian Railway has ordered several single and three-phase transformers from the British Thomson-Houston Co., Ltd.

MADRID.—The official *Gaceta* contains an announcement to the effect that an application has been presented by the 'Compañía Nacional de Tranvías," of Barcelona, to the "Dirección General de Obras Públicas," Madrid, for a concession for the construction and working of an electric tramway designed to join up Gárriga and Muntaner Streets, Barcelona. A period of one month from the date of the *Gaceta* is allowed for the presentation of competing offers at the above-mentioned "Direccion." The same issue of the *Gaceta* notifies that an application has been submitted by Don Isidro García to the "Dirección General de Obras Públicas" for a concession for the construction and working of an electric tramway from Rentería to the French frontier *viâ* Irún and Behovia, and that a period of one month from the date of the *Gaceta* is allowed for the presentation of competing offers at the "Dirección."

MONTEVIDEO (Uruguay).—Mr. E. C. Steer has deposited a sum of ten thousand dollars gold, as a guarantee in connection with his contract to build an electric railway between Montevideo and Colonia.

SANTIAGO (Chili).—H.M. Legation report that the Chilian Government are stated to be desirous of electrifying the State railways, making use of the water power which is to be met with all over the country. There is also a growing feeling in the country that much might be done by utilising this water supply in the irrigation of large tracts of country at present without water.

COMPANIES' MEETINGS AND REPORTS.

MANX ELECTRIC RAILWAY.

The report of the Manx Electric Railway Co., Ltd., states that the gross receipts amounted to £32,745 and the gross expenditure to £16,508. The directors state that the net result has been injuriously affected by the bad weather, as is the case with other undertakings in the island. The passengers carried during the 12 months totalled only 518,655, a decrease of 9.331. The ratio of working expenses to receipts was 50·3. The balance available goes to pay the interest on Debentures and Preference shares, and £1,126 is carried forward.

ELECTRICAL SECURITIES TRUST.

The accounts of the Electrical Securities Trust, Ltd., for the year ended November 14 show a loss, after providing for debenture interest, of £5,442, increasing the debit to profit and loss brought forward to £10,485. During the year the South-Western Traction Co., of Canada, in the First Mortgage Debentures of

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which this company is largely interested, was placed in the hands of a receiver, and the property sold in October. The amount which the company is entitled to in respect of its holding is about £50,000, and, as soon as this money has been received, meetings of the Debenture holders and the shareholders will be called to consider as to its distribution, and as to the future of the company.

CONTRACTS OPEN.

HOME.

BELFAST.—Tramways and Electricity Committee.—One 1,500 kw. continuous current turbo-dynamo. Specifications (10s.) and drawings (10s.) from Electrical Engineer. By January 10, 1910.

BRIDLINGTON.—Corporation.—One 300 kw. steam dynamo, either reciprocating engine or mixed pressure turbo, with switchboard and pipework extensions. (Spec., £2, Borough Electrical Engineer). January 1, 1910.

EASTBOURNE.—Corporation.—One steam-driven surface condensing plant. Specification (£1 1s.) from the Borough Electrical Engineer. By January 17, 1910.

OVERSEAS.

CAPE TOWN.—The Cape Town Municipal will consider tenders for the annual supply of motors on January 5, 1910.

LUCKNOW.—Municipal City Lighting. December 31.

ROME.—The Italian State Railways open tenders for supply of 50,000 metal filament lamps, January 26, 1910.

TENDERS ACCEPTED.

HUDDERSFIELD.—The Electricity Committee of the Borough accepted the following tenders for the supply of coal: Messrs. Chappell & Wood, 4,000 tons; Mr. John Senior, 4,000 tons; and Mr. Wm. Wood, 6,000 tons. The engineer reported that there were on November 30 4,051 consumers, and that 289,065 lamps were connected, increases of 51 and 2,602 respectively on the previous month. The committee decided to apply to the Finance Committee for the provision of £20,000 for capital expenditure. Accounts were ordered to be paid amounting to £2,930 17s. 7d. On the motion of Alderman Chatterton, seconded by Alderman Jepson, the minutes were adopted.

ONTARIO.—The Ontario Hydro-Electric Power Commission have signed two contracts with Siemens Bros. Dynamo Works for the supply of cables.

HINDHEAD (Surrey).—Analysis of tenders received for Diesel engine, alternator, and all fittings and attachments, and motor alternators, switch gear, cables and connections complete for the Hindhead Electricity Supply Co.'s high tension extension.

Contractors.	Engine.	Alternator	Total. £	s.	d.	R.P.M.	
Ferranti, Ltd. ..	Hirrlees.	not stated.	2,322	10	0	214	
Diesel Engine Co. ..	,,	E. C. C.	2,445	0	0	214	
Electric Constn. Co.	,,	E. C. C.	2,462	0	0	200	*
Mirrlees Bickerton & Day	,,	E. C. C.	2,475	0	0	200	*
British Thomson-Houston ..	,,	B. T. H.	2,507	0	0	200	
Brush Engineering Co.	,,	Brush.	2,520	5	0	200	
B. T. H. Co.	,,	B. T. H.	2,531	0	0	200	
Mirrlees B. & D. ..	,,	Brush.	2,532	0	0	200	
Mirrlees B. & B. ..	,,	G. E. C.	2,542	0	0	200	
Siemens Bros. & Co., Ltd.	,,	Siemens.	2,552	0	0	200	
Mirrlees B. & D. ..	,,	B. T. H.	2,557	0	0	200	
British Westinghouse Co.	,,	B. W'st'se.	2,583	0	0	200	
E. C. C.	Sulzer.	E. C. C.	2,587	0	0	214	
Mirrlees B. & D. ..	Mirrlees.	Siemens.	2,597	0	0	200	
Diesel Engine Co. ..	Sulzer.	E. C. C.	2,603	0	0	214 or 200	
B. T. H. Co.	,,	B. T. H.	2,632	0	0	214	
B. T. H. Co.	,,	B. T. H.	2,656	0	0	214	
Siemens Bros. & Co.	,,	Siemens.	2,696	0	0	214	
Diesel Engine Co. ..	,,	E. C. C.	2,716	0	0		
Dick Kerr & Co. Ltd.	Mirrlees.	Dick Kerr.	2,744	0	0	200	a
Dick Kerr & Co., Ltd.	Sulzer.	Dick Kerr.	2,877	0	0	214	a

* Accepted.
a Incomplete, excludes 10 kw. motor alternators.

Analysis of tenders received for cables, feeder pillars and all accessories, Hindhead Electricity Supply Co.'s high tension extension:—

	Amount of tender. £	s.	d.	Extra if oil break switches. £	s.	d.	Amount of tender with oil break switches. £	s.	d.
Messrs. Callender's Cable & Construction, Co., Ltd.	4,884	13	8	74	0	0	4,958	13	8
Messrs. The British Insulated & Helsby Cable Co., Ltd.	4,776	5	0	29	0	0	4,805	5	0
Messrs. Henley's Telegraph Works, Ltd.	4,752	13	2	55	0	0	4,807	13	2
Messrs. Siemens Bros. & Co., Ltd.	4,669	9	10	63	16	0	4,733	5	10*

* Accepted.

LONDON.—The London County Council have accepted the following tenders:—For electric carbons, Messrs. H. G. Mayer & Co., 67, Aldersgate-street, E.C. For electric insulating materials, Messrs. F. Wiggins & Sons, 102–4, Minories, E. For electric lamps, Messrs. Cryselco, Ltd., Kempston Works, Bedford (for tungsten lamps only); The Edison and Swan United Electric Light Co., Ltd., 36 and 37, Queen-street, E.C.; Pope's Electric Lamp Co., Ltd., Hythe-road, Willesden, N.W.; Siemen Brothers' Dynamo Works, Ltd., Tyssen-street, Dalston, N.E. (for tantalum lamps only).

TRADE NOTES.

Following upon an official inspection of "Imperial" water tube boilers under construction by Messrs. Edwin Danks & Co. (Oldbury), Ltd., at their Birmingham works, the firm has been placed on to the Admiralty list of manufacturers of water tube boilers. These boilers are placed on the market by the Water Tube Boiler and Engineering Co., of Queen Victoria-street.

CATALOGUES AND LISTS.

The General Electric Co., Ltd., have issued a fully illustrated catalogue of electric heating and cooking appliances, which contains the latest designs of radiators, stoves, chafing-dishes, kettles, hot-plates, urns, irons, etc., etc. Now that the public demand for these appliances is so much on the increase this handsome booklet should be kept well in evidence by dealers. The same firm are also issuing the "Greekoduct" patent insulated conduit catalogue, giving particulars of the conduits and fittings, which are specially suitable for tropical climates; the "Angold," short, shuntless type of enclosed arc lamps, showing new patterns and reduced prices; and on alternating current transformers.

Siemens Bros. & Co., I.td., are sending out a new edition of their "O.S. Wiring System," catalogue No. 517, Section II. The Kalkos system is, of course, well known, but in this publication attention is drawn to the advantages of combining Kalkos with Stannos wires, especially where wiring must be watertight throughout. Another feature dealt with is the employment of Kalkos alone or in combination with Stannos wires where concentric wiring is adopted.

From Siemens Bros. Dynamo Works, Ltd., we receive an illustrated price list of Shop Window Reflectors for use with "Tantalum" Electric Lamps, on the concealed lighting principle. The adaptability of the system is well demonstrated. They inform us that they are now placing on the market 10 c.p. "Tantalum" lamps for the following voltages:—50 to 60 volts, for direct or alternating current; 65 to 120, for direct current only. In addition to this they have for direct current a 16 c.p. lamp for 140 to 160 volt circuits. "Tantalum" lamps are now made in voltages ranging from 20 to 240 volts for ordinary use. "Tantalum" candle lamps can also now be obtained in voltages from 20 to 60 in 5 or 10 c.p. These candle lamps are manufactured in exceptionally neat type of bulb, and should appeal to all consumers of electric current, who have installed candelabra fittings. The efficiency is 1·7 watts per British c.p. It has also been decided to slightly alter the types of bulb, the diameter being rather less, but the length approximately the same. The firm are issuing a new Folder C. 3, which supercedes all former "Tantalum" lamp price-sheets, and which gives full particulars of the new lamps mentioned, together with details of the alteration in style of bulb. Copies can be had on application, and quantities of this list will be supplied over-printed with the name and address of any electrical dealer, contractor or ironmonger, free of charge, on receipt of *bona-fide* trade card.

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INSTITUTION OF MINING ELECTRICAL ENGINEERS.

INAUGURAL MEETING AT MANCHESTER.

The inaugural meeting of the recently formed Institution of Mining Electrical Engineers was held on the 17th inst., at the *Midland Hotel*, Manchester, and from every point of view turned out to be highly successful. Considerable enthusiasm exists among its members, and their strong social spirit was very noticeable. There is every reason to believe that this spirit will make the Institution a very useful one to its members and to the electrical industry in general.

Preceding the general meeting, a Council meeting was held, at which many important matters relating to the future work of the Institution were discussed. The inaugural general meeting was well attended by members from every mining centre in the country. Amongst those present were: Profs. W. M. Thornton, D.Sc (Newcastle) George H. Winstanley (Manchester University); Messrs. T. H. C. Brooking, A.M.I.E.E. (Warrington); H. W. Clothier, A.M.I.E.E. (Gateshead); H.T. Fisher, A.M.I.E.E. (Durham); R. Hood Haggie, M.I.E.E. (Wealdstone); Roslyn Holiday, A.I.E.E. (Featherstone); Wm. Maurice, M.I.E.E., M.Inst.M.E. (Hucknall Torkard); W. C. Mountain, M.I.E.E. (Gateshead); and Sydney F. Walker, M.I.E.E. (Bath). Letters of regret for unavoidable absence were received from Vice-Chancellor Hopkinson (Manchester University) and Prof. Schwartz.

The minutes of the preceding meeting were taken as read. The Secretary then announced the result of the election of officers, which are as follows: President, Mr. Wm. Maurice, M.Inst.M.E. (General Manager of Hucknall Torkard Collieries, Notts); Vice-Presidents, Mr. W. C. Mountain, M.I.E.E. (Gateshead), Prof. Wm Robinson, M.I.E.E., M.I.C.E. (Nottingham); Hon. Treasurer, Mr. J. Glynn Williams (Whitehaven); Hon. Editor of Publications, Mr. T. H. C. Brooking, A.M.I.E.E. (Warrington); General Secretaries, Messrs. Saunders, Derby. Council, Messrs. H. Arnott (Bedworth), S. H. Bill, H. W. Clothier (Gateshead), P. D. Coates (Burnley), F. Cusworth, E. Ivor Davies (Llandebio), H. T. Fisher (Durham), R. T. Frost (Doncaster), R. Hood Haggie (Wealdstone), Roslyn Holiday (Featherstone), A. Hall (Nuneaton), F. O. Kirkup (Newcastle), Reginald Krall (London), Prof. H. M. Thornton (Newcastle), Prof. G. H. Winstanley (Manchester). It was also announced that Mr. J. Glynn Williams, the founder of the Institution, had been elected the first honorary member. Mr. Robert Nelson. H.M. Electrical Inspector of Mines, also received the same honour.

The honorary auditors elected are Messrs. G. F. Dryhurst (Bignal) and J. Kirkby (Chesterfield). It was announced that Mr. J. Kirkby has offered a prize of the annual value of two guineas for the best electrical invention during the year relating to the prevention of accidents in mines.

The President delivered a long address in which he related how the Institution had been founded as the result of some correspondence in the technical press on the subject of a colliery electrician society. It was not, however, until February last that the idea got further than the talking stage. Then Mr. J. Glynn Williams made the important contribution to the correspondence which resulted in a representative meeting of interested electrical engineers being held at the *Grand Hotel*, Manchester, last April. At this meeting it was decided to proceed with the formation of an Institution of Mining Electrical Engineers. Since then the council had been hard at work organising the society. The Articles of Association are now in course of registration, and there are already over 500 members on the roll, of whom 75% are actually colliery electricians. The Institution (he said) was not an offshoot, or a rival of any existing organisations, but was founded to meet a distinct want, and its aims were to augment the safety and promote the advancement of technical knowledge relating to the application of electricity in mining, to extend the experience and increase the efficiency of those engaged in such applications, and generally to form a meeting point for a rapidly growing but hitherto unorganised section of electrical engineers and craftsmen. It would seek to work harmoniously with any other bodies whose objects were in any way related to its own. It was new in a wider and deeper sense than in merely forming the latest addition to the already almost uncountable number of technical societies, for although it was intended, and it would seek to obtain professional authority and distinction, it stood initially as the inspiration of a small body of hitherto unorganised craftsmen. It was indeed the beginning of a new way of life. It was the first indication of class consciousness in a large and responsible group of electrical engineers and artisans who had acquired practical experience in mines and were desirous of extending that experience and making it more generally useful to the community. It was a development which would attract the attention of all interested in the welfare of the mine workers, and in general social progress. It was an indication of the trend of events, that a number of mine workers occupying for the most part subordinate though responsible positions, were devoting a portion of their limited leisure to the elucidation and publication of matter concerning the practical problems connected with their daily work, in order that the risks to life and property in mines might be reduced to the utmost possible extent. Though most of the members were electricians, they hoped that colliery engineers would also join, for their work was intimately connected. In fact, all classes of mining officials were admissible. He mentioned the various grades of membership, and said it was the Council's intention to appoint an examination board for the examination of members who desired to become diploma members. While examination certificates were often evidence of little more than the candidate's ability to pass the examination, still some form of evidence of competency was necessary. In connection with the examinations, it would be the object of the Council, while making the first tests such that present electricians would have some chance of passing, to steadily raise the standard of the examination so that the diploma members, qualified to take charge of electrical plant in mines, would be very highly trained men, and so the status of the class would be improved.

Many people looked upon the engineer and electrician as men whose only real work was the repairing of breakdowns. Wise people to-day paid their doctors to keep them in health, and did not wait to be ill before obtaining his services; the same thing applied to the electrician's work His true work was to keep his plant in health, and so prevent breakdowns and accidents. Only careful, intelligent and constant attention would give immunity from breakdowns. As a rule, he who guarded best against breakdowns, guarded best also against accidents. The reports issued from time to time dealing with the breakdowns of electrical machinery, showed that by far the largest proportion could be traced to carelessness in handling, mis-use, or want of ordinary attention on the part of some person. Many men had not the power of observation sufficiently developed, and from want of knowledge as to the consequences, allowed plant to get rather out of repair, such as steam joints leaking, brushes sparking, etc. It was the aim of this Institution to so educate the colliery electrician as to help him to do his work in the most efficient way, and thereby arouse his interest in it, increase his capacity for enjoying life, increase his value, and reduce risks to the smallest amount. It would also strive to raise his status in the social scale. He showed at great length how very necessary it was that the men in charge of the machinery of a colliery should be men of fine character and conscientious workers.

A vote of thanks to the President for his address was proposed by Mr. W. C. Mountain, who said his 25 years' experience in connection with colliery work told him that electricity was the safest agent in mines, and that breakdowns were due, not to defective machinery, but to want of proper attention.

Mr. Sydney F. Walker, in seconding the vote, mentioned that when he suggested, 30 years ago, the use of electricity in mines, no one would consider it.

The vote was carried with acclamation.

The President briefly replied, and the meeting closed.

The Banquet.

A banquet was held after the general meeting. In proposing the toast of "The Institution of Mining Electrical Engineers," Prof. W. M. Thornton said 15 or 16 years ago low tension alternating current was considered the correct form of electricity to use in mines. It was rather displaced

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later by direct current, but now there seemed to be a tendency to consider alternating current more suitable. Personally, he thought single-phase working was the best. Proceeding, he said the first thought which must occur to every one who went down a coal mine was "why is coal so cheap?" There were always great risks in working in a mine, he himself had once had a narrow escape from falling rock. It was the object of this Institution to reduce the risks and so help the miner in getting the coal. They were greatly indebted to Mr. J. Glynn Williams for his work in founding this Institution, and to the President for his work in organising it. Few had the gift of building up an institution from nothing, as had been the case in this instance.

The toast was received with great enthusiasm.

The President, in replying, announced that a telegram had been received from Mr. Robert Nelson regretting his inability to be present, and wishing the Institution every success in its work. Proceeding, he said the Institution would become a force in the mining industry. During the last few weeks many colliery electricians had been uncertain whether to join or not, because they were uncertain as to the views of the colliery managers. He could tell them that the Council of the National Association of Colliery Managers were very enthusiastic, and were warm supporters of the new Institution. The Colliery Managers' Association was the only other body which could make or marr theirs. He recognised the great work that north-countrymen had done in connection with the formation of the Institution. Mr. Clothier had brought in, perhaps, more members than any other member had done. They were not rivals to any existing body, and while they would make it a society that would fear no one, they desired to be on good terms with everybody.

As to the points raised by Dr. Thornton in regard to alternating and continuous current in collieries, he had just installed a new direct current plant at his colliery. It was an extension to an alternating current one, and he thought the combination would be the most economical in the country. In mining work the great point was safety, it came before economy of working. He ventured on the speculation that alternating current would not come out on top in the enquiry as to which kind of current was the best for colliery work.

Prof. Winstanley proposed the toast of "The Mining Industry." He said it was with great pleasure that he did so, for he had had a long connection with the industry. Coal mining was the industry of greatest importance to the country. All other industries were directly dependent on it. If for any reason the output from the collieries were to be suddenly stopped, it would be a national calamity. The railways would soon be unable to run trains, and the food supply to inland towns would be cut off. Riots, bloodshed and civil war would follow. It was, therefore, of the greatest importance to ensure that there should be no breakdown in the operations of mining. It was most interesting to trace the development of electricity in its connection with mining engineering. No other application had made such great strides, or taken place so quickly. The installing and successful working of machinery at such great depths and distances underground presented special problems. A few years ago compressed air was the only power allowable in mines, consequently, compressed air engineering was at a very low ebb. It was only the competition of electricity which had brought compressed air work to its present efficiency.

Mr. W. Ritson replied, and said the present great effort in mining operations was largely due to the work of mining electrical engineers.

Mr. R. Holiday supported the reply, and complained of the excessive legislation in regard to the use of electricity in mines. Much better results could be got by leaving the details to the men in charge. Let the inspectors suggest alterations if they were not satisfied. The prayer of the colliery electrical engineer was, "Save us from legislation." The Institution was on the right lines, its members could speak from actual knowledge of working conditions, but those who made the rules were not so well placed for gaining this knowledge.

Mr. T. H. C. Brooking proposed "The President."

Mr. Maurice, in replying, said he would be pleased to help them so long as they went on "crystallising." They wanted the colliery engineers as well as the electricians. They must not pose as a highly proficient society; they were really an educative organisation, and their object was to educate those men with practical work to do. He thought they would be doing very badly if they did not reach 1,000 members before the end of their first year.

Mr. Hood Haggie proposed "The Visitors," to which Mr. Cheeseman replied.

A visit was paid, the next morning, to the works of the British Westinghouse Co., where much applicable to mining was seen. After the visit the company entertained the party at lunch. The President thanked the firm for their hospitality, and Mr. Layton replied.

PATENTS.

Dynamo Electric Machines.

19392.—1909. B. G. LAMME, Pittsburg. The commutator is provided with ventilating passages formed longitudinally at the base of the commutator bars and radially between the annular flanges. When the commutator is in action the warm air adjacent to its surfaces is thrown out by centrifugal force and cool air is taken in at the ends of the commutator through the passages. A forced circulation of air is thus automatically established which will effect the desired ventilation.

Electric Snap Switch.

6832.—1909. CUTLER-HAMMER MANUFACTURING CO., Milwaukee, U.S.A. The switch comprises a stationary switch contact and a movable switch contact, a helical spring and a movable cam. The spring is bent to embrace the cam, the surface of which is inclined. The inclined surface can be moved into engagement with the helices of the spring, whereby a quick relative movement between the cam and spring is brought about to operate the switch contact.

Electric Hand Lamp.

803.—1909. H. J. FULLER, Leeds. The handle is made of wood, and provided with a deep recess to carry the lamp holder and the guard. The handle has a central hole for the passage of the conductor.

Electric Switches.

5805—1909. W. H. FLOOD, Canning Town. An elastically mounted, movable contact, carried in a frame, is provided in combination with the fixed contact. Grooves are provided in the frame, and with these lateral pins are made to engage. The grooves are at an inclination to each other. A driving plate engages the pins upon the movable contacts.

Points and Switches on Electric Tramways.

12614.—1908. R. HACKING, West Bridgford. This is an improvement in the means for automatically operating electric tramway points and switches from the car travelling on the tramway, so as to avoid the necessity of pointsmen. Levers and rail switches are connected to one or more solenoids in such a manner as to first release the points and switches from their normal position, change them over to the opposite position, and then relock them in this position by means of a timing device.

Electric Motor Starting Switch.

16537.—1909. SIEMENS BROS., LTD., Westminster. A flicker piece is pivoted to the contact arm of the switch. A contact piece is pivoted to the flicker piece so as to make contact successively as the arm is rotated with a number of fixed contacts connected to the main switch.

Actuation of Controllers.

15203.—1909. H. B. VAN DAALEN, Maida Vale. Two or more rheostats are successively actuated by means of a single arm mounted on a rotary spindle, and acting upon two independent arms in such a manner that, on its backward movement, the other arms return successively and gradually to their former positions, this return being possible at any point of the forward path.

Telephones.

10255.—1909. M. C. CONNER, Hale. In a sytsem for selectively signalling party line telephone subscribers, a manual switching device for selecting the proper current for calling the subscriber required is combined with a relay for connecting the signalling current to the line. The relay is operated upon the completion of a circuit containing a source of E.M.F. through its winding by the closing of a contact associated with the manual switching device, and released by the opening of another contact in the circuit brought about by the removal of the receiver from the hook of an instrument on the line of the subscriber.

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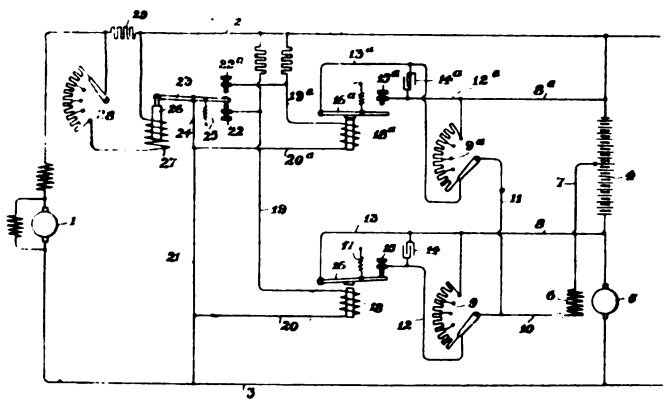
Automatic Regulating Devices for Systems of Electrical Distribution.

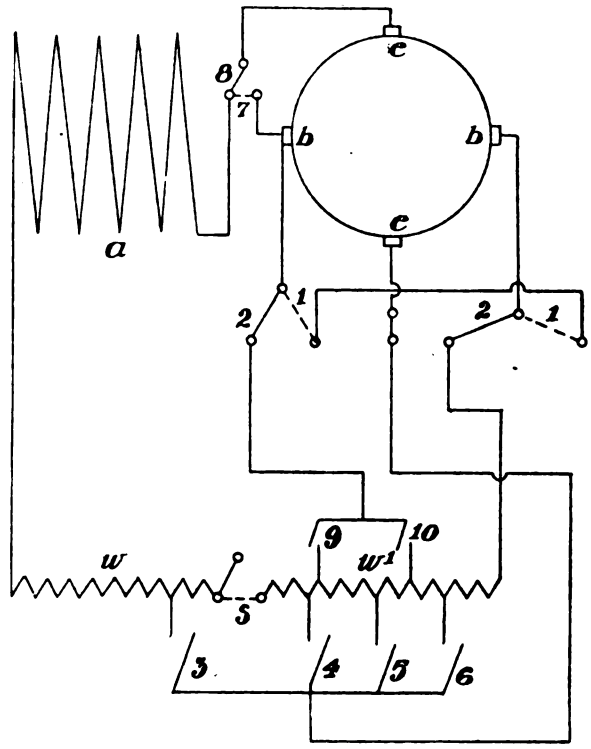
345.—1909. The British Thomson-Houston Co., Ltd., London, E.C. This is an improvement in regulators for systems of electric distribution, comprising dynamo electric machines such as boosters, in which the voltage delivered by the machine is automatically varied in response to conditions on the system, and more particularly to regulators for systems in which a storage battery is used to equalise the load on the generator supplying the system, and the charging and discharging of the battery is regulated by a booster connected in series with it. The diagram shows a regulator applied to a booster in series with a storage battery. When the load is normal, the lever 23 connected to core 26 may assume a position between the contacts 22 and 22a, both shunt circuits across the rheostats being then open, and the opposing voltages on the two supply circuits balancing each other, so that no current flows through the coil 6 and the booster generates no voltage. As the load begins to decrease, the generator attempts to furnish less current, and the regulator magnet permits the lever 23 to vibrate into and out of engagement with the fixed contact 22, causing intermittent flows of current through the field coil. The duration of the flow of current through the coil depends on the length of time the lever is in engagement with the fixed contact 22, and the voltage developed by the booster depends upon both the duration of each flow of current and upon the intervals between the flows. As the load decreases, the vibrations of the lever change to cause a corresponding increase in either the number or length, or both, of the periods during which the circuit is closed to permit current to flow through the field coil, and a corresponding decrease in the intervals between said periods The field coil is energised just enough to cause the booster



to develop a voltage which will charge the battery from the line at a rate sufficient to maintain constant load on the generator. As the load becomes steady, although less than normal, the vibration of the lever 23 change, until the periods when the energising circuit of the coil is closed bear such a relation to the intervals between said periods, that the booster charges the battery at the proper rate to make the load on the generator constant. As the load begins to increase from normal, the lever 23 swings from neutral position into engagement with the other contact 22a, causing the booster to develop a voltage which tends to discharge the battery. As the load increases, the periods during which the lever is in engagement with the contact 22a correspondingly increase either in length or number, or both; while the intervals between periods correspondingly decrease until the field coil is energised just enough to cause the booster to develop the proper voltage to discharge the battery at a rate which will make it take enough of the load to maintain a constant load on the generator. A modification is described and illustrated in the specification, in which the operation of the system is substantially the same, except that the circuits through the relay magnets are controlled by a regulator responsive both to load on the consumption circuit and to the voltage on the exciter circuit.

Alternating Current Dynamo Electric Apparatus.

10497.—1909. The British Thomson-Houston Co., Ltd., London, E.C. In alternating current machines of the commutator type, having two externally energised working circuits and excitation by the rotor, it is usual to arrange either an exciting transformer having two coils, or to derive the rotor working potential from another secondary circuit of a transformer other than the one which supplies the stator working potential. This arrangement, on account of the numerous secondary windings and conductors employed, is inconvenient, and, moreover, the employment of the transformer is unsatisfactory. In the diagram *a*, indicates the working winding on the stator of a machine, the rotor of which is provided with main brushes *b b* and exciter winding *e e*. The main transformer has two secondary brushes *w* and *w*1 connected together by switch *s* when the latter is closed. For starting the machine the two winding sections *w* and *w*1 are connected together by the switch *s*, and the working brushes *b b* are short circuited by establishing the connections 1, 1, shown in dotted lines, the connections 2, 2 being broken. Regulation of the machine is effected by the controller having contacts 3, 4, 5 and 6, by which the potential supplied to the motor may be varied. The motor potential, when contacts 4, 5 and 6 are in use, is derived from the two winding sections *w* *w*1 in common, and the latter winding section is also used in starting. In the present case, the excitation at starting may be regulated in such a way that the current from the stator is, for example, at first led to the rotor through the



connection 7, shown in dotted lines, and subsequently through the connection 8, so that the motor is first excited through half the armature and, subsequently, through the whole armature. For high speeds the switch *s* is opened and the connection 1, 1 broken, while at the same time the connection 2, 2 (shown in full lines in the diagram) is established. By this means the main brushes *b b* are supplied with working potential supplied from the secondary winding section *w*1, which potential may be regulated by the switch 9, 10. The stator working winding remains in series with the rotor exciter circuit, and both are fed from the secondary winding section *w*, when contact 3 is closed. The various connections shown in the diagram may obviously be established by a single controller having the requisite number of operating positions.

Starting and Reversing Davices.

9275.—1909. The Electric Pulley Block Co., Ltd., Westminster. This is an improvement in starting and reversing devices specially, though not exclusively applicable to electric pulley blocks. Fig. 1 is an elevation of the rope wheel and zero stop device; Fig. 2 is a plan of the parts shown in Fig. 1; Figs. 3 and 4 are respectively a vertical section (on the line *a*—*b* of Fig. 4), and an end elevation of the casing in which the rope wheel and other devices are mounted; 1 is a wheel which carries rubbing contacts adapted to rub over fixed contacts on the wheel, being rotated on its axis by means of the ropes 2 and 3. The contacts on this rope wheel and the fixed contacts may be of any convenient kind, and mounted in any suitable manner. They form no part of the invention, and are not illustrated in the drawings. On the rope wheel is a projecting lug 4, and the contacts are arranged so that, whilst the rope wheel is in a position that this lug is engaged by the zero stop 5, no current passes to the motor. On the rope 3 being pulled downwards, the rubbing contacts sweep over the fixed contacts of a starting rheostat, and the motor is operated. On releasing the rope 3, the wheel flies back under the influence of a returning spring, (not shown in the drawings) until the lug 4 is arrested by the zero stop 5. The parts will then be in the positions shown in Fig. 1, and the motor will stop. Other fixed contacts used for reversing are arranged on the other side of the stop 5, and, in order to reverse, therefore, it is necessary to raise the stop 5, so that the lug 4 may pass beneath it. The ropes 2, 3 are

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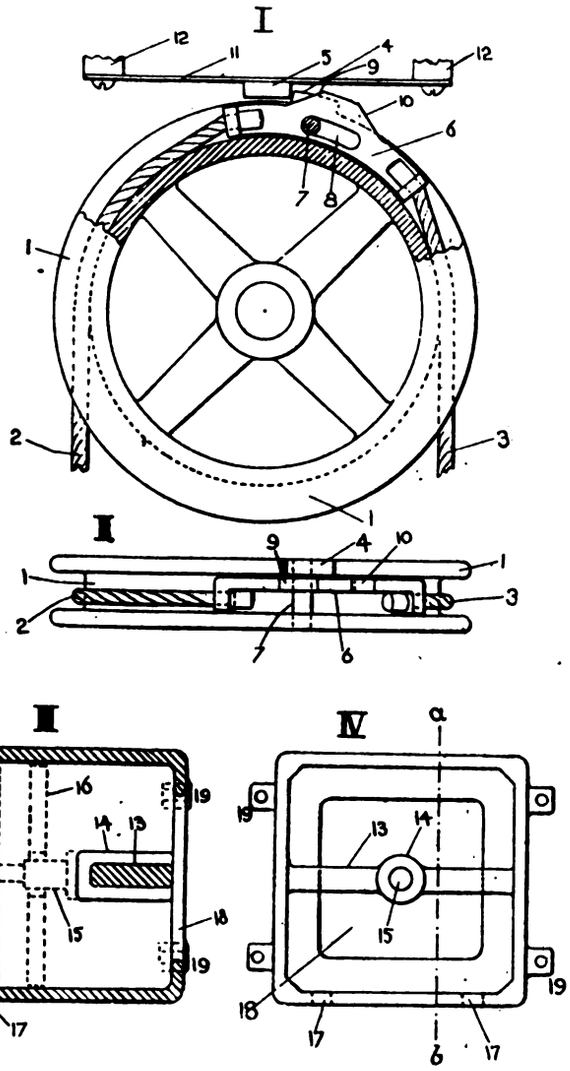
attached (as shown) to a metal block 6, which slides between the flanges of the rope wheel 1, and is connected to the wheel by means of a pin 7, extending between the flanges of the wheel and passing through a slot 8 in the block 6. The block is provided with inclined surfaces 9 and 10. Now, assume that the parts are in the positions shown in Fig. 1. the wheel having been returned to zero position by the returning spring mentioned, and the motor being at rest. The motor cannot move in the desired direction, that is, in counter-clockwise direction, because the stop 5 engages the lug 4. On pulling the rope 2 downwards, however, the block 6 is pulled to the left, and by means of the inclined surface 9 raises the stop 5, which is mounted on a stop spring 11 attached to any convenient fixed supports 12. The movement of the block independently of the wheel is permitted by the slot 8. When, however, the block has been moved so far to the left that the right hand end of the slot comes in contact with the pin 7, the wheel is pulled round with the block, the raised stop admitting of this, and



reversing is effected. As soon as the inclined surface 10 has passed the stop 5, the latter is returned to its normal position by the stop spring 11. After the desired reverse movement of the motor has taken place, the rope 2 is released, and the wheel is returned by the spring until the lug 4 engages with the left hand side of the stop 5, in which position also the motor circuit is broken. In order to drive in the forward position again, the rope 3 is pulled, and a similar action to that previously described takes place. It is preferable to place contacts so as to allow contact to be made just before the rope wheel reaches zero position on either side of the stop 5 and complete a circuit, operating any form of brake serving to stop the rotation of the motor. The zero stop prevents any accidental operation of the motor, and at the same time no separate rope is required to raise the zero stop. Figs. 3 and 4 illustrate a casing for enclosing the rope wheel, contacts and starting resistance. In this there is an internal rib 13 provided with a boss 14. The rib carries a spindle 15 upon which the rope wheel is mounted, and the contacts and the coils of the starting resistance are disposed in the casing. By this construction the rope wheel, contacts, and starting resistance may all be conveniently included in one common casing, so that the parts may all be protected from dirt or injury, and a considerable economy in space and material is effected. In Fig. 3 the spindle 15 and rope wheel 1 are indicated by dotted lines, and a contact plate 16 for carrying the fixed contacts is also shown in dotted lines as being mounted upon the spindle. Openings 17 are provided at the bottom of the casing for the passage of the rope. The left hand end of the casing in Fig. 3 is shown open, but may be closed by a cover plate. In the right hand end of the casing an opening 18 is provided, through which the leads may pass to the mains and to the motor, and this end of the casing is provided with perforated lugs 19 to admit of the casing, with its contents, being bolted to the frame of the pulley block. The starting and reversing device, it will be seen, embraces a lever pivoted at a point between its ends, a projection on the lever normally engaged by a movable stop, a sliding block attached to the lever by a pin and slot, and ropes attached to the block and passing over the ends of the lever, the block being adapted to move the stop out of engagement with the projection, when it is moved relatively to the lever by pulling one of the ropes.

Brake Mechanism.

26089.—1908. Electric Control, Ltd., Edinburgh. The controller is acted upon by a spring which tends to move it in its normal position for applying the brake. The release is effected by mechanism deriving its power for action from an electrical source. This comprises a magnet furnished with an armature supported below the position of magnetic equilibrium when the controller is in its normal position which is adapted to be brought into a position of magnetic equilibrium for moving the controller.

Electric Current Interrupter.

28870.—1908. T. McClelland, Muirend. This current interrupter consists of a commutator to which the current is led from the source of supply, which is made of varying contact surface so that while at one end of it the maximum current can be taken and obtained, the current obtainable at other parts of the commutator varies as the contact surface varies. By moving a brush to various points on the commutator surface and consequently making contacts of various lengths of working surfaces, various strengths of current may be obtained. The commutator is rotated by any suitable means.

Electric Circuit Breaker.

25353.—1908. Verity's, Ltd., London, W.C. Two distinct electro-magnetic attracting cores are provided within one yoke with either one or two coils surrounding the cores within the same yoke and electro-magnetically operating them. Both cores are axial and attracting ones. One operates upon a plunger for a positive or certain release under overload conditions, and the other, which holds the circuit closed, automatically opens the circuit from a demagnetising effect such as no volt, reverse, or no load conditions.

Electrical Block Signalling.

2150.—1909. E. W. Smith, Acton. The coils of the relay are in circuit with one line and the contact is in circuit with a line of another section. The contact is broken when a current is received by the block apparatus referring to a line of another section. The contact is broken when a current is received by the block apparatus referring to the other section.

Clasps for Unscrewing Electric Lamp Shades.

2730.—1909. D. L. J. Broadbent, Southport. The clasp has a set of spring arms connected at the bottom and tending to spread outwardly. The clasp is arranged in a sleeve attached to a handle so that by forcing up the handle the sleeve slides over the arms and brings them together to grip the shade ring of the lamp and to hold it firmly while it is being turned.

Insulated Wire Cables.

4172.—1909. British Insulated and Helsby Cables, Ltd., Liverpool. A number of wires are twisted together in pairs and these pairs are then twisted into sets of three pairs. Seven sets of the three pairs are laid side by side to form the core of the cable. During construction these are passed through a flat tubular former, which bears the strain of the lay up of the signalling wires and prevents them causing the core to collapse or depart from the flat formation.

Electro Magnetic Counters.

4271.—1909. M. S. Conner, Hale. In this counting device the armature is arranged to rotate through an angle corresponding to the angular space occupied by one division of the registering wheels and operates the first registering wheel by means of a pawl mounted directly on the armature. The actuating armature rotates about the same centres as the registering wheels.

Rotors of Dynamo Electric Machines.

19012.—1909. Siemens Schickertwerke, G.m.b.H., Berlin. In order to minimise the noise of rotors having salient poles or projections, side discs are fitted to the body of the rotor in such a manner as to enclose the poles in a ring-shaped canal. Air ducts are arranged at the inner sides of the canal between the insides of the discs and the body of the rotor.

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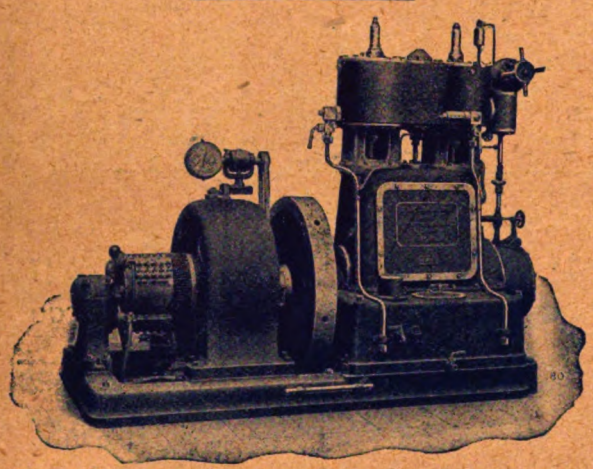

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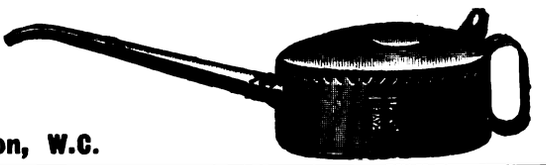

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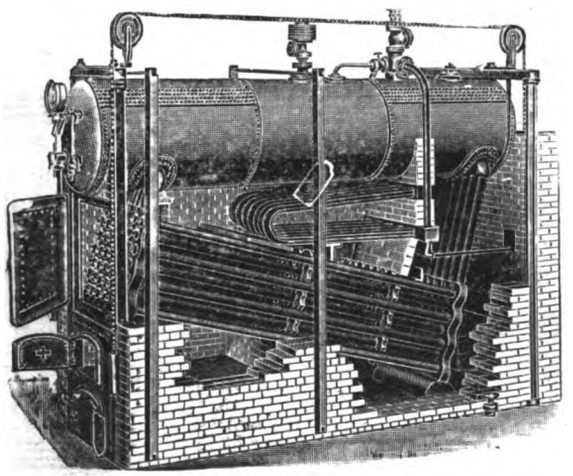

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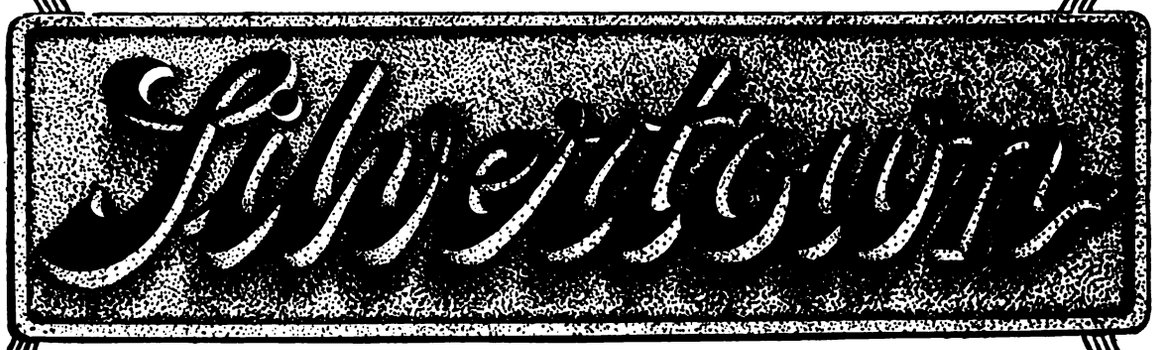

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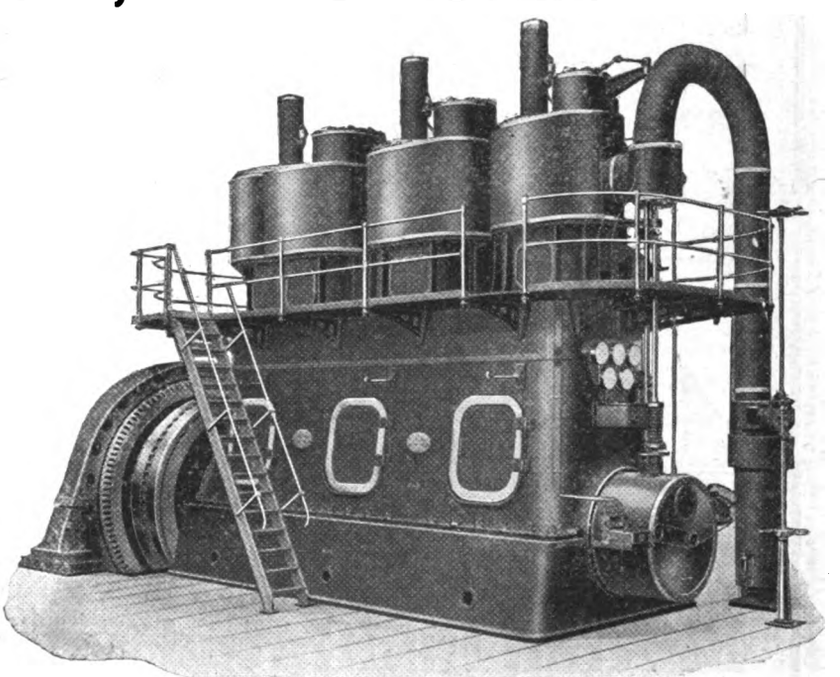

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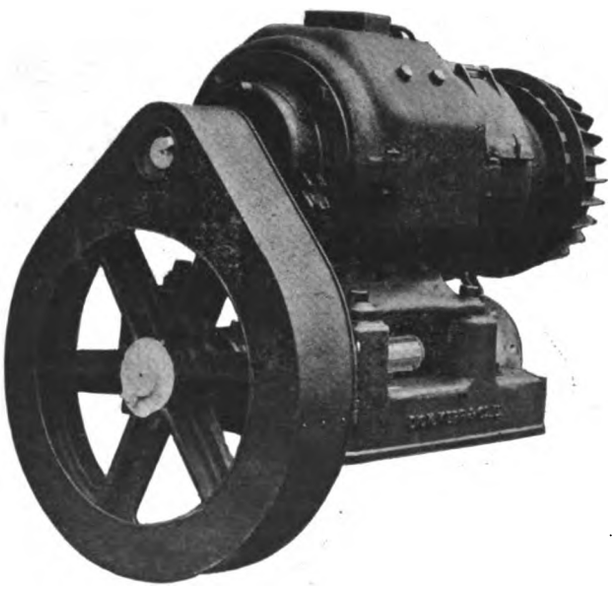

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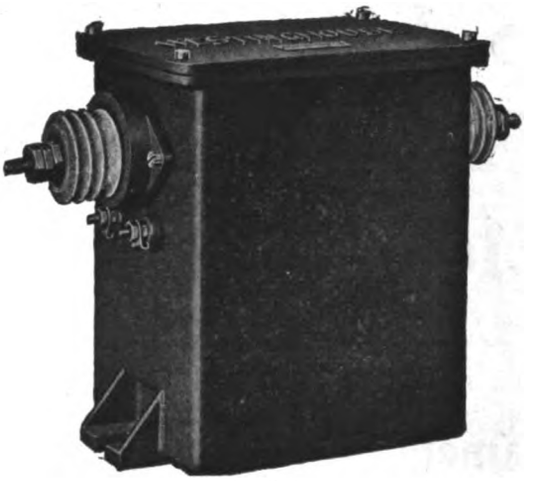

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NOTES.

THE INSTITUTION AND ITS MISSION.

Referring to our leading article of last week on Mr. E. Garcke's correspondence with the Secretary of the Institution of Electrical Engineers concerning the attitude of the Institution towards questions affecting professional and public interests, the suggestion thrown out that an Emergency Committee of Electrical Societies of all kinds might be formed should receive careful consideration. The advantages of such an organisation would be many, as it would leave freedom for the various societies to act independently whenever the particular interests of their own class of members had to be safeguarded or advanced, while it would provide a ready means of all sections of the industry to meet together and discuss matters of mutual concern. The organisation might even be used as the means towards explaining opposing attitudes, and of smoothing over difficulties that must inevitably crop up in business life, especially in these days of keen competition. When such a body had to approach heads of Government Departments or Parliament, members could speak boldly enough from the business or trade point of view, and there would be a distinct gain when it was clearly understood that it was the business side of a question that had to be discussed. An Emergency Committee, call it what you like, provided it is sufficiently widely representative, would have greater freedom in action than any learned society could aspire to.

THE EMERGENCY COMMITTEE.

Such a committee might, while being thoroughly representative of every class and branch, be organised on a plan allowing sufficient elasticity to enable the whole body to meet for general purposes, or any combination of groupings to be gathered together to consider topics of more restricted interests. It could be a consultative and conciliation body for internal affairs, a fighting organisation when necessary to meet Imperial or Municipal inertia or opposition. It is quite possible that with some such means as this, certain of the difficulties that are troubling the industry to-day, and which to a large extent have been overcome by our Continental competitors, could be straightened out. Probably a committee of the kind outlined would be the very best body to arrive at an understanding as to how far co-operation was possible in business organisation, whether on the much discussed German "Kartel" or some other system.

LIGHTING EFFICIENCY IN AUSTRALIA.

The battle of the lights is being carried on vigorously by our kinsmen in Australia, the struggle being chiefly, of course, between electricity and gas. At the "Building Australia" Exhibition, Sydney, Messrs. Scott, Henderson & Co., electricians, and the Australian Gaslight Co. conferred together to make a public demonstration of comparative tests, Mr. Corin, Government Electrician, taking a hand in the matter. The display was brilliant, and attracted attention, though inconclusive. The experiments are now being carried out by Dr. Marsden at the University. At the same Exhibition the Technical College made a series of demonstrations as to the colour, degree of brilliancy and cost of modern illuminants, this work being carried out by the demonstrator, Mr. Bruce.

AUSTRALIAN OFFICIAL ENGINEERS.

The Institute of Local Government Engineers of Australasia, which has Mr. J. M. Smail, M.Inst.C.E., as its President, and Mr. G. A. Taylor as its Secretary, is doing excellent work. Under its auspices, it appears, the chief local government electrical engineers of Sydney and Melbourne have met in conference to exchange ideas, and this innovation is to be continued. The same necessity for co-operation on broad lines in matters concerning public electric service called into being the Association of Municipal Electrical Engineers of London, which, although yet young, has already abundantly justified its existence.

INTERNATIONAL EXCHANGE OF POWER.

An instructive instance of long-distance transmission of power is furnished by the Helsingborg-Helsingöre service. Close by the town of Helsingborg, in Sweden, the river Laga has a sudden fall of over 300 feet, and this has been utilised for the establishment of a hydro-electric station. The power so generated is conveyed by cable over a few miles of land to the coast, and there by submarine cable across the narrow straits (about three miles) to Helsingöre in Denmark. The distance is not very great as such things go, certainly very much less than many others both in Europe and America, but the two peculiarities here are the facts of a submarine cable being used and that the undertaking is of an international character—the force of a Swedish river being utilised for running Danish industrial and domestic appliances.

IMPROVING THE STATUS.

Mr. W. Maurice, in the course of his Presidential address at the inaugural meeting of the Institution of Mining Electrical Engineers, had some very pertinent remarks on the service such organisations can render to professional men. But, as he reminded his auditors, "It is you who must first raise the Institution. If you aid it to become efficient in the promulgation of all those objects for which it has been established you will discover that the effort is regenerative and reciprocal. The amount of benefit which you derive from association with the Institution will bear a direct relationship to the amount of aid in personal service, and in efforts to attain its objects which you give to it. Remember that the Institution cannot do other than reflect the collective character and ability of its members. If they are careless, or apathetic, so will the work of the Institution be carelessly, or half-heartedly done." These are words of wisdom which should be remembered, for they have a wide application.

QUARRY EQUIPMENT.

Monsieur Alfred Lambotte has just published in the *Bulletin Mensuel de la Société Belge d'Electriciens* the second part of his most instructive paper on the electrification of Belgian quarries. He deals with his subject under four main headings, pointing out the type of machines used for, and the methods of applying electricity in, quarrying proper, that is, the actual extraction of stone, etc. (drilling, sawing, exploding, excavation); the transport of stone and other material by means of gantries, overhead trolleys, cranes, travelling cranes or transbordeurs, tramways; pumping; and lighting. In each section he gives valuable details.

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EXTENT OF QUARRY ELECTRIFICATION.

It appears from Monsieur Lambotte's essay that quarry electrification is in a very forward state within the small but industrially well advanced kingdom of Belgium. It is interesting to give a brief note as to the relative distribution of electrical appliances. It appears that upwards of 10,000 h.p. of electricity is utilised in Belgium for the quarrying and dressing of stone. This is divided up approximately as follows: Actual quarrying: (a) winches 2,200 h.p., (b) travelling cranes 1,500 h.p., making together 37% of the total. Handling and dressing: travelling cranes 1,300 h.p., transbordeur 100 h.p., together 11%. Pumping: piston pumps 300 h.p., centrifugal pumps 900 h.p., or 12% of the total. The balance (37%) of 3,700 h.p. is required for lighting, secondary motors, and reserves. Some 50 quarry companies are concerned in this phase of exploitation, and one of these generates more electricity than it can use, and sells current not only to other industrial undertakings, but to local authorities. This is an excellent record, and more than one of the installations would well repay inspection by quarry owners and engineers. A noteworthy feature in some of these is the fine steel girder Gantries with electrical conveying appliances.

ARTIFICIAL THUNDERSTORMS.

On June 21, 1908, a district in the South of France, measuring about 7 by 1¼ miles traversed length ways by a main carrying a 35,000-volt current, experienced a heavy thunderstorm accompanied by showers of hail. Many physicists associated the storm with the artificial current, and Professor Violle told the Academy of Sciences that the ionisation of the air due to the high voltage would make it a conductor between the thunderclouds and the earth. There seem to be some difficulties here, but we will keep our own remarks to the last. Having heard of the occurrence and of M. Violle's pronouncement, Professor Houllevigue, of Marseilles, determined to see what he could do in the way of causing a laboratory thunderstorm by reproducing the conditions observed by M. Violle. He tried 50,000 volts, and found that not only was there no ionisation of the surrounding air, but no thunderstorm. What we should like to say is that if ionisation of the air makes it conductor, the ionisation should rather prevent than cause thunderstorms. We have always understood that lightning is an indispensable adjunct to a thunderstorm, and that the lightning consists of sparks passing through a gaseous medium of bad conducting power, and so overcoming great resistance and developing intense heat and light. If, too, the 35,000-volt conductor causes thunderstorms and hailstorms, are these meteorological visitations always on while the current is passing. One would expect that to be the case. Should it be so, the neighbourhood should enjoy low house rents.

MINE SIGNALLING APPARATUS.

Mr. C. E. Grayson has given a description of new electric signalling system installed at the Great Boulder Mine, Western Australia. It appears that 29 levels in the main shaft to a depth of 2,500 ft. are equipped with 30 polarised bells and the Edward shaft with 16 bells. The first section has been at work for 18 and the second for 10 months, giving complete satisfaction. Alternating current is used. Mr. Grayson adds: "For localities which supply such current a transformer, four insulated wires in armoured cable, water-tight polarised bells, junction boxes, pulls and pushes, consisting of platman's pull and interplat pull, for platman to communicate with engine-driver and miners stationed at the various levels, and *vice versa*. For localities without supply current, the same as the above, with the exception that, instead of a transformer a generator must be used. The working of the circuit wired to illustrate the actual procedure is as follows: Assuming a platman hauling at the 400 ft. level, and a shift boss at the 1,400 ft. level requires the cage, the shift boss simply rings the platman his number of rings by using the interplat pull corresponding to the level from which he rings. By so doing the bells are ringing at every level, excepting, of course, the engine-driver's bell; the platman replies to the shift boss by using the interplat pull with the same number of rings and calls engine-driver by using the platman's pull for the level at which the cage is required. The engine-driver, by using his pull, replies to the platman's signal and lowers the cage to the signalled level. By this system perfect communication and understanding between levels will be obtained, and the engine-driver can secure the highest degree of safety. With the use of polarised bells the interruptor in the circuit, which causes so much trouble with the continuous current bells, is eliminated. By means of the transformer the high voltage current from the main supply is reduced to 25 volts, which is not dangerous to life. The saving of time in signalling allows more time for hoisting. The maintenance and working expenses are much lower than in any other bell system, and the possibilities of breakdown are practically nil. . . . The following are the working and maintenance costs: Transformer—No load losses per day, equal to 0·24 units, or 87·6 units per year at 2d. per unit, equal to 14s. 7d. Assuming these bells work continuously for two hours per day, then 30 bells will consume 0·069 units, or 25·185 units per year at 2d. per unit, or 4s. 2d. Maintenance cost about 10s. per month, or £6 per annum. Total annual cost, £6 18s. 9d."

ELECTRICITY IN AMERICA.

Mr. Samuel Insull, speaking at the annual dinner of the Electrical Trades Association of Chicago, gave an interesting account of his 30 years' experience. Thirty years back practical engineering was in its infancy. Since then the most wonderful progress had been made. The first large American steam turbine unit started in Chicago in 1903. The steam turbine had met with more or less success in different parts of Europe, and especially in England, a number of years prior to that, but the large use, or rather the use of large units as they are now understood, in the central stations of to-day, where units running up to as high as 22,000 h.p. are used, dates as recently as October 2, 1903, when the first unit was started in the Fisk-street station of the Commonwealth Edison.

Some of the figures of the investments in the electrical business are simply stupendous. In Chicago alone there is probably invested in electric lighting, telephones, the electric portion of the street railways and the elevated railways, and the isolated electric lighting plants throughout the city, a sum which must exceed $500,000,000. "Just imagine for a moment what that means. Here we are, engaged in a business that a little over 30 years ago was never dreamed of, and to-day we have as customers of the concerns which are represented in this room, businesses that employ a capital of $500,000,000. The figures are simply stupendous."

There are at the present time 5,500,000 telephones in use in the United States, and the amount invested in exchanges and the lines connecting them is upwards of $550,000,000. There is a track mileage of electric and inter-urban railways of 40,247 miles, using 89,216 cars, and representing capital liabilities of $4,557,000,000. Mr. Insull said that, of course, those figures represent capital liabilities, and probably some of that capitalization is water, but, personally, would very much doubt if the cash invested in electric street and inter-urban railways at the present time is less than $3,000,000,000.

Turning again to electric lighting investments, there are about 6,000 central stations in the United States to-day. Of this number, upward of 3,000 of the companies engaged in central-station work are also in the electrical supply business, a business that 25 or 30 years ago the representatives of which could be counted on the fingers of one hand.

The central-station companies of the country have an investment of $1,250,000,000. They have a gross income of upwards of $250,000,000 a year, and they develop somewhere between 2,000,000 h.p. and 2,500,000 h.p.

The total investment engaged in the several departments of the electrical business exceeds upwards of $600,000,000; and that entire business has been created by the inventors of this country, who have no rivals anywhere on the earth in what they have been able to accomplish anywhere; in the ability of these inventors to produce that which would be commercially successful; by the wonderful confidence of the capitalists of this country; and by the adaptability of the people of the country to seize upon new things which are conducive, either to their comfort or to the economy of manufactures or to the improvement of means of communication and transportation.

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POINT CONTROLLERS FOR ELECTRIC TRAMWAYS.*

By J. P. TIERNEY, A.M.I.E.E.

The subject of automatic point controllers is one which has engaged the attention of inventors since the advent of electric traction. One of the first forms of electrically operated point controllers was brought out in Detroit, U.S.A., as far back as 1892, and since that date numerous applications have been received at the Patent Offices throughout the world, but few have been tried. Judging by the Patent Office applications, the subject has been receiving an enormous amount of attention during the past five years. The reason why so many designs did not get beyond paper appears to be due to the fact that the inventors when designing their apparatus were not in possession of the difficulties to be met with, nor aware what conditions their apparatus should fulfil.

An electrically operated point controller must satisfy a variety of conditions. It must be approved by the head of every section of the tramway undertaking on which it is to work; the electrical engineer who is responsible for the power supply, insulation of the line, etc., must be satisfied that the apparatus will not be a menace to the safe working of his end of the business; the local authority must be satisfied that the apparatus is not a street obstruction or dangerous to vehicles, horses, etc.; the permanent-way engineer must be satisfied that the apparatus will not hamper, or in case of failure obstruct the points. Last, but not by any means least, the traffic department must be satisfied that the apparatus will answer all the requirements of the service, and possess the necessary flexibility to cater for all deviations of traffic.

Before proceeding to describe what we call the standard design of our apparatus which is now placed on the market as the "Tierney-Malone Point Controller," some references to the various forms which this apparatus passed through before reaching its present state will probably be of interest to the association.

Experiments were started by Mr. Malone and myself in September, 1902, with a form of apparatus which in the light of recent designs may appear cumbersome and crude; however, the fact remains that it performed its work satisfactorily from the time of its inception at the London Bridge Road Junction, Dublin (Dublin United Tramways Co.), in May, 1903, until replaced by an improved and cheaper pattern some months later. This first apparatus consisted essentially of two parts:—(1) car equipment; (2) street equipment. The car equipment consisted of an electromagnet placed in a position midway between the two car motors and centrally across the track. It was of the two-pole type, and was hung vertically; the two poles facing downwards were elongated in shape and fitted with long shoes so that the period of time the magnet exerted its influence on the street switch-box was extended as much as possible. This magnet was energised at will by the motorman of the car.

The street equipment consisted of two switch-boxes, one placed before and one after the point; these consisted of a cast-iron box with a manganese steel lid under which was hinged an iron armature connected to mechanism for closing the circuit. When the magnet on the car passed over this switch-box it exerted no influence on the cover of the switch-box, the cover being non-magnetic, but lifted the iron armature beneath, which closed the circuit from the trolley wire to an electromagnet fixed in a cast-iron box at the point. This electromagnet then operated the point. The circuit of this electromagnet was broken immediately the car-magnet passed from over the switch-box. When the car had passed through the point the magnet on the car passed over the second switch-box which switched the current into a second electromagnet at the point which returned the point to its original position. If a motorman did not wish to operate the points he did not energise the magnet on the car.

The main drawback on this design of apparatus was the heavy initial outlay for the magnet on each car. This apparatus was superseded by a design consisting of contacts fitted to the trolley wire which performed the function of the street switch-box, and by the contacts on the trolley heads of the cars which performed the function of the car-magnet. The trolley head of each car was fitted with an insulated contact which the motorman could make electrically alive at will. A contact strip was mounted on the trolley wire some 50 ft. before the point. This strip was insulated from the trolley wire and was connected to an electromagnet fitted to the point. If the motorman of the car desired to operate the point he closed the switch on his platform, thereby making the contact-piece on the trolley head alive. When the trolley of the car passed under the contact strip on the line the contact-piece on the trolley head made contact with the contact strip on the line, thereby sending a current from the car through the contact-piece on the trolley head, the contact strip on the trolley wire, and the electromagnet at the point. This electromagnet being thereby energised operated the point; when the car had passed through the point the trolley head of the car passed through a second contact strip on the trolley wire identically similar to the first. This second contact strip was electrically connected to a second electromagnet placed in the same box as the former at the point. The car thus sent a current through the second electromagnet which returned the point to the original position.

An alternative form of this type was designed to permit the running of trailer-cars, and consisted of the two contact strips being placed side by side and on opposite sides of the trolley wire about 50 ft. before the point, each strip being insulated from the other, and from the trolley wire, and each strip connected to one electromagnet at the point. The trolley head of the car was fitted with an insulated contact on each side, the motorman by means of a switch on his platform being empowered to make either but not both electrically alive. Thus either contact strip on the trolley wire and either electromagnet at the point got the current, and the point was operated accordingly in the required direction.

In the former case the points were always set for one particular route, and in the latter case the car on each route operated the points for themselves, and did not shut the points back after passing through. These latter forms worked very satisfactorily in actual practice from August, 1903, to September, 1906, but possessed the disadvantage of requiring a special attachment in the form of these trolley head contacts above mentioned being fitted to every car. This constituted an item of expense which was really of more consequence on small systems with a small number of points than it was on large, as the number of cars per point to be fitted was excessive on the latter. Being fully cognisant of this drawback, we directed our subsequent endeavours towards bringing out a design of apparatus which required no alteration of or addition to the cars of the service. This we accomplished, the details of the design of the apparatus encountering several minor changes before reaching its present form, the most notable change being the substitution of one large box containing all the equipment on one side of the point for the two small boxes, one on either side of the point, each containing half the apparatus.

I will now proceed to describe the standard equipment as it is now working on several systems, including Dublin, Belfast, Newcastle-on-Tyne, Salford, Hull, Birmingham, Stoke, and Bristol. The method consists in having each point always set for one particular line; the cars on this particular line do not move the point, but the cars going on the other line always move the point for themselves and set it back again after they have gone through. It is equally applicable to all systems of electric traction, whether operated on the trolley, conduit, surface-contact, or accumulator systems.

Its principal advantages are:—(1) Motormen are able to see the point moving before they come up to it; (2) If the current should leave the line when the wheels of the car are going through the point, the point will not spring over, as it does not depend on the current for keeping it is any position; (3) The fact of a point being fitted with the apparatus does not in any way prevent the point being operated by the ordinary bar should occasion arise.

The point equipment consists of a cast-iron box placed next to the point, the cover of this box being flush with the street surface. This box contains two specially designed stopped solenoids (one series and one shunt) placed side by

* Abstract of paper read before the Institution of Electrical Engineers, Dublin Section, Dec. 9.

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side. A steel spindle is mounted vertically inside the box. This passes out through a packed gland to an outside chamber of the box. Mounted on the spindle inside the box is a lever having equal arms on each side of the spindle. This lever arm is at such a height that the nose of one solenoid plunger pushes against one arm of this lever, and the nose of the second solenoid plunger pushes against the second arm of this lever. On top of this vertical spindle in the outside chamber is mounted a lever arm, which is connected by a rod to the tongue of the point. Thus, when one solenoid is energised, it pushes one arm of the inside lever, thereby giving a turning movement of about 15° to the vertical spindle; this in turn operates the outside lever arm, and thence the tongue of the point. When the other solenoid is energised, it pushes against the other arm of the inside lever, thereby giving a turning movement in the opposite direction to the vertical spindle and lever arm, consequently shifting the point in the opposite direction.

The inside of the box containing the solenoids is perfectly water-tight, the connection to the outside chamber being by the vertical spindle through the packed gland. As this spindle only turns through an angle of 15°, it is an easy matter to keep the gland watertight. A watertight joint between the cover and the edges of the box guards against water coming through in that direction. The principal advantage of this design lies in the fact that there is not one mechanical joint in which wear may take place. There are no holes or pins to wear. The inside lever is securely keyed to the vertical spindle, inside the box, and the outside lever is securely fixed to the top of the vertical spindle, these three being for all practical purposes the one piece. Wear of any kind would greatly injure the efficiency of the apparatus, as it would increase the air-gap of the solenoids necessary to operate the point, thereby losing power practically fourfold on account of the law of the pull of an electromagnet.

The solenoids used are of the stopped type, but instead of the plungers pulling their work after them when sucked into the coil, as is the general practice, the stop of the solenoid is bored out, and a brass rod, screwed into the plunger, passes through the stop. By this means the solenoid plungers are used to push instead of to pull their work. This arrangement has the advantage that the plunger rod, pushing against the inside lever arm, does not necessitate alignment or levelling, and further dispenses with the necessity of a mechanical joint between the solenoid plunger and the lever. The solenoid coils are hermetically sealed, and are further protected by the cast-iron casing of the solenoid, which is also waterproof in itself. Thus the winding is triply protected.

The overhead-line equipment consists of two contacts. The first, or series contact, is placed about 50 ft. in front of the point. This gives the driver full opportunity of seeing that the point has been properly operated before he goes through; the second, or shunt contact, being placed at a suitable distance after the points. The series contact consists of a pair of inverted ramps, secured to the trolley wire. Between these ramps is a contact strip or centre-piece, insulated from the trolley wire. These are so arranged that a trolley passes along the underside of the ramp (and in doing so leaves the trolley wire), and from the ramp it passes on to an insulated inset, thence along the centre contact strip, under another insulated inset, along the second ramp, and thence on to the trolley wire again. By means of two bridging-pieces over the insulated insets there is no part of this contact from which the trolley cannot get current, so that, no matter what position a car stops in, it will have the necessary current to start off again. This centre contact strip is electrically connected to the trolley wire, through the series-wound solenoid placed in the street box at the point. Thus it will be seen that whatever current the car is taking from the line when the trolley is passing under this insulated contact strip will pass through the series solenoid in the street box at the point as the trolley head makes electrical connection with the centre contact strip. The second, or shunt contact, consists of an ordinary ear with two hubs attached in the usual manner under the trolley wire. Each of these hubs carries a special insulator, and these in turn carry between them a contact strip. This strip is insulated from the trolley wire, and is so suspended and placed

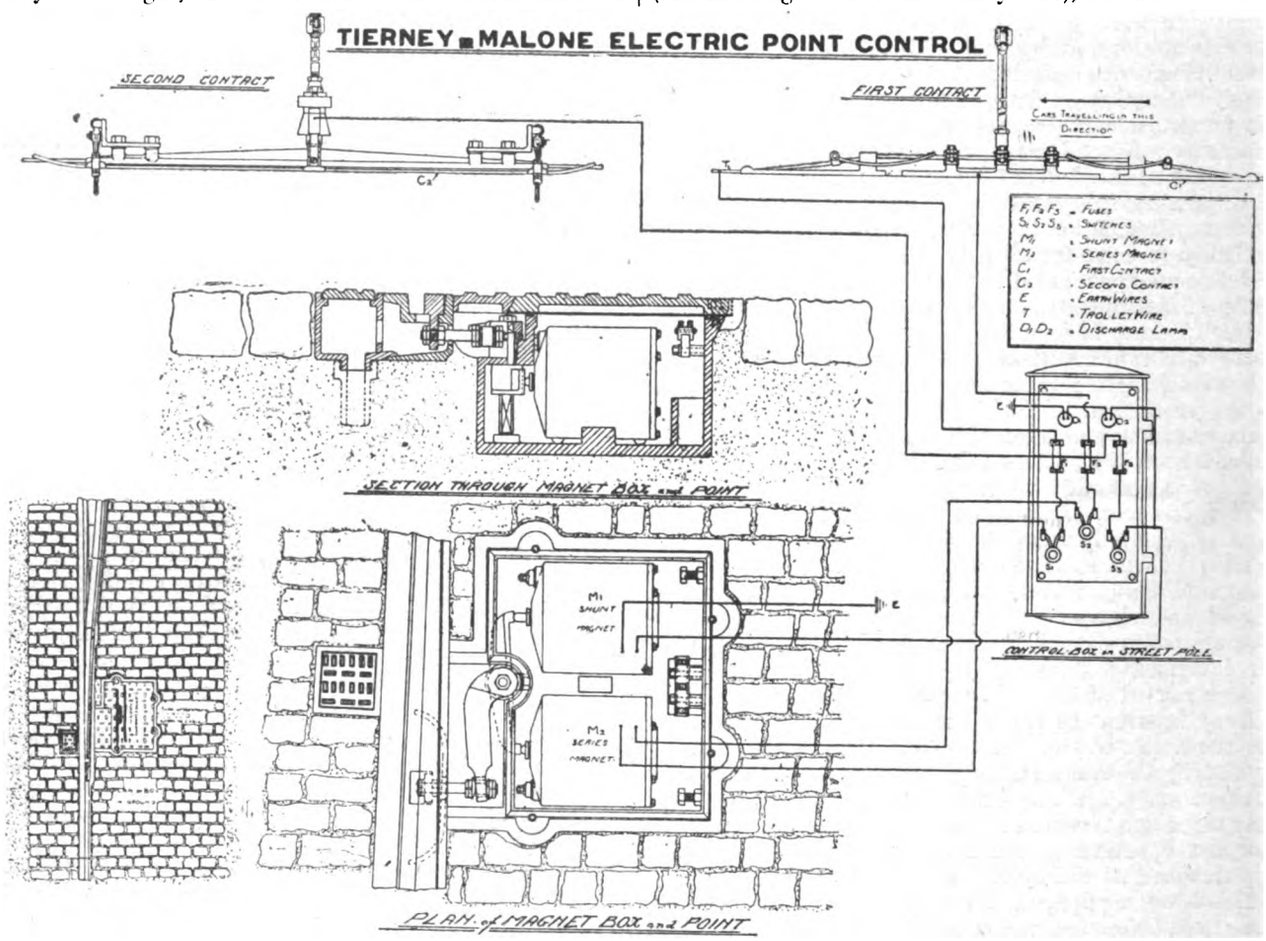
TIERNEY & MALONE ELECTRIC POINT CONTROL
SECOND CONTACT
FIRST CONTACT
CARS TRAVELLING IN THIS DIRECTION
F1 F2 F3 = FUSES
S1 S2 S3 = SWITCHES
M1 = SHUNT MAGNET
M2 = SERIES MAGNET
C1 = FIRST CONTACT
C2 = SECOND CONTACT
E = EARTH WIRES
T = TROLLEY WIRE
D1 D2 = DISCHARGE LAMPS
SECTION THROUGH MAGNET BOX and POINT
M1 SHUNT MAGNET
M2 SERIES MAGNET
CONTROL BOX on STREET POLE
PLAN of MAGNET BOX and POINT

ILLUSTRATION IS A GENERAL VIEW OF THE WHOLE ARRANGEMENT, SHOWING OVERHEAD CONTACTS ON THE TROLLEY WIRE, THE FIRST OR SERIES CONTACT, THE SECOND, OR SHUNT CONTACT, A PLAN AND SECTIONS OF A POINT, WITH THE APPARATUS FITTED, THE CONTROL BOX ON THE STREET POLE, CONTAINING THE CUT-OUT SWITCHES AND FUSES, AND THE GENERAL WIRING CONNECTIONS.

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that, when the trolley head of the car is passing under the car, the side of the trolley head will rub against and make contact with the contact strip on the line. This contact strip is connected to the shunt solenoid in the street box through a suitable switch and fuse placed in a control box on the nearest street-pole. The other end of this solenoid is connected with the rail.

An alternative method of constructing this contact is to have it uninsulated from the trolley wire and to mount on it a spring contact which connects to an upper insulated fixed contact when the former is lifted by the trolley head, the upper contact being connected to the shunt solenoid. A control box on the nearest pole contains three switches and three fuses. Two switches and two fuses enable the series solenoid to be entirely disconnected from the overhead-line contact when the points are being examined or overhauled. The third switch and fuse performs the same operation for the shunt solenoid. In case of a fault developing on a magnet or a cable going to earth, the fuses protect the apparatus from damage and also protect the line from being grounded. Two 260-volt 16 c.p. lamps in the control box connected in series with each other are permanently connected between the wire connecting the second, or shunt, contact with the shunt solenoid and earth, and are therefore permanently in parallel with the shunt solenoid, thereby acting as a discharge resistance for the solenoid coil, and take up the back E.M.F. which would otherwise be set up owing to the solenoid being open-circuited. In the case of the series solenoid this function is performed by the bridging-pieces, as by their operation when the trolley of the car is leaving the centre contact strip it makes contact with the bridging-piece on the trailing end of the first contact before leaving the centre contact strip. This has the effect of short-circuiting the series solenoid before open-circuiting it, and consequently discharging the back E.M.F.

When the driver of a car approaches a point which it is necessary for him to move, he keeps his car controller on one of the operating positions while the trolley of his car is passing under the first or series contact. When the trolley of the car passes it will draw its current from this insulated contact, thereby drawing the current the car is taking through the series solenoid at the point, which solenoid, on becoming energised, will move the point to the desired position. When the trolley of the car has passed from under this contact the current is cut off this solenoid. The car having passed through the point, the trolley passes under the second, or shunt contact, which is then made electrically alive, thereby sending the current to the shunt solenoid, which throws the point back to its original position. If drivers do not require to move the point they keep their car controller on the "off" position while the trolley is going under the first contact. It is immaterial whether the car controller is in the "on" or "off" position while passing under the second contact, either in the case of a car which has operated a point for itself, and requires to close it, or in the case of a car which has passed through the point in the direction for which the point is set.

I may here add that the length of the insulated contact strip, first contact, is only 18 in., so that it does not in any way inconvenience the motormen who require to drift through without power. If a motorman were forced to stop with his trolley under the first contact, a thing which need not occur except through want of judgment on his part, he would naturally take the starting current of his car through the series magnet, and thus operate the point. If he did not require to shift the point for his route, he would then bring the front of his car close to the point, and operate the point by the ordinary points bar. As the first, or series contact, is only 18 in. long, this rarely happens, and need not happen at all. For continental working, where the use of trailer-cars is extensive during the rush hours of the day, this method of working the points, which answers all the conditions in Great Britain would not apply, as the shutting back of a point by a car with a trailer attached would cause the motor to take one road and the trailer the other, whereas, if this second contact was placed so far ahead as to permit all the trailers to pass through before the point were shut back would cause considerable delay during the slack period of the day when the single motor-cars would be running.

To meet these conditions we have altered the design in the following details:—There is only one overhead contact instead of two, that one being the same identically as described above as the first or series contact, and being placed as before, 50 ft. in advance of the point; each car requiring to open the point does so as explained above, but does not shut it back—*i.e.*, the car on each road makes the point for itself; this design possesses all the advantages of the one I have just described, and, in addition, it is specially designed to facilitate the running of trailer-cars to an unlimited extent, and it is equally efficient and successful for the operation of single motor-cars as it is for motor-cars with trailers attached. There is only one overhead contact on the trolley wire and only one solenoid. The overhead-line equipment, as just mentioned, consists of only one contact, which I have described already.

The point equipment consists of a cast-iron box placed next to the point, the cover of this box being flush with the street surface. This box contains one specially designed stopped solenoid which is pivoted on the bottom of the box in such a way as to take either of two positions, according to the position of the point tongue. A steel spindle is mounted vertically inside the box. This passes out through a packed gland to an outside chamber of the box. Mounted on the spindle inside the box is a lever having equal arms on each side of the spindle. The extremities of these arms are each connected by a rod to the back of the solenoid; these two rods pass one on either side of the solenoid, and each has mounted on it a spiral compression spring. This lever arm is at such a height that

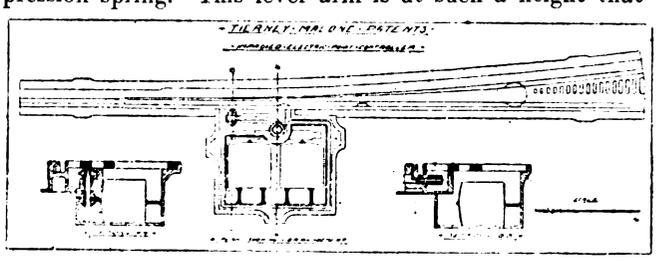

ILLUSTRATION SHOWS A PLAN OF A POINT WITH THE STREET BOX CONTAINING THE SOLENOIDS ATTACHED, ALSO SECTIONS THROUGH SAME.

the nose of the solenoid plunger pushes against one arm of this lever when the magnet is in one position, and pushes against the second arm of this lever when the magnet is in the alternative position. On top of this vertical spindle in the outside chamber is mounted a lever arm which is connected by a rod to the tongue of the point. Thus when the solenoid is in one position and is energised by the current its plunger pushes against one arm of the inside lever, thereby giving a turning movement of about 15° to the vertical spindle, this in turn operates the outside lever arm, and thence the tongue of the point. This movement of this arm of the inside lever compresses the spiral spring on the rod connecting that arm of the inside lever to the back of the solenoid. When the current is cut off the solenoid the pressure between the nose of the plunger and the inside lever arm is in consequence relieved, the compression spring which has just been compressed then relieves itself, and in so doing turns the solenoid on its pivotal mounting from its then position into the second position, which is such that the nose of the plunger is brought in front of and in contact with the second, or opposite, arm of the inside lever.

When the solenoid is next energised by the current of another car its plunger pushes against the second, or opposite, arm of the inside lever, thereby giving a turning movement in the opposite direction to the vertical spindle and outside lever, and consequently shifting the tongue of the point in the opposite direction. This movement of this arm of the inside lever compresses the spiral spring on the rod connecting that arm of the inside lever to the back of the solenoid. When the current is cut off this solenoid the pressure between the nose of the solenoid plunger and the inside lever arm is relieved, and the compression spring which has just been compressed then relieves itself, and in so doing turns the solenoid on its

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pivotal mounting back to its former position. Thus each time the solenoid is energised the point is operated in the opposite direction to the previous operation, or the solenoid is always in such a position that when it is energised it will operate the point. Likewise the operation of the point by hand will turn the solenoid. The same remarks as to mechanical parts in which wear may take place applies in this case as it did in the other design.

When the driver of a car approaches a point which it is necessary for him to move, he keeps his car controller on one of the operating positions while the trolley of his car is passing under the contact on the trolley wire. When the trolley of the car passes underneath it will draw its current from this insulated contact, thereby drawing the current the car is taking through the solenoid at the point, which, on becoming energised, will move the point to the desired position in the manner explained above. When the trolley of the car has passed from under the contact the current is cut off the solenoid. The solenoid will then turn on its pivotal mounting, as before described, so that when it is next energised it will operate the point in the other direction.

If the next car following is going in the same direction, the point being set right for him, the motorman will keep his car controller in the "off" position while the trolley is going under the contact, and thus draw no current through the solenoid and not operate the point. If, on the other hand, the car following wishes to take the other route, the point being against him, the motorman will keep his car controller on one of the operating positions while the trolley is going under the contact on the trolley wire, thus energising the solenoid, which is now in a position to operate the point in the reverse direction. Thus any motorman requiring to operate the point keeps his current on, and any motorman not requiring to operate it keeps his current off. The point is not set back after the passage of a car. The length of the insulated contact strip is only 18 in., so that it does not in any way inconvenience the motorman who requires to drift through without power.

The contact above mentioned as being attached to the overhead trolley wire is in the conduit system mounted on one of the conductor rails in the conduit. The contact is specially designed to go on the conductor rail, and in no way impedes the passage of the car-ploughs.

The overhead frog on the trolley wire can be operated in connection with the track point if desired, or can be operated mechanically by automatic mechanism. It will thus be seen that this point controller differs from other designs, inasmuch as when a car has operated and passed through a point the car does not throw the point back, so that this controller permits every car to operate a point in whatever direction the driver chooses. It also permits the running of an unlimited number of trailer-cars if desired, which is not permitted when the point is shut back after the passage of a car. After the magnet has moved the point it does not hold it over, but the point is then an ordinary point, and any failure of current does not in any way affect the passage of the cars or cause the point to spring back. At night the position of the point tongue can be shown to the motormen by coloured lights on the nearest street-pole.

A 2,750-VOLT DIRECT CURRENT SYSTEM.*

By A. H. BARRINGER.

The transmission of energy becomes a remarkably simple matter when direct current is employed, and given that the generators, rotary transformers and apparatus could be brought to a sufficiently high voltage without the cost of becoming prohibitive, and that they could be guaranteed as reasonably reliable and durable, then undoubtedly direct current would be an ideal agent. But the difficulties have proved so many, and the risks of installing such plants so formidable, that, except for a few isolated instances, direct current systems of any size operating at over 1,000 volts are practically unknown. Moreover, the results obtained from the few in operation can scarcely be called inviting enough to encourage such enterprise in this field.

* Paper read before the Canadian Society of Civil Engineers.

Before going into details of the particular system under review, it may be as well to give a brief description of the district which it is operating.

Twickenham is one of the south-western suburbs of London. It is chiefly residential, as are the other towns along that part of the Thames, and, except for a few saw-mills and the like, and the National Physical Laboratory, there are no power-users. This lack of day load is probably what influenced the designers to run D.C. in the first instance, for otherwise it is more than usually well-adapted to alternating current. It is so scattered that there has been constant trouble in keeping the low tension network balanced and up to standard pressure. The area supplied at present is about 25 square miles, but the company have powers which will eventually treble that total.

The low tension mains, comprising about 60 miles of complete three-wire, are all linked up into one network, fed at suitable points by rotary transformers, and, of course, largely from the central. The generating station

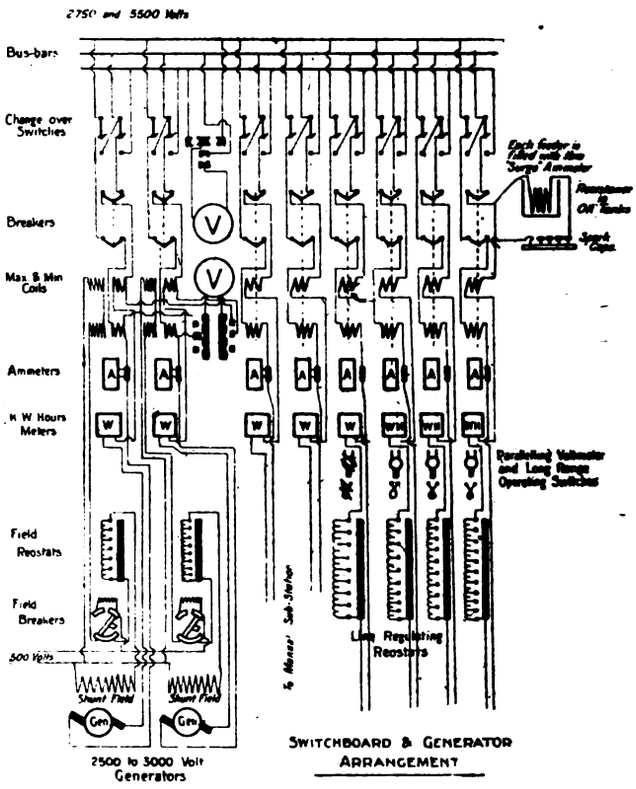

FIG. 1.

is situated in about the centre of Twickenham, about two miles from one end of the district now operated, and between six and seven miles from the other. The transmission is by direct current at 2,750 volts, with future intentions of making it three-wire at 5,500 volts.

Generating Station Equipment.—The present H.T. equipment consists of two 200 kw. 2,750-volt generators and one 100 kw. 2,500: 500-volt rotary transformer, with booster attached for raising the low tension side for transforming up, so that whilst during the day one H.T. set is run, supplying the two principal sub-stations and the home rotary transformer, during heavy loads the home rotary transformer is taking current from the L.T. board and transforming up. This has saved installing another generating set.

Generators.—The generators are four-pole, direct-coupled, running at 475 r.p.m. They are shunt wound, with shunt separately excited at 500 volts. These machines have now been running for about five years, and it is a curious fact that, although they have continually been in trouble from flashing over and other causes, the armatures have never had even a new former. For two years each machine was running without a break for 18 hours on each alternate day.

Switchboard.—The switchboard (Fig. 1) consists of nine panels. They are of iron throughout, with mica washers and bushings. There are two generator panels, six feeder panels, and a voltmeter panel. The circuit breakers are D.P. air break, and are ranged along the top, with a slate

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division between each set. Immediately behind are the change-over switches, and above these the busbars. The generator switches are fitted with maximum and minimum cut-outs, the minimum coil being fed from the 500-volt shunt circuits. The feeder cut-outs are simple overload. At the bottom of the generator panels are the field rheostats and field breakers. Five of the feeder panels are fitted with line regulating resistances, L.T. long-range operating switch, and paralleling voltmeters for running the automatic sub-stations. The method and connections are shown on Fig. 2, and will be referred to later. Each feeder is fitted with a surge arrester, consisting of a series of spark gaps in series with an oil tank resistance. These arresters were installed after one of the lines had been twice broken down on charging. Lastly, the voltmeter panel, which, as will be seen from the figure, has two electrostatic meters, and a plugging arrangement for paralleling and for plugging on to the three bars.

Transformers.—The rotary transformers (Fig. 2) are two-pole machines of overtype design, with double wound armatures running in a single field, and have copper brushes. They run at 500 r.p.m., and have a fixed ratio of 5 to 1. The regulating is done by the resistance in the high-tension circuit. They are started up as series motors, and for this purpose are fitted with a small series field, which works in conjunction with a short-circuiting switch. The actuating solenoids of this switch are connected in series with the shunt-field circuit, which in its turn is connected straight across the L.T. end of the transformer. These switches are so adjusted that, when the L.T. pressure equals about 450 volts, the series field is cut out. The transformer bearings have small oil pumps working on a cam on the shaft ends, as well as the usual oil rings. These oil pumps have proved somewhat of an expensive luxury, as will be shown later. The figure is of the home transformer, and shows the method of attaching booster necessary to make up-transforming possible.

Sub-stations.—There are at present four sub-stations, and these form what is perhaps the most interesting part of the system. One of them, the Teddington, is a manual, equipped with two 100 kw. transformers, H.T. and L.T. switchboards, and a 1,000 ampere-hour battery. This is arranged after the same pattern as the generating station, but it is the automatic stations which will most likely prove the more interesting. Each of these is equipped with a transformer of 50 or 100 kw., a set of balancers worked by a time-switch, and a distance operated single-pole L.T. circuit-breaker. The only H.T. apparatus is the short-circuiter and a pair of switch fuses for isolating purposes. The Molesey station differs in that it has a 600 ampere-hour battery and a small L.T. switchboard, but it is so arranged that it is worked automatically with the battery floating. A man cycles out every morning to put the battery on charge, and again in the afternoon to take it off. The other stations are visited only about two or three times a week.

The regulation of these stations is done from the central by means of the line resistance, and for starting up, etc., a five-core ·008 armoured pilot cable is run back from each. (Fig. 2, sub-station arrangement). Coming to the method of connection, it will be seen from Fig. 2 that the actuating solenoid of the L.T. auto is connected from the opposite pole of the transformer and through to the "firing switch" at the central. From the firing switch another line is run back to the transformer side of the auto. Being on this side is important, as, were it on the other side, the switch could be operated whether the machine was running or not. As it is, when the machine is shut down there is no potential across the firing switch. This same line also serves for the paralleling voltmeter, whilst for the other side of this meter another line is taken from the busbar side of the auto. Across these lines the electrostatic pilot voltmeters are connected, the fourth line in the cable serving for their neutral and the fifth for the telephone.

Some operating Troubles.—Taking the sub-stations first, the most frequent cause of trouble has been the H.T. brushes. These, as has been explained before, are copper, and when the commutator gets rough they have to be literally soaked with oil to prevent them wearing down between visits. Sometimes, too, they slip. Except for burning up the brush-holders, this never does any actual damage, and it is amusing to note that invariably the first intimation of such a state of affairs is received from a policeman, hastily despatched by the alarmed residents in the neighbourhood. So far as the actual damage is concerned, the oil pumps and the L.T. autos have been the worst offenders. The weakness in the oil pumps is a sight-glass fitted on the pipe leading into the bearing cap. These glasses occasionally crack, the oil is pumped out on to the floor, and central is probably notified by the breakers coming out through the shaft seizing. Coming to the switches, it is necessary to first give a description of their action. The solenoid plunger operates the switch through a ratchet and pawl arrangement. When thrown in the switch is held by contact friction, the exciting current is broken, and the plunger falls back to its original position. Next time the solenoid is excited the switch is pulled out, and so on alternately. The trouble is the pawl springs. These are only light spirals, and often break. When this happens the switch is only partly thrown in—to be exact, just into the carbon ends. Naturally, in a short time the switch resembles an arc light, and, unless the operator notices the jumpy, or falling load, he is not aware of anything untoward until the policeman arrives or the switch burns out.

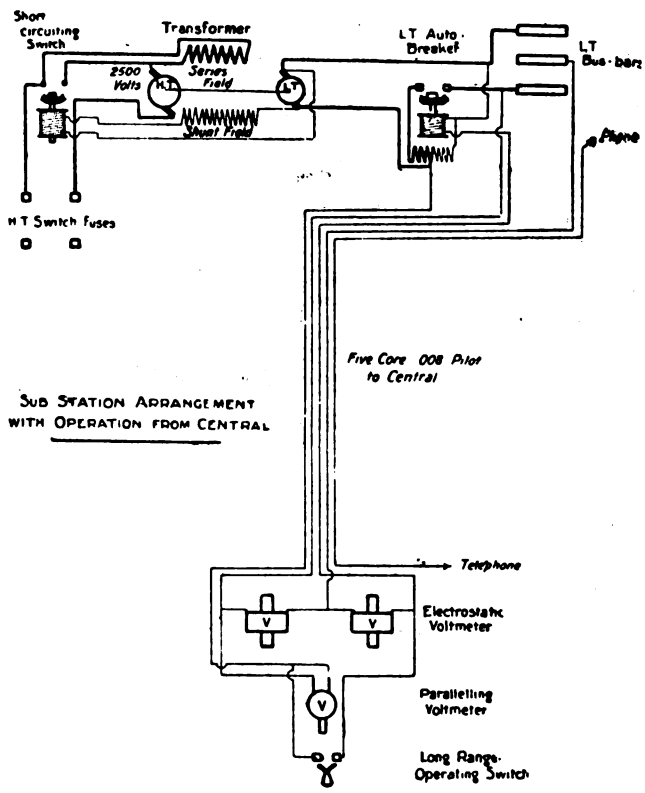

FIG. 2.

Then there are the short-circuiting switches. These are designed to fall out by gravity when the machine is shut down, but occasionally they will stick up, and then the machine cannot be started until someone is sent down to pull it out. Another peculiarity of these switches is sometimes in evidence on starting up. If the pressure is higher than usual, or the starting resistance is cut out too quickly, the inductive effect set up by the series field is so considerable that a surge is started in the shunt, and the short-circuiting switch is thrown violently in and out for 20, or perhaps 30, times before the machine begins to revolve.

There are six transformers installed, and whilst being subjected to all manner of strain through short circuits, etc., they have never been known to flash over. This may be due to the copper brushes. The chief trouble found with them is in the armatures and series coils. The latter, unless kept scrupulously free from copper dust, are liable to break down to earth. So far the system is not grounded on one side, and on one occasion the series field of an outlying transformer broke down to earth when the other side of the system was grounded in one of the generator ammeters. The writer's head was about three feet from the ammeter when it went, and the resultant display has founded a lasting impression.

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There is one transformer in particular which seems to have an unfortunate penchant for discharging across the field air gap. The armature has been twice burnt out, probably through this, and the last time it was re-wound it discharged so badly that it could not be run. There was a continuous stream of sparks right along the armature tunnel. It was found that the only measure to stop it was a coat of insulating paint on the pole-pieces. A standing menace which has been active on one occasion is the danger of losing the shunt-field. This has been provided for in so much that it is made fool-proof by dispensing with lifting attachment on the L.T. brushes. What is likely to happen if the field is faulty was seen on the home transformer on the first starting up of the plant. Somehow a faulty connection in the shunt-field circuit was overlooked, and when the current was switched on the machine built up in speed until the binders burst. An idea of the speed atatined may be gathered from the fact that when the current was switched off the armature took well over five minutes to come to rest. Pieces of the *debris* were found on top of the crane.

A serious drawback to these transformers presents itselt in time of mains trouble. The L.T. network pressure is 480 volts, and, in time of a bad short-circuit, this may fall as low as three, or even two hundred, volts. The transformers will not come down as low as this, and to switch them in at, sani 00 volts is simply to throw the breakers out. The only way is to catch them speeding up, but then the series field is not cut out. Once, in very desperate straits through a dead short on a ·5 feeder, a transformer was switched in in this manner as a last resource, in the hope that the short-circuiting switch would act on load. But the hope was misplaced. In five minutes the machine was on fire, and the fire brigade was down squirting chemical extinguishers over it.

Coming now to the generators, as has been previously stated, the chief trouble is in commutation. This remark must not be misunderstood, for, when everything else is right, the commutation leaves nothing to be desired. But it is when there is outside trouble that the generators behave badly. A transformer burning out, or a short circuit on the mains, and sometimes even a big jump in the load, will cause them to flash over. Beyond burning off a belt or pitting the commutator, no harm is done to the machines. But it is awkward in other ways, for if two machines were running in parallel, and one went, undoubtedly the other would go too. As was remarked earlier, it is the intention in the future to run it as a three-wire system, with two machines in series, and if ever that is tried the results will be very interesting.

The switchboard has not so far given any trouble, except for voltmeter panel blowing out. At first there was a little difficulty in breaking the shunt-field current. The switches are single pole, and threw a high resistance across the shunt when breaking. They are enclosed in an iron frame, and the arc on breaking would sometimes ground the L.T. system. Finally, after an operator's arm had been burnt, they were enclosed in asbestos boxes.

Summing up, the most inefficient part of the system is in the method of regulation. When, as is nearly always the case, one station is taking a comparatively heavy load, then the H.T. pressure must be run 100 or 200 volts higher than would suffice for the other stations. Consequently, this energy has to be absorbed in the regulating rheostats, and entails a very serious loss. Apart from this, the transformer efficiencies are very high.

Finally, a word on the mains. These are, of course, in all cases underground, and, except for the troubles before referred to, due to the surging, there was only one fault developed on the H.T. system in five years. The cables are ·5 two-conductor concentric, paper insulated, with lead sheath and outer steel wire armouring. The method of laying is to draw them into earthenware conduits. They cannot be spoken too highly of.

Perhaps, though it is foreign to the paper, a few concluding remarks on the L.T. system of mains will be allowed. The experience with these has been so remarkable that it is felt to be justified, and, as underground mains seem destined to come on the tapis here sooner or later, it may prove of interest.

The L.T. mains are of what is known as the solid system. The cables are coated with vulcanized bitumen, the only other protection being a covering of thick braid. They are laid in wooden troughs, supported on wooden bridges the troughs then filled solid with bitumen, and a layer of tiles put on top.

These mains have been an endless source of trouble. The troughing rots, the bitumen cracks, and the water gets through to the cables. Sometimes a "short" will burn away as much as 50 ft. of cable. But the most remarkable thing is that the mains have been opened up and not a vestige of copper found for as much as 18 ft., yet at the same time a motor has been working beyond the break.

There have been as many as three breakdowns in a day, and for a year the average mains faults have not been less than four a week.

METHODS AND PRACTICE IN THE GERMAN ELECTRICAL INDUSTRY.

By L. J. LEPINE and A. R. STELLING.

DISCUSSION

FINANCING CONTRACTS.

Mr. J. S. Peck (British Westinghouse).—The financial relations between the banks and electrical manufacturers in Germany is of enormous value to the works. In England many important contracts are lost to foreigners simply because English firms had not sufficient financial backing. There was formerly a somewhat similar arrangement to the German in America. The old Edison Co. financed many supply stations, and these had turned out very prosperous. He had recently been through some of the shops mentioned, and found that at the A. E. G. three shifts a day of 8 hours each were being worked. This continuous working was of great benefit to in reducing standing charges. He did not think the German workman so careful as his English brother. One of the German managing directors of the works he had visited was much impressed by the British workmanship he had seen, and thought our finish was too good, and that we could not make it pay at the price. Before the electrical industry in this country could be prosperous, combination between the firms was necessary, and he would like to see this.

FINANCING AND PIECE WORK.

Mr. T. L. Miller.—Their foreign arrangements and financial methods were the great causes of Germany's success. British design was quite as good. While we employ only commercial managers at banks, foreign firms have also technical staffs on the spot, who are able to advise the customer. Continental firms can afford to take greater financial risks in giving quotations and installing work.

The "Kollonen" system of piece work is not new here. Shipbuilding trade has used it. In one firm, a man contracts with the firm to build a ship through for a stated price, employing the necessary men and doing the work to time. Very rarely is there any trouble through the price being too low. Its advantages are that the firm know exactly what it will cost, and the men work to make a profit for themselves. The shops and drawing office ought to be in very close connection, and he thought the draughtsman should not only be in touch with the shop, but also with the costs and estimating. Only by this means could the results of previous experience be satisfactorily employed. At Bellis & Morcoms' works they have an ideal system in operation. There are four committees, which consider every design got out: (1) the Designs Committee, (2) the Works Committee, (3) the Costs Committee, and (4) the Sales Committee. A design proceeds from one to the other, and when the whole have reported on it, final arrangements to give the most satisfaction to all concerned are made. Some members serve on all the four committees, but the majority of the men on each are drawn from the departments suggested by the titles. This has been found very successful.

COMPETITION, RATE OF OUTPUT, AND REGULATIONS.

Mr. K. M. Faye-Hansen.—He had had practical working experience in both England and Germany, and as a foreigner in both. He agreed with much and disagreed with much in the paper. While there were practically only four large firms as stated, there were many smaller ones with £100,000

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to £1,000,000 capital. It was the competition of these smaller firms which saved the large combines from Trust stagnation. There was not so much sub-division of work as method in doing it. In his opinion, the British workman does not work up to his full capacity, and so costs are increased here. He instanced saving where some great rush order had to be got out quickly and overtime was worked. The labour costs for such work came out less than standard, even allowing for increased rate of overtime pay. German skilled labour rates were higher than given in the paper, and were about the same as ours. The German firms were as willing to depart from their standard designs, if pressed, as we are, but the requirements were much more uniform, and so special work was not so common. He thought there was, as a rule, quite 5% increase in cost in meeting consultants' little fads. Our Board of Trade regulations were also very severe, much more so than anything in Germany, and kept our development back.

DISCIPLINE AND OUTPUT.

Mr. H. W. Wilson.—Seven or eight years ago he made a tour of the German works, and was impressed by the exceedingly good discipline, and by the small amount of work done per man. At that time, fitters got 35 marks, which corresponded then to our rate. Female labour was dearer than here. The German firms then reckoned to employ the technical man to every 10 workmen. The technical men's pay was very bad, but the costs must be greater than here, even so. They have larger outputs from their works, and so smaller standing charges.

THREE CAUSES OF SUCCESS.

Dr. H. F. Bowman.—He had visited the German works and must confess that, although he saw many interesting things, he came back with a poorer opinion of German machinery than he had going. He thought the three great causes of Germany's success were: (1) Their sales departments were better than here, (2) the greater banking facilities, (3) the longer hours worked. As a practical banker, he could tell them that, although the German banks were very useful to trade, their security was not great, and Germany's credit to-day was not much better than the city of Manchester's, let alone England's. Their workshops were better organised, and he noticed the effect of the military training in the discipline of the men and in the way they worked together on one piece of work. There was, however, much slipshod work, and on complaining of some very poor work, was told it "was only for export." The best work stays in the country. Their machine tools were not so up-to-date as ours, but they got more work done.

GOOD CARBONS.

He went on to say that English firms were slow to take advantage of new knowledge. The Morgan Crucible Co. in London have published a set of curves relating to their carbon brushes. This is the only reliable information available on this subject, and the German firms take over 1,000,000 brushes every year from them, while English firms have hardly considered the matter. The contract system was unfair to the employés, and lead to sweating. He saw some automatic machines in Germany, and was told the attendant got 42s. per week, but looked after six machines. He knew a place in England where machines of exactly the same type, employed on the same work, were tended by a 28s. man, who, however, was only allowed to take two machines. The Germans paid 7s. a week per machine, and the English 14s., and only got about the same amount of work.

DIRECT CURRENT AND INDUCTION MOTOR DESIGNS.

Mr. W. Cramp.—In the direct current design data the formula $\frac{\text{Total active iron}}{\text{Total active copper}}$ would not lead to the curves given, but to a set in which the curves crossed twice. It would have been better if the curves had been taken from the net effective material weights. Regarding induction motor design, it had recently been recognised that the self-induction of the end wedges was very much greater than had been supposed, and since had lead to long rotors of small diameter, which were found to give much better power factors than the short rotors could give.

IGNORANCE MEANS LACK OF CAPITAL.

Mr. D. Adamson.—He thought the difficulty of getting capital for the electrical industry was largely because the public did not understand electrical matters, and regarded them with a certain amount of suspicion. The Institution might be well advised in laying such interesting facts before the public as would inspire their confidence in electrical work. In other industries capital could easily be got. It was always easy to get money to put up new cotton mills, because every one understood something about the cotton trade, and saw the possibilities in it. In the same way, when people understood the prospects in the electrical business, there would be no difficulty in getting the necessary financial backing to push forward important developments.

TECHNICAL SALESMEN.

Mr. T. H. M. Swinburne.—The technical staffs at branch sales offices were important. When German firms opened a branch here, they at first employed British engineers, but when they were established, they brought in Germans instead.

COMBINATION AND FINANCING.

Mr. A. R. Stelling (in reply).—Their object had been to raise a discussion, and they had done this. British firms must combine to get work. While the English electrical firms had no money to open large showrooms abroad and employ a staff of engineers on the spot, much might be done by combining in the possession of a common showroom and staff, with other interests. In some firms two men sign all letters, one a technical man, and the other a commercial man, so that both sides are satisfied as to arrangements. In reply to Mr. Watson, each of the small communes has a large measure of self-government, and has power to borrow money on communal bonds (subject to getting the Government's permission). The banks and the firms advance money on these bonds, and it is, therefore, in the interests of the bank and the firm to see that the supply system is efficiently worked. The arrangement ensures to the public the combined advantages of a municipal and a private company's supply.

MELVILLE-MACALPINE REDUCTION GEAR.

Mention is made in our American Notes of a new invention due to Rear-Admiral Melville and Mr. Macalpine, and we give below some further particulars, as well as comments, from *The Electrical Review* and *Western Electrician* of Chicago:—

In spite of the present development of the marine steam turbine, it is nevertheless true that the greatest possible advantage is not made of this prime mover in present day marine practice. The reason of this lies in the fact that the steam turbine operates at its best efficiency only when running at a high speed, whereas the propeller that it has to drive must be operated at a much lower speed in order to obtain the best results. The consequence is that neither of these component units can be worked at its maximum efficiency, for a compromise speed, too low for the one and too high for the other, must be employed, inasmuch as hitherto it has been impossible to employ a speed-reduction gear which is capable of withstanding the enormous stresses to which it must be subjected in the transmission of a great horse-power and at the same time have of itself an efficiency which would not more than offset its other advantages.

A solution of this problem has now been offered through the instrumentality of George Westinghouse, the head of the great mechanical and electrical companies that bear his name.

At Mr. Westinghouse's suggestion, and with the immense resources of the Westinghouse works at their disposal, Rear-Admiral George W. Melville, ex-Engineer in Chief of the United States Navy, and John H. Macalpine, a well-known consulting engineer, have invented and constructed a speed-reduction gear by which it is possible to couple together the turbine and propeller shafts so that each may revolve at its critical speed of maximum efficiency. This gear has been tested by a specially designed 6,000 h.p. hydraulic absorption dynamometer at the Westinghouse works for a period of 40 hours of continuous running, and the remarkable efficiency of over 98·5 % was attained, this while the driving turbine was running at 1,500 revolutions a minute with a reduction to 300 revolutions at the dynamometer end (representing the ship's propeller).

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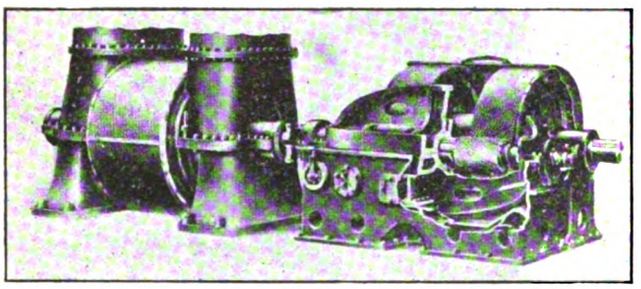
When this performance is compared with a statement made by President Denny in his inaugural address to the Institution of Marine Engineers in Great Britain on October 5, 1908, it will be apparent that a revolution in the design of steamship machinery is imminent. Mr. Denny said in this address: "It has frequently been suggested that if some inspired engineer would evolve a system of gearing that would be lasting and reliable, not too noisy, and would not absorb in friction more than, say, 10% of the power turbine engines would be capable of application to any speed of vessel, and to any size of propeller; you would then have a high-speed turbine and a low-speed propeller, which is the ideal condition for marine propulsion."

The Melville and Macalpine reduction gear absorbs but one-seventh of the power proposed by Mr. Denny as a loss reconcilable with efficient working conditions.

The accompanying illustration of the reduction gear connected to a Westinghouse turbine gives a good idea of the device, part of the frame and casing being broken away in the view to expose the interior.

The teeth of the gears are helical to permit of noiseless running, and end thrust is eliminated by reversing the pitch of the gear wheels of the opposite halves of the mechanism. In order to reduce pressure on the teeth to



the minimum required by good engineering practice, and at the same time keep down the size of the teeth to insure the best possible running conditions, the width of the gears had to be made very large, as can be seen from the illustration. Wear on the teeth is equalized by introducing an additional cog, technically called a "hunting cog," in each of the larger gears; that is, one more cog than is necessary for an obsolutely integral speed reduction is used, which, while hardly affecting the velocity rates to an appreciable degree, insures that each cog of one wheel will come in contact at definitely recurring intervals with each and every cog of the gearing wheel.

The smaller gear or pinion is mounted in what the inventors call a "floating frame," and this is the real feature of the invention, that makes possible the remarkable efficiency and durability attained in the test.

This floating frame is a heavy steel casting supported only at a single point midway between the bearings. The support is flexible so that the frame is free to oscillate in a vertical plane passing through the axis of the pinion, but is held securely against motion in any other direction. Furthermore, the pinion is free to move endwise in its bearings. Any tendency of the teeth to bear harder at one end of the gear than the other would tend to unbalance the respective end thrusts due to the right and left hand spirals of the teeth; but as the pinion cannot present any resistance to unbalanced end thrust, it constantly adjusts itself in the direction of its axis to the position corresponding to equilibrium between the opposing forces. This means that the tooth contact pressures are always automatically equalized.

Mr. Westinghouse states in a letter over his own signature, that the machinery described and illustrated herewith, "while costing less and weighing only about one-half as much as the turbine machinery successfully used on British vessels, will effect not only a great economy in fuel, but will also permit of much higher speeds in cases of emergencies. Were the United States Government," he says, "to apply this type of marine turbine to the large 26,000-ton battleships for which contracts have only just been let, we could have the fastest battleships yet projected by any nation."

A NOVEL 2,000 kw. GENERATOR.

The Packard Motor Car Co., of Detroit, have recently laid down a 2,000 kw. generator, which possesses certain special features. *The Electrical World*, in describing the plant, says that the chief item is this 2,000 kw. direct-current Hawthorne generator, which is direct driven by a Cooper horizontal cross-compound engine. The unusual feature about this generator was the fact that the question of shipment was the chief factor of its design. The whole generator was shipped practically in pieces and assembled at the plant. The frame was 22 ft. 1 in. in diameter, weighing 24 tons, so that one-half of the frame when loaded on the car for shipment stood a little over the railroad limits for clearing. In order to ship the frame, therefore, special arrangements had to be made with the railroads between the shipping point at the Hawthorne works of the Western Electric Co. and the works of the Motor Car Co. at Detroit.

Another special feature was the dividing of the armature centre or spider, and the bolting and keying of it on the engine shaft in a manner similar to the usual method of flywheel installation. The armature core laminations, after punching and japanning at the factory, were packed in boxes, and stacked to form the core after the spider was mounted on the shaft at the plant.

The commutator presented the most difficult problem. While the commutator proper is but 10 ft. 4 in. in diameter, the diameter over the tangs is practically the same as that of the armature, namely, 15 ft. 6 in. It was necessary, therefore, to split it. To divide and send thus divided this annular ring, built up of 816 copper and an equal number of mica segments, was a very undesirable proposition, but it was done successfully. An accompanying illustration shows the generator just after the commutator was placed on the shaft. The ring around it was used to tighten it as much as possible. As soon as the windings were all in place the motor was run with a weak field, separately excited, and short-circuited. By this process the commutator was thoroughly baked. While still hot, all the cap screws were brought up as tightly as possible. The commutator was then turned down and trued for operation.

For several weeks previous the Packard officials had planned a banquet on October 8 in the engine-room to celebrate the completion of the installation. As a result, the Western Electric Co.'s installers were so rushed to complete the work, that no preliminary testing, except for a few minutes to determine the polarity and make tests for brush position, could be made. The work of connecting up was completed but six hours before the banquet was served, yet when President Joy threw full load on the generator his guests saw it carry a load without a spark and without further adjustment.

YORKSHIRE ELECTRIC POWER CO.

NEW FINANCIAL ARRANGEMENTS.

A Bill to confer further powers upon the Yorkshire Electric Power Co. has been deposited for introduction into Parliament next Session. The Bill proposes to empower the company to issue Preference shares to the extent of one-half of the capital, provided that the nominal amount of Preference shares shall not at any time exceed the nominal amount of ordinary capital at the time issued and fully paid. The Bill also provides for the issue of a separate class of shares and the allocation to any such class of "so much of the profits of the company as may be derived from any specified portion, or portions, of the undertaking." Power is also sought to raise "the remaining capital as additional capital," and to pay a commission of 7½% "for underwriting or procuring subscriptions for any shares in the company." The Bill also makes provision to enable the company to subscribe for shares in other companies to whom they may be giving electrical energy in bulk, provided that the sum so invested shall not exceed £100,000.

MUNICIPAL AND COUNTY CLUB.—The Right Hon. the Lord Mayor of London, Sir John Knill, Bart., will be the guest of the evening at a house dinner to be held at the Municipal and County Club on January 17 next.

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Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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CONTENTS.

	PAGE
Notes	903
Electricity in America ..	904
Point Controllers for Electric Tramways ..	905
A 2,750 Direct Current System	908
Methods and Practice in the German Electrical Industry	910
Melville-Macalpine Reduction Gear	911
A Novel 2,000 kw. Generator	912
Yorkshire Electric Power Co.	912
The Needs of Small Towns	913
Correspondence	914
Apprenticeship for Telephone Engineers ..	915
Tesla on Radio-Telegraphy	916
Continental Subterranean Goods Railway ..	916
Adjustable Screen Photometer Head	917
Holophane Globes and Reflectors	918
Estimate for Arc Lamp Installations..	918
New Year Souvenirs ..	918
Technical Problems, with Solutions by Practical Men	919
Tyneside Notes	921
Midland Notes	921
Lancashire Notes	922
American Notes	923
Electrical Installation in Italy	925
Lighting & General Notes	926
Traction Notes	926
Companies' Meetings and Reports	926
Companies Registered ..	927
Patents	927

THE NEEDS OF SMALL TOWNS.

It is good augury when we find such a paper as that of Mr. W. A. Ker on continuous current boosters and balancers, read before the Glasgow Section of the Institution of Electrical Engineers, followed by a large and interested audience. For Mr. Ker's lecture was concerned with the needs of small towns, and that shows how steadily the adoption of electricity is spreading. The more closely we study the economic side of such small installations, the better it will be for the industry and the public. Mr. Ker set himself to consider first of all small towns with a two-wire system. He pointed out that in a large majority of such cases the generating station was placed close to a railway siding, or on the banks of a canal, in some situation where land was cheap and facilities existed for getting coal without much handling. That usually meant that the station was at a distance from the consumers, which rendered the provision of a feeder or feeders necessary. Now, under these circumstances, if the growth that all pioneers looked for came about, measures had to be taken to equalise pressure all along the system. The usual method was to lead a two-wire feeder to the mid-point of the network and supply the network from that point, in which case the original two-wire line could be used as second feeder or be disconnected. If disconnection is adopted, it is possible to regulate the voltage at the feeder point by shunt regulation of the dynamo. But, as Mr. Ker pointed out, when such regulation becomes necessary it is usually the case that a second and perhaps a third dynamo has had to be laid down. If this is so, then it is better practice to put in a booster to compensate for the drop in the feeder and to keep the busbar voltage constant. Such a booster might consist of a single shunt or a series-wound generator, and could be driven by an electric motor or engine as local conditions dictated. Excellent as are the single-shunt machines, Mr. Ker argued that they were unsuit-

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able for small town service, as it was difficult to secure satisfactory and economical hand-regulation, especially as in these cases there was nearly always unsteadiness of load; so the series-wound booster, requiring no hand regulation, was to be preferred. It is a cheap form of booster and acts capitally, except when there is more than one feeder, when special precautions have to be taken. One method is to use double two-wire series boosters, a small one on the positive and another small one on the negative side. But it is essential that they should work equally, because if one slightly over-compensated for the drop in the feeder, it would gradually absorb the greater part or the whole of the load. In a three-wire system, having regard to the fact that it is impossible to adjust the consumers' demands on each side to produce an exact balance, a balancer becomes necessary, which not only provides a path for the current in the neutral wire, but is actually a means of balancing when a sudden demand is made either on the positive or negative side. It is, therefore, an aid to smooth working and to economy, especially if the excitation arrangement is obtained by cross-connecting the fields. Moreover, by placing the balancer at the network there results a saving of the copper in the neutral from the station to that point, and a saving as regards the drop in the long neutral, which would be inevitable where there was an out-of-balance current. Mr. Ker, however, seems to think that these gains scarcely compensate for the drawbacks of having working machinery away from the station, and so he inclines towards the policy of placing the balancer at the generating station itself with double-series boosters, or better still, with treble three-wire boosters. In towns where there is a fairly equal density of population and demand, Mr. Ker favours a system of using one booster for two or more feeders. In such a case, at times of light load the group of feeders is supplied direct from the station busbars, the balancer dealing with the drop in the neutral. It is only when the load has reached a given amount that the booster, consisting of two generators, one positive and one negative, is switched on to the circuit, but it is necessary to take measures to prevent the flicker which would result in the lamps, and therefore a potentiometer has to be utilised. This does not give true automatic action, but it has the advantage of making the use of small boosters possible, and of keeping the generator at or near full load all the time. It will be seen from this necessarily rapid survey of a paper packed full of information, that Mr. Ker advocates close study of local conditions and the intelligent use of appliances of precision, for he holds that a wise expenditure of capital conduces not only to efficiency but economy of running charges.

TRADE NOTES.

The Calcutta Electric Supply Corporation, Ltd., delivered 581,567 units to consumers during the four weeks ended November 26, 1909, compared with 358,911 units in the corresponding four weeks of 1908.

Messrs. Feld Bros. & Co., Ltd., announce that Messrs. Watson & Wyte, of 19, Waterloo-street, Glasgow, have taken over the agency for their new "Portable Electric Circular Saws" for Glasgow and district.

CORRESPONDENCE.

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The Editor is not responsible for, nor does he necessarily endorse, opinions advanced by correspondents.

METHODS AND PRACTICE IN THE GERMAN ELECTRICAL INDUSTRY.

Sir,—I received last week an invitation to be present at the Institution meeting, where the paper of Messrs. Lepine and Stelling was discussed. I declined that invitation on the ground that I did not think I could possibly discuss such a paper without contravening the rules of the Institution, which, I believe, preclude political opinions. A perusal of the reports available shows me that I need have had no such fear, and as I do not find my point of view exactly expressed in the discussion as reported, I should esteem it a favour if you would grant me the space necessary for such expression in your paper.

Messrs. Lepine and Stelling's paper sets up a comparison between Germany and this country, apparently to the disadvantage of this country, and offers as a reason the lack of enterprise of the English financiers and commercial leaders, saying: "If they were as enterprising and as successful as their German rivals, English manufacturers, supported as they are by the superiority of their products, would not have to fear German competition in the open market." That, in my opinion, is entirely untrue. The question is: "Why are they not?" If it is admitted that our work technically is better than the German, how is it that the English financiers and commercial leaders fall so far behind their technical advisers? That Germany is ahead of us no one who is content to judge by results can deny. A country supporting four or five electrical companies, to say nothing of the numerous smaller ones, aggregating in capital some £20,000,000 sterling and paying from 8 to 18% on such capital, is far ahead of us. That we are unable to even mildly imitate this is due to our fiscal policy, which began to act to our detriment at the very moment it was introduced.

As Mr. Rich very truly remarked in the discussion, "A financial artillery duel precedes all technical arrangements." If the electrical industry is to advance in this country, the very first essential is that profit should be made in order that more money may be found.

The reason why money is so readily forthcoming for industrials in the leading protected countries is that they start off with a certain market. Another reason—the essential difference between England and Germany—is that the vast wealth of England has been made. It is, consequently, in the hands of the most conservative class; the people who are looking for safe investments and not industrial speculations. Wealth under these conditions can go on increasing, and possibly does increase, as claimed by our Free Trade friends. In the younger countries, however, the wealth is in the process of making, is consequently being handled by those who are making it, which means the younger generation, which means industrial speculation. The term "industrial speculation" contains within it all the experimental work and commercial pioneer work which is so necessary to keep the engineering science and the engineering trade of the country in the forefront.

To come back to my point, if England—a country importing 250 millions annually more than its exports—were making money instead of living to a very large extent upon its income, income which is spent abroad, while our unemployed, to our lasting shame, are increasing every day, we should be doing all that the Germans are doing, all that the Americans are doing, and, in my humble but convinced opinion, a little more. All that we want is a fair chance, and I am satisfied that we shall maintain the position which we have not yet lost, although it is being rapidly undermined.

Yours faithfully,

A. B. Anderson.

Ferranti, Ltd., Electrical and
General Engineers, Hollinwood,
Lancashire, December 24, 1909.

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LIGHTNING CONDUCTORS.

SIR,—I have read with great interest a letter in your issue of October 8, from the pen of Mr. Alfred Hands, on the subject of Lightning Conductors and sharp bends. As a contribution to the discussion, I would refer to the following case: In the year 1890 a violent thunderstorm burst over Brisbane, a discharge of lightning of great violence taking place over the Wesleyan Church, where it struck the finial and passed harmlessly down the lightning conductor until it reached the place where the copper tape was bound around the parapet. Here it pierced the work as though making a short cut through from one part of the lightning conductor to another. I can vouch with accuracy on this statement, as I took care to go and investigate the matter myself.

Yours, etc.,
EDWARD C. BARTON,
Consulting Engineer.

New Zealand Insurance Building,
Queen-street, Brisbane,
November 16, 1909.

ELECTRICAL PROPULSION OF INTERNAL COMBUSTION ENGINED SHIPS.

Sir,—The letter that appeared in your issue of the 24th inst., bristles with points of great interest to all those engaged on the problem of cheap power production for main marine propulsion, by means of internal combustion engines, and Mr. Stewart's remarks as to being in a position to construct gas producing plant from bituminous coal, will be received with great interest.

Many attempts have been made to bring this matter to a successful issue and many claims have been made to have achieved this object, and if Mr. Stewart has really brought out a plant that will use this cheaper coal, in the event of the general adoption of electrical driving of propellers, and by which means the successful application of the internal combustion engine can only be made in such large power that is required for cargo boats, etc., then there should be a very large demand for this type of producer.

The usual excuse, and the only one with any sort of argument, *i.e.*, that if suction gas engines were used for general power production on ships, that difficulties would appear in getting the right kind of coal at foreign ports would disappear, and this news will certainly assist in the ultimately successful application of Electrical Power for driving ships, where internal combustion engines are proposed as the prime-movers, provided that the space occupied by such plant is not excessive, and all other things being equal, this bituminous coal gas producing plant should be welcome.

Yours faithfully,
WILLIAM P. DURTNALL,
M.I.Mar.E., M.I.Auto.E.

"Electra," Marine-parade,
Herne Bay, Kent.
December 28th, 1909.

APPRENTICESHIP COURSE FOR TELEPHONE ENGINEERS.

By VOLNEY D. COUSINS.

In view of the recent discussions on the question of apprenticeship, the following abstract of a paper presented at the 1909 Convention of the International Independent Telephone Association is typical:—

Mr. ousins said that the graduate of a technical school, on entering the operating field, finds many diverse conditions. Undecided as to his proper sphere, not knowing wherein he will best fit, he becomes discouraged. Some men rise above the barriers and succeed in making places for themselves. However, we cannot help but believe that some of the failures were capable of becoming at least fairly capable engineers. Many of the graduates of engineering schools come to their employers without having done a day's practical work. They are theorists, but not of the hopeless variety. You are all desirousof getting brainy workmen and trained executives, yet how many endeavour to educate your employés? Your resources are few, your laboratories scarce, and your time is valuable. The technical schools endeavour to relieve you of this duty. They train the youth of this country to think. It is your duty to train them to *do*. To attempt the instruction of telephone work and telephone engineering in a four-year course would be to fail. We, therefore, try to give the men a good foundation in principles and design; leaving the moulding and the finishing to the field. You need these men and they need you.

Some of the graduates come originally from the farm; others from the city. All come from that great middle class, of which this nation boasts. Some have done practical work in the telephone field, and have held responsible positions with the various companies prior to entering college. Others have failed to enter the field previous to graduation. The time of practical experience of graduates ranges between zero and five years.

From a motley group of applicants you are expected to select your future employés. Much of the economy of plant operation will depend on the grade of men you secure. What is better than an apprenticeship course to weed out the bluffer, the sloth, or the undesirable? The largest of the manufacturing companies have instituted courses, and consider them paying investments. You can line up your own men and learn their true value. You can select the man for the position and prepare him for it.

The proper kind of apprenticeship course to inaugurate in a company will vary with its size and organization. No set course should be followed by every student; nor should all men be treated alike. No man should be kept at one thing until it becomes distasteful. In an educational institution instruction to individuals and elective courses are impossible; but in an industry this does not hold true. Some engineering schools maintain a separate course in telephony. The graduate of the electrical engineering course who enters the telephone field must learn the principles before he can enter into the spirit of the work. The apprenticeship course should provide him with facilities for doing so. A graduate in telephone engineering is equipped for immediate practical work, and would require less time to complete the course.

The course should not be a dead expense to the company. Let the men learn while actually doing work. The students should be carried through the course as rapidly as their progress permits. Their time should be divided among all departments, and a record kept of their ability in every line of work. A student, generally, makes his best grade in the subject he favours.

The following course may be followed with more or less success subject, however to changes in the order and the addition of other branches:

a. Installer.
b. Switchboard helper.
c. Repairman.
d. Tester.
e. Draftsman, statistician, and traffic clerk.
f. Line foreman.
g. Engineering department.
h. Permanent position.

This is a mere skeleton outline, and is offered as a suggestion. The apprentice should stay in each branch of work until he has shown his ability. A failure in one branch should not disqualify him. A failure in several branches will usually relieve you of the burden of dismissing him. When a man applies for a poistion and claims he has done this and that, send him out as an apprentice and call his bluff, if he has made one. By all means make your course flexible. The telephone course of the Western Electric Co. usually gets inexperienced men chiefly because it offers no premium to those who have had practical experience. I know of one instance where the above company employed a switchboard wireman for two years. Lately this man graduated from a technical school and applied for credit in the apprenticeship course for the work he had done. The iron clad rule could not be set aside, and they lost a good man.

The apprentice should be paid at the start more than he is worth, otherwise he may starve to death. No fixed wage scale should obtain at the start, as you may frighten away some good men, as was shown in the incident mentioned. As the men acquire skill and show that they can earn more, pay them accordingly. When a man desires to leave the course and seek a prominent position in your employ,

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pay him the scale for that class of work. When you desire a man to resign, keep him on one class of work at a low rate of pay.

A word is not out of place as to the number of apprentices a company should employ. The safest plan to follow is to avoid preparing too many executives. When a company employs a greater number of apprentices than it needs, the scale of wages must be low for economy, and the grade of men lower. Prepare only a few more men than you need; and, if you cannot satisfy their ambitions, trade them to the neighbouring independent companies. Let the apprentices be handled from the main office; let their fate not rest in the hands of the department heads, for prejudice is inevitable. Do not exclude the practical telephone applicant from the course. Let the two classes go hand in hand. The best one will win out.

If the cost of operation and maintenance is to be reduced, much of it must come from the employment of more skilled men. A few such will do your work better and at less total cost than the many less able men, who would be needed in their place. In closing, I wish to prophesy on the future need of the technical men. To properly lay out a plant and study its development requires an engineer. Small companies cannot afford this luxury. An effort should, therefore, be made to unite the smaller companies, at least through a combination of brains. Several companies, paying a proportionate share of the expense, could well afford to employ a fairly good engineer, to whom they could submit their problems. Such combinations must, unquestionably, result in greater economy.

TESLA ON RADIO-TELEGRAPHY.

Those of our readers who have perused the long and thoroughly "documented" lecture of Mr. Marconi will turn with added interest to the words of that other happy worker in the same field. Mr. Nikola Tesla, in an interview with a representative of the New York *Press*, discussed the subject of wireless transmission of electric power. He said that he has worked persistently on the wireless transmission of energy since 1893, when he presented a paper on that subject before the National Electric Light Association in St. Louis and the Franklin Institute in Philadelphia. The popular idea, he said, is that the wireless system of transmission is just one invention, but the fact is that it involves in its present state of perfection six fundamental discoveries, or inventions, in combination. They are as follows:—

First.—The method and apparatus for transforming ordinary currents into electrical oscillations of great intensity.

Second.—The apparatus for intensifying those vibrations immensely, so that they penetrate into the distance.

Third.—A receiving apparatus which collects and focuses energy which a transmitter supplies to a large territory. For instance, if such receiver, properly constructed, be placed in Ireland it will collect practically the entire energy conveyed to that country from the transmitter.

Fourth.—The method and apparatus for making the electrical impulses secret and non-interferable. That is to say, making it impossible to prevent their passage or to read them. The energy of the transmitter, which is collected by the receiver, only can be released by a sort of safety lock or combination.

Fifth.—The production of stationary waves. That is, waves which excite the entire earth and pass through it under a vibration much the same as though you were to draw a string tight and then strike it. With these waves the distance is absolutely eliminated, as the effects are the same whether the receiver is thousands of miles away or close to the transmitter.

Sixth.—A number of inventions which cannot very well be described in a short interview, but which go together to make the system practically operative.

With a plant constructed under the observance of these principles it will, he said, be just as easy to telephone from here to Melbourne, Australia, as across a room, and there will be absolutely no distortion of the voice, such as is observable now in communication by wire. This, he added, is not a theory, but a fact absolutely demonstrated by his experiments, which have shown that the current passes without loss over the entire extent of the globe and through the globe. He has carried the construction of such an installation very far and hopes to be able to complete its construction during the coming summer.

From that moment every telegraphic, telephonic as well as every wireless station will, he said, be ever so much more valuable, as they will be able to receive messages from any part of the world. As this will be done without the slightest change in the existing equipment.

"Will it be necessary, under your plan, Mr. Tesla, to build high towers on the shores of the countries using it, and also in interior points?" the inventor was asked.

As to large towers these, he said, are comparatively ineffective. The tower he has built near Port Jefferson, L.I., is only 187 ft. high, but the plant will produce an effect which can be pushed up to a rate of 1,000,000,000 h.p., which is more than all the wireless plants that have been put up so far altogether. This enormous activity is secured by the use of certain artifices on which he also bases a confidence that it will be possible to flash signals through interplanetary space.

Mr. Tesla added that his electric power inventions are not altogether his own, and that he has merely laid the foundation. Great work has been done in perfecting the devices by the staff of engineers of the Westinghouse and General Electric Companies, so that at present there are hundreds of millions invested in enterprises in which his alternating system forms the underlying foundation. This has harnessed 6,000,000 h.p. waterfalls.

There are probably enterprises aggregating 20,000,000 more under consideration. The enormous importance of this water power, or the so-called "white coal," can be understood readily when it is borne in mind that 1 h.p. for 24 hours is equivalent to the average performance of 24 men. Therefore, the 6,000,000 h.p. which has been harnessed have virtually added to the world's population from the point of view of labour 144,000,000 of working men, who consume no food and need no clothes.

As to power other than that derived from waterfalls, he was happy to say that in this direction also he has been successful, having perfected a new reversible gas turbine of ideal simplicity and beauty, which will permit the harnessing of the waste of the steel and iron furnaces, in which we now are losing in the United States not less than 50,000,000, h.p. Mr. Tesla added that he is just about to introduce that invention commercially.

As to his wireless system for the transmission of electric power, he said that if it had not been for unfortunate circumstances a plant of this kind would long ago have been in operation. Just one single plant of, say, 10,000 h.p., would be sufficient to drive several thousand flying machines, aeroplanes and dirigibles anywhere in the world. While supplying them with wireless power it also would keep them in constant touch with the earth by wireless telepone and telegraph.

Referring to interplanetary signals, he said he had in his experiments in Colorado discovered certain planetary disturbances, and attained with his transmitter activities which surpassed in power in many ways those of lightning. In his present plant he will be able to reach a rate of energy-delivery of about 1,000,000,000 h.p. A simple calculation will, he said, convince any expert that with such an intensity and energy reaching a certain area of the planet Mars, it is ample to produce a perceptible effect in a delicate instrument there.

In answer to a question as to return signals, he said he believed that these signals are being flashed now and waiting for us to answer.

CONTINENTAL SUBTERRANEAN GOODS RAILWAYS.

A company has been formed in Paris for constructing an electric subterranean goods railway in that city to be quite independent of the already existing passenger roads. The company has already come to an agreement with the Paris Municipality. This is, of course, a development as yet undreamed of in London, where goods and passenger traffic jostle each other in the heart of the city as if it were at the back of beyonds. Vienna has, however, successfully initiated a similar undertaking, and the Paris line is to be modelled on the Austrian prototype. The new railway is intended to carry goods only, and goods of all kinds not too big to get through the tunnels. If Vienna and Paris find it necessary to relieve the congestion of their open air traffic in this way, what about London?

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The Student's Guide to Knowledge.—*Chap. X.*

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R. MULLINEUX WALMSLEY, D.Sc.
Principal.

WANTED, by a young gentleman (aged 26) educated at Wellington College and having 4 years experience in shops of large Electrical Engineering firms and 3 years experience in the Drawing Office: an opening in a good Electrical Engineering firm where there is a chance of advancement. Present salary not of much consideration.—Address, Box G., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

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C. W. ROCHER,
Town Clerk.

Town Hall, Launceston,
November 16, 1909.

MISCELLANEOUS.

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DYNAMO (compound wound), Holme's patent "Castle," 110 volts, 80 amps., 1,000 r.p.m., 2 pole, 4 brushes, oil ring bearings.

DYNAMO (Mordey's), by Brush Engineering Co. 101. 5 volts, 20 amps., 1,500 r.p.m.

FAN (Ventilating). 4 blade air propellor, 4ft. in diameter. Arranged to run on shaft, and for fitting into wall, etc.

PUMP. No. 1 Pulsometer Boiler Feeder, suitable for supplying 10 h.p. Boiler. ½in. steam pipe, 1in. suction, ¾in. delivery. Price £4.

Address—S. H. P., c/o THE ELECTRICAL ENGINEER, 149, Fleet Street, E.C.

20—20 inter-communication telephones for sale, 10 wall type and 10 desk type, 15 of the G.E.C. Co.'s make, and 5 of the Stirling Telephone Co.'s make. In good condition, only reason for selling going on National Telephone System. Can be seen working at any time. Box D., c/o THE ELECTRICAL ENGINEER, 149, Fleet Street, E.C.

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RANIC
CONTROL GEAR
Adams Mfg. Co., Ltd., London & Bedford.

PLANT WANTED.

WANTED, on loan or to purchase, 100 H.P. MOTOR, at 1,700 r.p.m., 500 volts, continuous current.—Box No. 21, c/o ELECTRICAL ENGINEER.

WANTED, METALS, RUBBER, LAMP TOPS, MERCURY PLATINUM, FALSE TEETH, etc.—WASTE AGENCY, 2, Jackson Road, Holloway.

PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND CO., LTD., 44, Clerkenwell Road, London, E.C. N.B.—Platinum Sold.

Electrical Trades Employment Register.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions 2s. 6d.

SITUATIONS WANTED.

ELECTRICIAN.—Speciality—Armature Winding.—Box O., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

ELECTRICAL ENGINEER, well up in all kinds of work; abstainer, good refs.—U., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

PERSONAL.

A testimonial has been voted by the Town Council to Mr. W. H. Hall on his resignation of his post as Borough Electrical Engineer at Morecambe.

A note from Buenos Aires states that Mr. Samuel Hunt has been appointed Telegraph Superintendent to the Great Southern Railway, in place of Mr. Jackson who died a short time ago. Mr. Hunt joined the Midland in 1885, and four years ago he went to Africa to the Gold Coast Railway, and for the past three years has been Telegraph Superintendent on the Beira Mashonaland and Rhodesia Railway.

Mr. F. A. C. Leigh having accepted the appointment of Chief Electrical Engineer to the London and North-Western Railway Company, there has been a dissolution of partnership in the firm of Lacey, Sillar & Leigh, consulting electricians. The firm will continue under the style of Lacey & Sillar.

CATALOGUES AND PRICE LISTS.

Messrs. Siemens Brothers & Co., Ltd., have issued an instructive illustrated pamphlet on "Roentgen-Therapy in Gynæcology," which deserves to be brought under the notice of all surgeons and general practitioners.

We have received from the Maschinenfabrik Oerlikon an illustrated catalogue of their portable electrically driven hand-drilling machines.

ELECTRICITY IN THE ARGENTINE.

That the electrical industry in Argentina is progressing can be gathered from the very favourable reports received from time to time from the various companies employed in that industry, says the *Review of the River Plate*. There are only three English companies engaged in the electric light business in Argentina, they are the River Plate Electricity Co., with works at La Plata and Tucuman, the Rosario Electric Co., and the Cordoba Electric Light and Power Co. The annual general meeting of the Rosario Co. was held in London on November 2, and the Chairman, who had recently returned from a visit to Argentina, stated that the receipts had increased from £73,100 to £91,300. The working expenses have only gone up by £1,900, which is due to cheaper fuel and also to the benefit of the new condensing plant; had it not been for these two items the expenses might have been much heavier for the increased revenue. As regards the City of Rosario the Chairman stated that the population had increased about 20% during the last four years and the development of the town had been truly remarkable. If there be a fly in the ointment, it is that municipal taxation has increased to an extent which has caused a general protest in a vigorous form. The question of future development was thoroughly gone into on the spot, and it was finally decided to build a second station at Sorrento, the total cost of which is estimated at £200,000, this will double the capacity output of the Company. That the Chairman fully grasps the situation, and the necessity of moving with the times, is gathered from his remarks to the effect, "That I am fully convinced that the policy of at once commencing to erect a new station is preferable to filling up our existing site to its possible maximum capacity and postponing the inevitable construction of a new station." Mr. James Anderson, a gentleman who is connected with other Argentine enterprises, and well knows what are the requirements of the country, said that the policy of the board had been one of caution combined with that amount of enterprise which tended to soundness and prosperity. Rosario was a growing city and unless the company took steps to meet the increasing demand for electric light, competitors would enter the field. The directors are to be congratulated on their action and in following the course laid down by the board they would place the Company on a very sound footing. It is indeed satisfactory to find that directors of our industrial companies are looking well ahead and not allowing the grass to grow under their feet, as was the case a few years ago.

PUBLICATIONS.

We have received the last quarterly issue of "Public Works, an illustrated Record of Public Works at Home and Abroad." The principal article, by Mr. H. B. Poynder, A.M.I.E.E., deals with "Polyphase Motors for Machinery Driving." It is fully illustrated. "Public Works," by the way, is in future to be issued monthly, at the reduced price of sixpence. The first number of the new issue is to appear in January.

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TUNGSTEN LAMP FITTINGS

(Regd.)

Hook Suspension with Ornamental Bracket and Chain; Plain Shade.
Prices from £1 18s. 0d. to £2 8s. 0d.

Fixed Suspension with Ceiling Plate; Pocketted Shade.
Prices from £1 2s. 6d. to £1 12s. 6d.

B.T.H. Tungsten Lamp Fittings are of superior workmanship, style and finish; they are artistic in appearance and inexpensive.

Hook Suspension with Ornamental Bracket; Plain Shade.
Prices from £1 15s. 0d. to £2 5s. 0d.

Hook Suspension without Chain; Pocketted Shade.
Prices from £1 2s. 6d. to £1 12s. 6d.

The fittings are of best quality copper or zinc with a standard finish of oxidised copper.

Supplied with either plain or pocketted frosted glass globes.

PRICES SUBJECT.

Hook Suspension with Chain; Plain Shade.
Prices from £1 5s. 6d. to £1 15s. 6d.

THE . . .

BRITISH THOMSON-HOUSTON CO., Ltd.,

ELECTRICAL ENGINEERS AND MANUFACTURERS,

Head Office and Works:
RUGBY, ENGLAND.

London Office:
83, CANNON ST., E.C.

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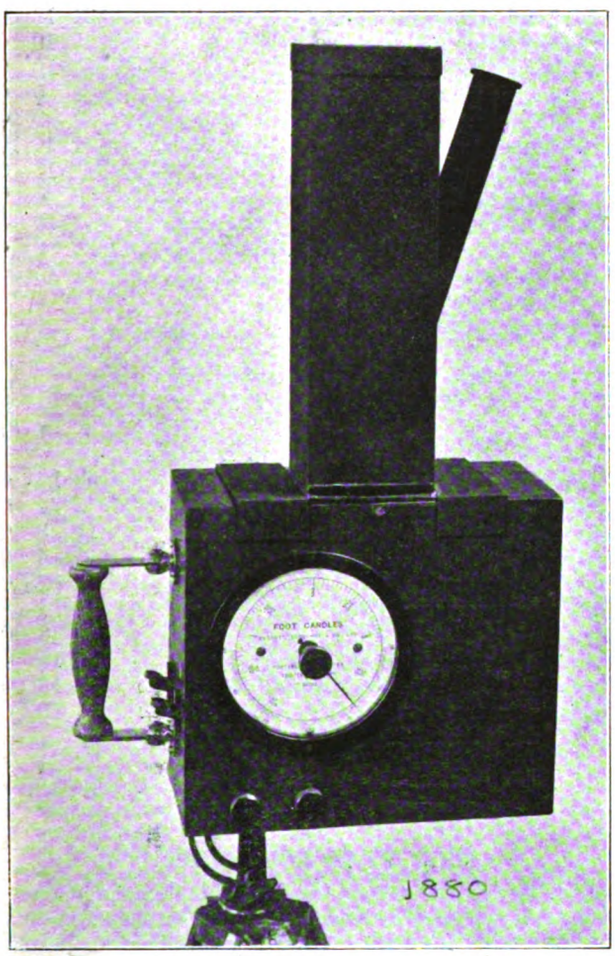
PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

Adjustable Screen Photometer Head.

Combined Flicker and Contrast Patterns.

Far greater attention is now being paid to the comparative value of illuminants and different types of lamps, with the result that the demands for measuring instruments of precision is steadily growing An instance of this was shown at the Physical Society's recent exhibition, when the photometers shown by Messrs. Everett, Edgcumbe & Co., Ltd., came in for very close scrutiny and approval. It should be mentioned that in connection with their photometer bench, one of the

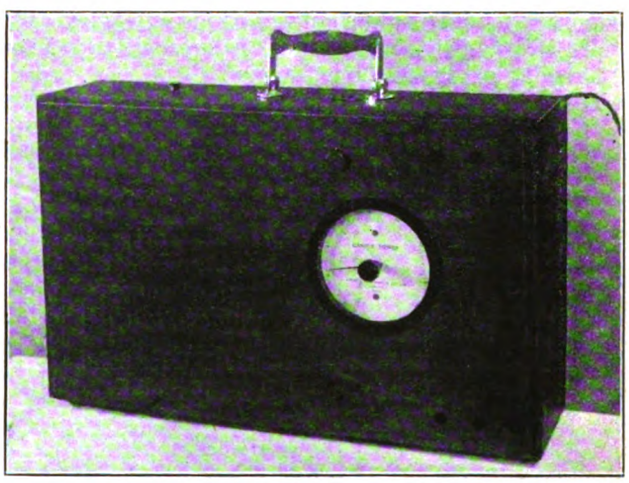


No. 1.

chief points of novelty lies in the photometer head itself. This is distinguished by the fact that the adjustment of illumination can be made by altering the angle of incidence of light of one of the two screens. The advantage of this is that instead of it being necessary to move a heavy carriage with a standard lamp, etc., both lights can be fixed and the entire adjustment made on the photometer head itself. Of course this is of immense use when dealing with flame standards, whether gas, pentane, or what not. It is also much easier to obtain a balance by this means than with the comparatively slowly moving lamp carriage.

A further advantage possessed by this arrangement is that it affords a ready means of reducing the illumination from one of the lamps, so that it is easy to test high candle power lamps, such as arcs and metallic filament lamps in a comparatively small photometer room. Moreover, it affords a rapid means for comparing a number of almost similar lamps where it is merely wished to know by what percentage they are above or below a given value. Incidentally it may be mentioned that the rays of light strike the screen at right angles so that angularity errors are entirely avoided.

Another excellent appliance brought forward by Messrs. Everett, Edgcumbe & Co., is the Portable



No. 2.

Direct Reading Lamp Photometer, illustrated herewith, which consists of a wooden case measuring $11\frac{1}{2} \times 18\frac{1}{2} \times 4\frac{3}{4}$ins., and weighing only 12 lbs. It has been particularly designed for the rapid testing of metal filament and other high efficiency lamps. The scale is perfectly direct reading, and is almost evenly divided. Besides this, the range is a very extended one and can be used for taking measurements up to as much as 100 c.p. It can, moreover, be employed for the testing of arc and other lamps, which can be placed in the photometer itself. The adjustment is extremely easily made, even where the lamp under test and the standard with which it is being compared are very different in colour. It may be added that the photometer can be at any moment checked on an ordinary photometer bench against either an electric or flame standard.

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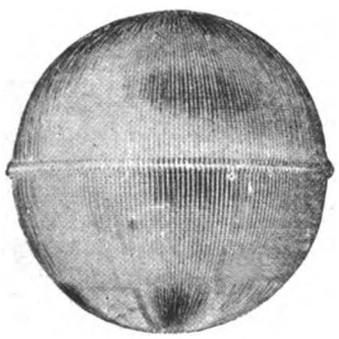
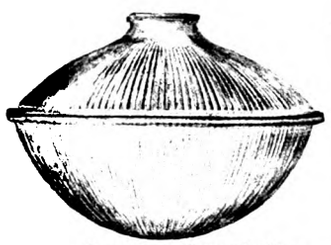
HOLOPHANE GLOBES AND REFLECTORS.

Referring to the art of lighting, Mr. E. L. Elliott, Editor of our esteemed New York contemporary, *The Illuminating Engineer*, wrote as follows:—"It is a wonderful testimony to the achievements of science that it has equalled nature in so great a thing as light. The statement that artificial light can be produced, which is the equivalent of daylight in every respect, is as yet but little comprehended, and yet such is a fact, To carry on any industry under poor artificial lighting is as contrary to the dictates of both humanity and economy as the ancient demand of the Egyptian rulers that their slaves make bricks without straw." This puts forcibly enough a truth which is only beginning to be understood in domestic, industrial and municipal circles. At the same time it is necessary to recognise



No. 1—Holophane Globe.

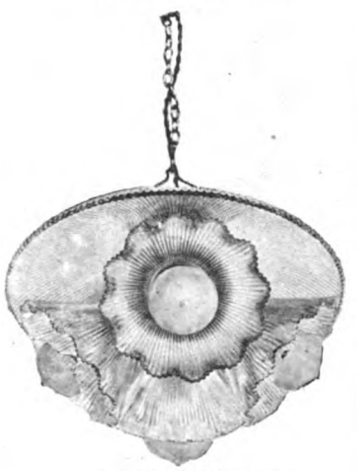


No. 2—Downward Concentration.

the fact that the choice of the nature of an illuminant does not by any means constitute the sole aspect of the problem. Perhaps the most difficult matter is that of distribution of light, and this side of the question is impressed upon us all the more sharply as we improve our source of illumination. With the intensely brilliant metal filament lamps some form of screening the incandescent wires, and at the same time filtering the rays so as to obtain as nearly as possible perfect diffusion, having due regard to special requirements, is especially necessary. It is for this reason that we desire to draw attention to novel forms of "Holophane" glassware, which Messrs. Siemens Brothers, Dynamo Works, Ltd., are placing on the market.

This glassware is manufactured in three grades, A, B and C. A is designed for concentrating rays downwards; for instance, in order to illuminate areas required for reading, writing, dinner-tables, billiards, and so on. B: Distributing—for the general illumination of doors and corridors. C: For throwing out the light sideways—needed in the lighting of large areas, such as public halls, streets, and the like.

No. 3—Holophane Glass Bowl.



No. 4—Holophane Cluster.

As this particular make of glassware becomes more widely known to users of electric light, there will be an increasing demand for it, because it facilitates the economical use of strong light with comfort. It should be pointed out that there are many so-called prismatic reflectors on the market, which do not possess the same reflecting effects as the carefully designed voluted glass.

We give herewith a few examples of the enormously varied patterns of Holophane globes. The pretty sphere as specially suited for "Tantalum" lamps, these being of the B type, for general diffusion, while the bowl is for downward concentration.

Messrs. Siemens employ Holophane in the make up of cluster fittings (one of which we illustrate), commonly known as "Tantalum" Arcs. These are manufactured in 3, 4, or 6 light fittings, for either spherical or bell-shaped lamps, and are becoming widely used for interior lighting of hotels, shops, etc., because as they give a uniform distribution of soft white light, they are far more effective for this class of work than the ordinary arc lamp which depends for its action on mechanical devices. The examples given here are only a few out of a great many kept in stock, particulars of which, with details as to the type lamp and voltage for which they are best suited, are given in a neat illustrated price list issued by the firm.

ESTIMATE FOR ARC LAMP INSTALLATIONS.

In Verity's remarkably complete catalogue there are some interesting estimates. Those we give below are for two typical arc light installations in one case for 10 lamps burning two in series on 200 to 220 volt circuit, and the other for 8 lamps, four in series, on a 440 to 480 direct current circuit. The quantities are suitable for exterior lighting of railways, docks and mines, or for interior lighting of large workshops.

10 Arc Lamps, Two in Series.
Power required 5·5 *kw.*

	£	s.	d.
10 Enclosed arc lamps, 5 amps.	34	18	0
5 Weather-proof line resistances	5	10	0
10 Automatic contact gears	14	10	0
10 Automatic winches	4	0	0
1 Handle for same		2	0
500 ft. of suspension wire, $\frac{1}{2}$ in.	1	10	10
24 Assorted pulleys		13	3
10 Arc lamp brackets	3	0	0
1 Main double pole, 50 amp. switch	1	15	4
5 Branch S.P., 25 amp. switch and fuses	4	2	6
2 Lightning arresters	1	15	0
Main Cable $\frac{7}{18}$.			
Branch Cable $\frac{7}{20}$.			

8 Arc Lamps, Four in Series.
Power required, 4·4 *kw.*

	£	s.	d.
8 Enclosed arc lamps, 5 amps. with internal contacts and sub-resistances	39	14	0
2 Weather-proof line resistances	2	4	0
8 Automatic contact gears	11	3	0
8 Automatic winches	3	4	0
1 Handle for same		2	0
400 ft. suspension wire, $\frac{1}{2}$ in.	1	4	8
8 Arc lamp brackets	2	8	0
1 Main double pole, 25 amp. switch	1	15	4
2 Branch S.P., 25 amp. switch and fuses	1	13	0
4 Lightning arresters	3	10	0
Main Cable $\frac{7}{18}$.			
Branch Cable $\frac{7}{20}$.			

E.K.S.

NEW YEAR SOUVENIRS.

The Electric Construction Co., Ltd., London and Wolverhampton, have forwarded a small vest pocket memorandum book, bound in dark leather, and with pockets for cards and stamps. Another neat little souvenir of their's is a two-bladed nickel-handled penknife, which is delightfully flat and handy.

From the Electrical Power Storage Co. we receive a large blotting pad, with adjustable calendar at top and a diary and address book at side. Certainly a good desk reminder of the serviceableness of the "E.P.S." specialities.

The Hart Accumulator Co., Ltd., are also issuing a useful desk plotting pad, strongly bound and most presentable.

John Spenser, Ltd., is sending a new illustrated price list of their celebrated tubes, also enclose an aluminium disc adjustable calendar, giving dates from 1907 to 1927.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

Owing to our steadily increasing circulation and the ever widening interest taken in these Technical Problems, it has been found necessary to revise the old regulations.

The new Rules have been framed in order to encourage fresh talent to enter the field; at the same time it is hoped that the progressive lines adopted will meet with the cordial approval and support of our old and valued correspondents.

It is to be noted that these Rules only apply to Questions 1213 and onward. The first replies under the new conditions will appear in our issue of January 7, 1910.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

QUESTIONS.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

WEEKLY PRIZES FOR SOLUTIONS.—For the best solution of any question we offer a cash prize of *seven shillings and sixpence*.

For the second best solution (if published) we offer a prize of *five shillings*.

For the third best solution (if published) we offer a prize of *two shillings and sixpence*.

QUARTERLY PRIZES.—No competitor will be awarded more than three third prizes, two second prizes, or one first prize during any one quarter. But, in adjudicating upon the merits of the various solutions, marks will be allotted to the four best solutions to each question, and at the end of each quarter extra prizes will be awarded to those competitors receiving the highest aggregate number of marks.

These prizes will be awarded in kind, the winners being at liberty to choose any book advertised or reviewed in our columns, or any instrument or appliance manufactured by any advertiser in our pages. These quarterly prizes will be of the value of *one guinea, half-a-guinea* and *five shillings*. Winners may, if they should so desire, order through us books or appliances of a higher value than their prizes, by forwarding to us the difference in price.

MSS. AND SKETCHES.—All answers to problems must be sent in within fourteen days of the question appearing in our columns. Replies should be concise and ought not to exceed one thousand words in length.

QUESTIONS.

Question No. 1213.—A large D.C. generating station (440 v.) Bellis & Morcom condensing engines, using superheat steam, is supplied with a Masson & Scott oil treatment and water-purifying plant. The discharge from the air-pumps (each set having its own condenser and auxiliaries) on its way to the hot-well flows through a cistern, the outlet being proportional to the supply, by means of a vertical slot at one side. A greater or lesser flow of water through the common discharge pipe raises or lowers a float in this cistern, which by means of a cord attached and passing over a pulley fixed on an horizontal shaft, just above, opens or closes the outlet needle valves (by rack and pinion) of two other cisterns; these cisterns are connected by means of pipes—one to a tank containing alumina-ferric solution, and the other to a tank containing caustic soda solution, the supply in each case being governed by a float operated valve. The air-pump discharge and chemical solutions mix as they pass into the hot-well. It is desired to find out what strength the solutions shall be—the best way of testing them, seeing their densities may be extremely weak—and how best to find the adjustment of the valves to automatically keep pure clear water, suitable for boiler use, under varying loads; also, if possible, taking into account the varying quantities of oil coming through with the condensed steam? The water is pumped from hot-well to feed tank, passing through sand-filter (automatically flushed) *en route*.—"W. B."

Question No. 1211.—How far is it possible to use a given cable for telephone *and* telegraphic purposes? To what extent does one interfere with the other, and what precautions must be taken when arranging for such double working? How does distance affect each form of communication?

Answer to Question No. 1211 (*awarded* 10*s.*).—There are two distinct cases to be borne in mind when considering the use of cables for telegraphic and telephonic purposes. (a) It may be merely required to contain telegraph and telephone wires beneath one sheath without confusion of working, the circuits being electrically independent except as regards induction effects. (b) It may be desired to use a given conductor or pair of conductors for simultaneous telegraphic and telephonic communication. Needless to say, the second requirement is much the more difficult to satisfactorily fulfil. To contain telephone and telegraph conductors in one cable beneath one sheathing without inductive interference between conductors merely necessitate a systematic and complete "crossing," "twisting" or "worming" of the various conductors and the enclosure of the telegraph conductors in a metallic sheathing (composed of a thin copper tape wound spirally and with an overlap).

To use a given conductor simultaneously for telegraphic and telephonic purposes is a more difficult problem, but one which has been satisfactorily solved by quite a number of arrangements of circuits. Essentially it is necessary to to arrange the circuit that the telephonic currents cannot dissipate themselves through the telegraphic instruments, and that the telegraphic currents cannot penetrate to the

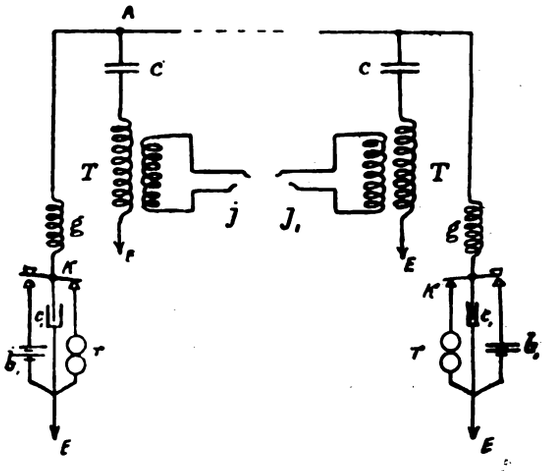

FIG. 1.

telephonic circuits there causing interference with speech. The statement of this requirement at once brings to mind the usual arrangement of the subscribers' circuits in a modern central-battery telephone system. In the latter case a condenser permits the flow of alternating currents for ringing up and for speech purposes, but prevents the leakage of the microphone direct-current supplied by the central battery. On the other hand, the high inductance of the alternating current bell used prevents leakage of high frequency voice currents while permitting the flow of direct current, and of low frequency "calling-up" alternating current. Herein lie the fundamental principle on which most combined telegraph and telephone circuits depend—condensers are arranged to prevent the flow of telegraph currents *via* certain paths, while inductances prevent alternating current flow through other circuits. Separation is thus effected at the receiving station, the component currents, which flow superposed along the line wire being

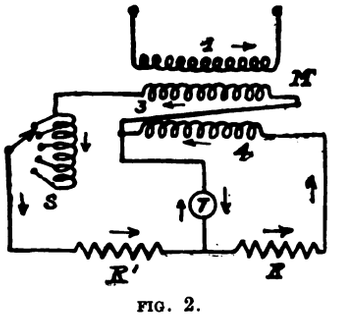

FIG. 2.

again resolved and forced to take desired separate paths at the distant station. On the completeness and accuracy with which this separation is effected the success of the combined telegraph and telephone working depends.

In Fig. 1 is represented a very typical arrangement of circuit for combined working. This system is used with very reasonable success in the Piedimanti and Caserta telegraph circuit (40 km. long: earth return). The arrangement shown presumes the use of a central battery system, the jacks j, j leading the subscribers' sets, telephone battery, etc., in the ordinary manner. The secondaries of the telephone transformers T are connected to line through condensers *c* (of 2 m.f.d. capacity) and to earth. The condensers *c*, *c* prevent the passage of telegraphic currents through the telephone transformers, while the inductances *g*, *g* (which should preferably be adjustable) prevent the flow

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of high frequency voice currents through the telegraph instruments. Such passage would not affect the telegraphic working, but would, of course, greatly weaken, if not utterly destroy, telephonic reproduction at the distant station.

The telegraphic connections in Fig. 1 need no comment, these being shown of the ordinary local battery single message type, though, of course, duplex or other systems can be employed without any alteration in the principle of the arrangement. This system is not perfect, but well explains the principle of most methods of combined telegraph and telephone working. Probably some slight interruption of telephonic communication will arise from clicking, due to momentary current flow caused by alterations in the potential of the top plates of c, c, such alterations being in turn caused by the telegraphic currents.

Perego has invented a "separating" circuit arranged as in Fig. 2. By this device he claims to enable wires used for the transmission of electrical energy or telegraphic currents to be also employed for telephony. Coil 1 is the primary of a small transformer M provided with two secondaries, 3 and 4, which are connected in series and form, with S R^1 and R a bridge across which is connected the telephone receiver T; 3 and 4 have an equal number of turns, and are of, approximately, equal resistance; S is a variable inductance, and R R^1 resistances. The currents induced in 3, 4 tend to flow through the bridge arm T in opposite directions, and S is so chosen as to give the minimum disturbance due to a current of frequency *f*. The condition for this is that

$$i = i^1 = \frac{E}{\sqrt{R_1^2 + (2\pi f L)^2}} = \frac{E}{R}; \quad \cos\phi = \frac{R}{\sqrt{R_1^2 + (2\pi f L)^2}}$$

Goldschmidt has recently proposed a somewhat similar arrangement for enabling telephonic communication over conductors used for lighting or traction systems. The telephone transformer is provided with a high resistance secondary, and the telephonic currents are superposed on the main D.C. supply carried by the wires. A toothed wheel interrupter is used for "calling up" purposes, and by continuously running this wheel and breaking up its signals by a Morse key placed in series with it, telegraphic communication may be established over the lighting or traction line. In simple telephone circuits (*i.e., non* central battery) telegraphic messages may be sent by removing the receiver from its hook and using the latter as a Morse key; telephonic communication over the line is, of course, meanwhile interrupted.—"WREN."

Answer to Question No. 1211 (*awarded* 5*s.*).—It is not very clear whether "Enquirer" desires information regarding the simultaneous use of distinct conductors in a compound cable for telegraphic and telephonic purposes, or whether he wishes to know if a given conductor can be simultaneously used for both means of communication. Brief information on both headings is, therefore, appended. Considering first the inclusion of both telegraphic and telephonic conductors in the same composite cable, this practice has considerably extended of recent years. The West of England and the great North underground cables are the chief

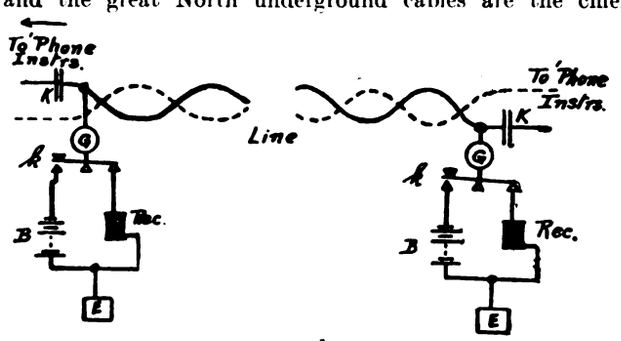

FIG. 1A.

examples at present extant; but from Leeds to Newcastle, from Manchester to Warrington, and from Liverpool to Leeds are shorter lines similarly arranged for both purposes. The telephone conductors are usually placed at the centre of the cable, and surrounded by several layers of telegraph wires. In some cases the telegraph wires mainly occupy the central position, a small number only being employed peripherally to fill the interstices between the telephone conductors. The telegraph wires are paper insulated, and each is separately "screened" with a $\frac{1}{4}$ in. to $\frac{3}{8}$ in. wide copper strip three mils thick wound spirally with a small overlap. This metal tape prevents telegraphic currents from inductively interfering with the adjacent telephone conductors. The cost of screening is heavy, particularly in cases where the active copper is of very small gauge. In such cases the screening copper may well be heavier than the conductor it protects. Iron, aluminium and tinfoil have been used as substitutes for copper screening, but with poor success. The screened telegraph wires must be "wormed" to further nullify induction effects. In small

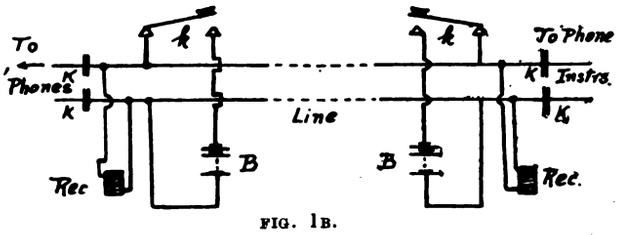

FIG. 1B.

cables it is necessary to screen every telegraph wire, but in larger cables it is sufficient to screen alternate layers; complete screening will, however, give better results and will facilitate the complete earthing of the screening by contact with the lead sheath of the cable.

Telegraphic communication between London and Glasgow through combined telegraph and telephone cables is maintained by Hughes instruments; no telephonic interruption is caused by the telegraph currents, and no repeaters are necessary for the latter. The practicability of the above type of cable is, therefore, fully demonstrated.

Use of one line conductor for simultaneous telephony and telegraphy.—A simple arrangement for this purpose is illustrated in Figs. 1(a) and 1 (b) (for single and double line working respectively). The arrangement is so simple as to require little explanation: the condensers *K* prevent direct incursion of continuous current into the telephone circuits, while the inductance of the telegraph instrument coils is sufficient to obstruct all telephonic currents. If the telegraph be worked with closed metallic circuit, it is unnecessary to twist the conductors whether the telephones have earth or metal return. If the telegraph be worked with earth return, and there be more than one line wire, the latter must be twisted or the telegraph wire "screened" to prevent inductive interruptions. In Fig. 2 is shown a rather more elaborate arrangement, which is actually used

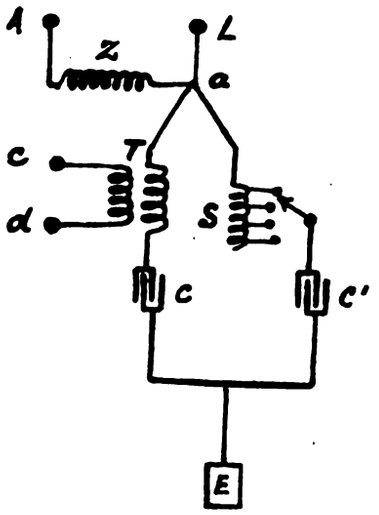

FIG. 2.

in Italy over a 25-mile line with earth return. The solenoid *Z* is placed between the telegraph and line contacts *A* and *L*. From the point *a* there are two parallel circuits to earth. One contains an inductance S and condenser c^1, and being of low resistance, is followed by all-disturbing currents, which would impair telephonic reproduction. High frequency voice currents, however, the follow alternative path *via* the telephone transformer *T* and a second condenser *C* to earth. The telephone receiver, etc., are connected across the primary terminals *c*, *d*. Perego, the inventor of this (as of several other similar devices), claims improved telephonic transmission for the system and reduced attenuation and distortion.—"S. M. P."

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ELECTRICAL PROGRESS AT HOME & ABROAD

FROM OUR SPECIAL CORRESPONDENTS.

TYNESIDE NOTES.

NEWCASTLE-ON-TYNE.

A rumour has been current on Tyneside for some little time to the effect that Messrs. Armstrong, Whitworth & Co., Ltd., have been contemplating increasing facilities for naval construction at their Walker yard. This has been obviously a desirable step, in view of the increasing difficulty of getting the larger ships built at the Elswick yard down the Tyne past the High Level and Swing Bridges. When the last big battleship went down the Tyne, a considerable amount of dredging had to be done. It is now reported that the Walker works are to be extended and made into an up-to-date shipbuilding yard, in which vessels up to 800 ft. long can be built. The frontage of the new yard, when completed, will be about half a mile, and is probably to have four berths for large boats. The important hint is also given that tenders for laying out and constructing the new yard are expected to be let early in the new year. As electric power and lighting enter so largely into the modern equipment of a shipyard, the importance of this news to contractors is obvious.

Tyneside Business Results and Prospects.

Other indications of a return of prosperity to Tyneside are not now wanting. For example, a report has been received from Messrs. A. Reyrolle & Co., Ltd., of Hebburn, which notes that during 1909 business has been exceedingly good, and that the firm is at present in the fortunate position of having its works continuously on overtime. During the year some important contracts for ironclad switchgear for voltages from 3,000 to 12,000 have been completed, and nearly all such gear has been fitted with their balanced system of protection. They have also supplied to several of the collieries in this and other mining areas a type of panel in which all the access doors, oil switches, and isolating switches are interlocked, and have also designed a complete line of motor starters, distribution boards, circuit breakers, switches, etc., fitted in flame and explosion proof cast iron cases. These are being placed in fiery and wet pits, and a number of motor starters of this type are being supplied to two of the largest coal companies in the country. They have also given considerable attention to the question of earthing portable apparatus, in view of the new Home Office regulations, and this process of keeping up-to-date has resulted in considerable prosperity. Reports from other manufacturing firms supplying in this area appear to point to encouraging symptoms. For example, the Newcastle manager of Messrs. Gent & Co., Ltd., writes: "In regard to next year's prospects, a decided improvement appears to have set in, and naturally we are very hopeful that this will be realised."

Facilities at Continental Ports.

A very interesting report has recently been submitted to the Newcastle Corporation by Councillor Herbert Shaw, who is Secretary to the Chamber of Commerce, and Mr. C. R. S. Kirkpatrick, the City Engineer. This deals with the charges and traffic facilities at Continental ports, and includes a very careful survey of the conditions prevailing in the important ports of Belgium, Holland, Germany, Denmark and Sweden. The report is the result of a tour of inspection with the object of examining the quays, sheds, and general trading facilities of the ports investigated. The interesting feature of the report to electrical engineers is the revelation of the immense strides which have been made in recent years in the electrical equipment of docks and quays. At Ghent, one of the largest Belgian ports, owing to very large recent extensions, both single and two-storey sheds are used. The former, together with a loading verandah, three railway sidings, roadway, and quay front 6,500 ft. long, are served by electric portal cranes of the most modern type, while the single storey sheds are served by electric cranes of the semi-portal type. The portal cranes are specially mentioned. As there is no fluctuation of the water level, the conduit system of collecting the current is used. The cranes, which will lift up to 2½ tons, run on the land side on a flat plate of iron, the rims of the wheels on the quay edge being relied on entirely to keep the crane on the track. At Amsterdam, electric portal cranes supplied on the conduit system lift 2 tons in quick and 4 tons in slow gear. One ton electric cranes are also provided. At Hamburg 3-ton semi-portal electric cranes are used. Bremen is the one port mentioned as having hydraulic cranes only; here electricity is used for electric capstans placed between each line of railway sidings between the sheds and the quay, for hauling the wagons. At Copenhagen there are two sidings between the quay and the sheds, and 2½ ton electric portal cranes traverse the outer of these sidings, and can reach from the ship to any one of three floors in the sheds. At Malmo, in Sweden, electric cranes are also installed.

Electric Accumulator Locomotives.

Another report from Mr. Kirkpatrick, dated December 20, deals with the subject of accumulator traction. The haulage problem in connection with Newcastle Quay is rather difficult owing to the inclines to be negotiated, this in one place being 1 in 40. Overhead trolleys cannot be safely used, as cranes have to travel up and down the lines constantly, and these would foul the wires. The conduit system is expensive, and liable to flooding at exceptionally high tides. Steam tractors burning coke or petroleum are available, but undesirable in the long tunnel if a successful fireless tractor can be found. Visits were, therefore, paid to Berlin, Mainz, Oberhausen, Duisberg, Barmen. The Hague and Antwerp were visited, and the electric accumulator locomotives of standard railway gauge in use there were examined. As a result, the City Engineer believes that the accumulator system could be adopted with advantage on the Quayside. The charging would be mostly done at night, when the tramways station could best supply. Two or three locomotives could be driven on the level by accumulators and on the incline from overhead wires. Each locomotive should be able to haul 80 tons on the level at 8 miles per hour on the accumulators, which should allow 12 hours' continuous shunting. Three charging places should be provided, one as far west as possible, another near the centre of the Quay, and the third near the Ouseburn gradient, where the overhead wires would begin. In this way the accumulators could be partly recharged during meal times or other intervals of rest.

MIDLAND NOTES.

BIRMINGHAM.

Important developments in the matter of electric supply were foreshadowed in connection with the Greater Birmingham Scheme by the evidence given just before the adjournment of the inquiry. The only district which claims, upon its past achievements, to be able to do better than Birmingham, is the borough of Aston Manor, where the rates for current are exceptionally low, though, as was admitted, the minimum rate is higher than the minimum in Birmingham. In the other districts, little, and in some cases nothing, has been done in the way of a public supply, while in Handsworth, the most advanced district in this respect, there is nothing below a flat rate of 4d. per unit. Yardley, it was admitted, had nothing to show except a Board of Trade Order which will lapse if not acted upon during the next few months, and King's Norton is in a somewhat similar position.

Birmingham's Electric Supply.

The leading witness for the Corporation on this subject was Mr. R. A. Chattock, the City Electrical Engineer, who gave some interesting statistics as to the present position of the Birmingham undertaking, and the probabilities of demand and supply in the event of the Corporation becoming the purveyor for the whole area, which would have an extent, if the whole scheme were adopted, of

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39,089 acres, with a population of 874,837, as compared with the present city of 12,639 acres, with a population of 553,655. The districts to be taken in are far from being purely residential, and there are many manufacturers, it has been stated, who would be ready to take current if they could get it upon the terms now ruling in the city. The present generating capacity of the Birmingham station was put by Mr. Chattock at 20,956 kw., with room for additional plant for 7,500 kw. Mr. Chattock did not commit himself to an estimate of the probable ultimate requirements of the extended city, but it was taken as significant that the figure of 100,000 k.w., which he mentioned, has not been beyond the future potentiality of the Corporation supply happened to be also the figure which the counsel for the Aston authority, who was cross-examining him, also had on his brief.

New Generating Station.

Incidentally Mr. Chattock confirmed the rumours that had been going about lately as to new generating provision to be made in Birmingham quite independently of the question of the extension of the city. When asked whether a new generating station was about to be constructed in Birmingham he replied that nothing had been decided but admitted that provisional plans were being got out, and that as a first instalment it was proposed to put in 8,000 kw. With regard to other possibilities, he said that in the event of a greatly enlarged area of supply being taken over it was intended to retain the present large generating stations, though possibly the small one would be done away with. His idea with regard to the supply of Aston Manor, in the event of that borough being annexed, was that the supply could be much more economically effected by means of transforming apparatus fed from the Birmingham station. This apparatus, he believed, could be installed in the space at the Aston Power Station, now unoccupied and thus the expense of a second generating station might be avoided. In fact, he counts upon a great saving in capital expenditure by supplying in bulk some or all of the districts now outside the city.

Manufacturers' Demands.

It was stated that some time since a syndicate was formed by manufacturing firms in the King's Norton district, to acquire the powers possessed by the District Council under a provisional order made in 1898. Up to the present time the syndicate has not been able to come to terms with the District Council and at present there is no supply for private lighting or power purposes in the district. In the meantime the firms interested have approached the Birmingham Corporation and have guaranteed a minimum demand of four million units a year. The Corporation had also been asked to supply current for lighting in certain residential portions of this district. Three courses were suggested by Birmingham, (1) that the District Council should make over their provisional order to the Corporation; (2) that the Corporation should supply electrical energy in bulk to the District Council, and (3) that the Council should be allowed to lay their mains through the highways of the district and supply direct. These proposals, however, likewise produced no result. From Yardley, failing the action of the District Council there, the Corporation has also received applications from certain firms who were willing to guarantee a consumption of 1,500,000 units a year. One of the firms mentioned as willing to take electricity from Birmingham was the King's Norton Metal Co. In view of the claims made on behalf of Aston as a purveyor of cheap electricity, it is noteworthy that some of the witnesses from that borough, who are large consumers, gave evidence in favour of the annexation, while among those who were cited as being in favour of the scheme were potential consumers of such importance as the Dunlop Rubber Co. and Kynoch's Ltd. A leading witness for annexation was Mr. George Verity, Chairman of Verity's Ltd., an electrical engineering firm employing between 700 and 800 hands.

Electricity Profits.

In his summary of the history and present position of the Birmingham undertaking, Mr. Chattock stated that in the year ending March, 1909, the Corporation were able to allocate out of the profits a sum of £10,000 in relief of the rates. There was at present a supply of electricity available to all parts of the city except some of the outlying districts. The demand was increasing rapidly, particularly for power purposes. At present the supply is something over 17,000 h.p. while four years ago it was 1,400 h.p. In April last a substantial reduction was made in the price for lighting and power, this being the third reduction during the last five years. Five years ago the average cost of production was 3·2d. per unit, and during the year ended March 31, 1909, it was 1·39d. per unit. The charge was 3·77d. per unit five years ago, and in the last financial year it was 1·72d. per unit. Under the charges which came into force in April last the average price will be 1·61d. per unit. Mr. Chattock had no hesitation in saying that the prices would be further reduced if the area of supply were extended, and that Birmingham was in a position to proceed at once with the supply of any new district that might be added to the city. It is noteworthy that in the many reviews of the year's trade in Birmingham and the district a great point is made of the great extension of the use of electrical power for manufacturing purposes. One of the firms which has during the past year completely replaced its old motive power by electricity is that of James Carlton & Son, of Constitution Hill, which for a century has held a leading position in the Birmingham brass trade, which employs some 500 workpeople. A factory like this, with its great diversity of operations and of uses for motive power, affords an excellent object lesson as to the economy and adaptability of electricity and the fact that such firms find it pays them to draw their power from the Corporation mains is likely to induce many in a similar position to follow their example. The arrangements in this factory for ventilation and the removal and collection of metallic dust, are of the most up-to-date kind, and in carrying them out electrical motors are largely employed.

LANCASHIRE NOTES.

MANCHESTER.

Orders, particularly small ones, are still increasing, and manufacturers report that they have now a considerable amount of work in hand for orders received during the past month. They expect a still further increase early in the New Year, from recent quotations they have given, some for very large contracts. In fact the coming year is regarded by some firms here as likely to be one of the most prosperous the industry has known. Apart from purely electrical or engineering schemes, much important work is projected by neighbouring Town Councils, which will directly or indirectly benefit electrical manufacturers. In Manchester alone an unusually large number of plans have been passed recently for new buildings, including some large works and warehouses, and in these electric light and power will in most cases be adopted. Some important street widening work will be commenced on very shortly, and it is possible the Corporation will take the opportunity of improving its street lighting by extending the use of electricity. So far, Manchester is very far behind the small towns outside in the matter of street lighting. Although Piccadilly and Albert-square have been successfully lighted by arcs for many years, no great development in the general conversion of the city's lighting from gas to electricity has yet taken place.

Developments in Trafford-park.

In Trafford-park too, great extensions are in hand or contemplated in the near future. The system of "Hive" works, recently introduced, has proved very popular, and many more will, no doubt, be built shortly. The Estate Co. are also putting up a number of "fireproof safes," for the storage of cotton and other material brought up the Ship Canal. The "safes" consist of long single storied buildings, each divided into sections, measuring about 110 ft. by 22 ft. by 30 ft. high. The structural iron work is quite covered up in the brick walls, while the roof is of ferro-concrete with wired glass lights. A large door is provided at each end of the section for receiving and dispatching goods. A siding is run down each side of the building, and loading and unloading is done by means of an outside overhead electric crane working in conjunction with an overhead electric crane in each section. The labour costs are thus reduced to about half the usual charges,

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while the very fireproof construction of the buildings (which are fitted with a double sprinkler system), has reduced the insurance rate to 2/6%, which is about a quarter of the usual rate. The excellent facilities are certain to lead to an increased demand for electrical apparatus by attracting many new consumers.

I.E.E. Students' Section.

Last Tuesday an interesting debate was held on "Alternating Current versus Direct Current for Railways." The proceedings were opened by the reading of three short papers by Messrs. R. G. Parrot, P. C. Jones, and R. G. Cunliffe. Messrs. Parrot and Jones pointed out the advantages of single-phase over 3-phase and direct current. High trolley voltage is desirable from the economy point of view, but with d.c. 1,200 volts is about the maximum which has been successfully used up to now, while with single-phase 13,000 volts have been used. Overall capital outlay is much lower for the single-phase system while its simplicity keeps down maintenance charges. The rheostatic losses owing to the use of auto-transformers, are extremely small as compared with the a.c. system. Mr. Cunliffe pointed out, by reference to the statements of some well-known railway managers, that the electrification of long lines, such as London to Manchester, was not likely to be carried out in this country for many years. He thought considerable progress was still possible in connection with d.c., and that much might be done yet in the running of two or four 1,200 volt motors in series. For inter-urban work d.c. was highly desirable. In the discussion, Mr. L. H. A. Carr raised the important point that standardisation was the real question and instanced the trouble experienced in early steam road days, through such railways as the Great Western and others adopting different track gauges, thus necessitating considerable expense in relaying, before through running, which will always be necessary, was possible. Mr. J. S. Peck, the chairman, mentioned that he had recently heard from the engineer of one of the large American single-phase railways, that they were now running practically four times the distance "per delay," as in steam days.

AMERICAN NOTES.

NEW YORK.

The current year will long be memorable from the fact that it marks the triumphant emergence of this country from a period of depression, brought about by "frenzied finance," which wrought wholesale disaster in every branch of commerce and threatened permanently to leave its mark upon the electrical industry. That this threat was not justified by the event is matter for great congratulation all round. As a matter of fact, all the big incorporations have done wonderful business during the year, and many have been overwhelmed with orders. The recovery, in short, has been complete and, as everyone hopes, permanent. At any rate at the moment of writing the outlook for the New Year is extremely bright. Cordial greetings to the English trade, and may we all find 1910 a "banner year!"

The Measurement of Resistance.

Referring in an editorial note to the absolute measurement of resistance, the *Electrical World* observes that up to the present time it has been necessary to make up primary standard ohms in pure mercury, using carefully calibrated glass tubes for the purpose, and verifying the resistance of these mercury standards occasionally by absolute electromagnetic measurements. In the Lorenz method, which employs a very small dynamo without iron cores, the armature is a simple rotating copper disc, from the axis and periphery of which the measured e.m.f. is derived. An innovation into this method has lately been proposed by Dr. E. B. Rosa. The plan is to use a wound armature, instead of a disc, in the standard dynamo. The wound armature will be two-phase in type, and each of the two phases will be led, through a two-part commutator, to one coil of a three-coil differential galvanometer. By rotating the two-phase armature at 25 turns per second, in a magnetic field produced by a pair of fixed enveloping air-coils, an e.m.f. of several volts may be expected. Another innovation suggested is the measurement of the magnetic flux linked with the rotating armature coils by direct comparison with mutual inductance standards.

The Value of Controllers.

A number of important points were touched on at the meeting of the Pittsburg Electric Boosters Club. Mr. A. P. Munning, of the Cutler-Hammer Manufacturing Company, referring to the fact that with the development of power-saving appliances when used with electric motors, the question of proper controllers had become so important as to practically dominate to a large extent the use of motor appliances, compared it in this respect with conditions existing seventeen years ago, when the controller was looked upon as purely a necessary evil in connection with the motor, and was designed essentially by rule of thumb. For instance, in 1892 a one-horse-power, 220-volt starting rheostat, without any automatic features, sold for approximately $20 to $25, its dimensions were 24 by 24 by 18 inches, and its weight about sixty pounds. To-day the same device with automatic features sells for approximately $3, its size is 9 by 9 by 4 inches, and its weight 11 pounds. Mr. Munning referred to the development period occurring between 1892 and 1896, and spoke of the 1,500 h.p., 220-volt, multiple-lever type speed regulators used at the Edgar Thomson works of the Carnegie Steel Company, where the final contacts on the controller are arranged to carry 10,000 amperes, and the resistances for each controller consist of approximately 5,000 feet of culm T rails. Referring to the use of larger motors for steel-mill work, he called attention to the application of the series-relay type of controller, and stated that before the advent of this construction, mill tables were not as successfully operated, since the drum-type control previously employed involved a much greater strain on the machinery, required harder service on the part of the operatives, and involved the use of a larger amount of time than with the new types.

Power and Irrigation Project.

A large project is being mooted with the object of tapping Lake Tahoe for 500,000,000 gals. of water to irrigate the south-eastern portion of Sacramento County. Judge Waymire states that there are about 300,000 acres in Sacramento County which are now worth little for agriculture, but which, with water brought on, would acquire a value of $100 per acre at once. Legal obstructions have been overcome, and the engineers have traced the route through the mountains down to Auburn, where an immense reservoir will be constructed. A large dam will be built near the entrance of Truckee River at the lake. Thence a tunnel five miles long will be cut through the mountains. From the western terminus of the tunnel the north fork of the American will offer a convenient grade to take the water down to the Auburn reservoir. In the course of the canal or conduit to Auburn there will be five falls or drops at which electric power can be generated to the extent of 230,000 h.p. These falls will have a height of 900 ft., 400 ft., 1,500 ft., 700 ft.

Canadian Water Power.

A Canadian correspondent of the *Electrical World* says that within a radius of 8 miles of Ottawa are undeveloped waterpowers amounting to 200,000 h.p., and within a radius of 45 miles of the city the amount is estimated at 917,400 h.p. Of this vast amount only 58,400 h.p. is, at present, in use. Just now, electric power can be purchased here for less than $15 per h.p. per annum, continuous service. A new company, which is seeking a charter from the city, has agreed to sell electrical energy at $11 per h.p. Another use, to which the electric power will soon be put will be in the development of the mines in the vicinity of Ottawa, by means of the electric furnace for smelting, there being rich deposits of iron ore within a mile or two of immense waterpowers. It will also be employed in the development of the deposits of zinc, plumbago, mica, phosphate of lime, etc., which as yet have not been properly exploited owing to the great cost of fuel.

Trade or Profession.

President J. M. Smith, in his presidential address before the American Society of Mechanical Engineers, urged that if "they were to have a profession of engineering, as distinguished from the trade of engineer, they must have a broad education befitting men of a learned profession, as distinguished from a narrower education sufficient for men of a trade." President Lowell, of Harvard, in his recent remarkable inaugural address, gave this as his conclusion:

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"The best type of liberal education in our complex modern world aims at producing men who know a little of everything and *something well*." If that conclusion be true of a liberal education leading to the learned profession of the law or medicine or theology, why is it not also true of a scientific education leading to the learned profession of engineering? If preponderance be given to one part of President Lowell's conclusion over the other part, certainly knowing "a little of everything" leads to superficiality; while just as surely knowing but one thing well leads to narrowness. There would seem to be a happy mean between these two extremes, in the education of the engineer. The engineer knowing something of many things, several things well and one thing profoundly, is, however, still one-sided if all this knowledge is confined strictly to his profession. He will be a much broader man, and a better engineer, if in his leisure hours he can turn his thoughts entirely away from his professional work and toward those things in nature and art which give that rest and renewal of the professional mind necessary to continued work.

Electric Railway Notes.

It is announced that the Southern Pacific Railroad Company is planning the electrification of 110 miles of its main line over the Sierras. This work will, it is declared, be the most important piece of mountain electrification yet installed in any country, and it is likely that, if the work is completed as now proposed, the Southern Pacific will have the longest stretch of electrified main line in this country. The only competitor will be the New Haven Railroad, which is pushing its electric zone east from Stamford. The Southern Pacific has a series of 2% grades, and the heavy 2,500 ton freight and 800 ton passenger trains will require larger electric locomotives than any now in use. It is also notified that the Pennsylvania Railroad Co. has prepared plans for the electrification of its line from Harrison, N.J., where the Thirty-third-street tunnel line joins the main line which has heretofore run into Jersey City, to the Park-place station, Newark. It is proposed on this line to run through trains from Newark to the Hudson Terminal-buildings, at Cortlandt-street, and to transfer passengers at the Harrison, N.J., station to trains that will take them to the main terminal at Thirty-third-street and Seventh-avenue, New York. It is said that later on a local service may be installed between the Thirty-third-street terminal and Newark. All through trains coming into New York over the Pennsylvania line will stop at the Harrison station so that any passengers who desire to go into the lower end of Manhattan can there transfer to the Hudson terminal station.

Brooklyn Developments.

The Brooklyn Rapid Transit Company is planning developments which will involve an expenditure of about $50,000,000. The plans contemplate the following extensions: To equip and operate the Fourth-avenue subway; to extend its Fifth-avenue elevated railway as an elevated road to Fort Hamilton; to elevate its West End line from Coney Island to Eighteenth-avenue, and depress the tracks from that point north to Forty-second-street, where they will run into the Fourth-avenue subway; to elevate its Sea Beach road from Coney Island to the point where it joins the West End line; to elevate its Culver line its entire length; to extend its Brighton Beach division, as already announced, by subway to Flatbush-avenue and Fulton-street and thence *via* the Fourth-avenue subway, the Manhattan Bridge and the Canal-street subway to Manhattan, to a loop at the North River; to third track its Fulton-street line; to third track its Lexington-avenue line; to third track its Broadway line; to make various extensions to its elevated system in the eastern districts with a view to furnishing the East New York and Ridgewood sections with a much better transportation service than at present exists.

Thousand Candle-power Tungsten.

Reference has already been made in this column to the new high power tungsten lamps imported by the Electrical Accessories Company, of this city. The 600 c.p. lamp has a round globe 8 in. in diameter, while the globe of the 1,000 c.p. lamp is 9 in. in diameter. Each lamp is made up of two filaments in parallel, so that if one filament breaks, the other filament will remain in service and the lamp burn at half rating. The lamps are designed to take the place of ordinary arc lamps, and flaming-arc lamps for interior illumination. The filament is anchored in the centre and also at the bottom, and the connections at the top are fused electrically. The anchors at the middle and bottom are arranged so that one leg of the filament is in a different plane from the other. This results in obtaining better distribution, and prevents the filaments from touching each other. There are 16 complete loops in the 600 c.p. lamp, and 20 complete loops in the 1,000 c.p. lamp, the length of the loop being about 6 in. in each case. The anchors are held by a glass rod over $\frac{1}{8}$ in. in diameter. The lamps are fitted with Edison bases so as to screw into an ordinary incandescent lamp socket, and they are designed for voltages ranging from 100 to 120, and from 200 to 250. With the introduction of these lamps there are now available tungsten lamps ranging in candle-power from 16 to 1,000, those above 100 being rated at 200 c.p., 300 c.p., 400 c.p., 600 c.p., and 1,000 c.p.

Oscillation Valves.

In a paper on the conversion of electric oscillations into continuous current by means of the vacuum valve, read at a meeting of the Wireless Institute in New York, Mr. W. E. Smith, who exhibited two Fleming oscillation valves, explained in detail their operation when employed in wireless telegraphy. The valve consists of a low voltage incandescent lamp, the filament of which is surrounded by a metallic band separated slightly from the filament, the intervening space being exhausted to a high degree. When the filament is heated by means of electric current from a battery of a few cells the space between the filament and the metallic band becomes ionized and possesses practically unidirectional conductivity. When inserted in a circuit subjected to electric oscillations partial rectification takes place on account of the high resistance for current in one direction and low resistance for that in the other. When arrangements are properly made from 80% to 90% of the oscillating current appears as unidirectional current. Either a galvanoemtre or a telephone receiver can be used as a detector of the received oscillations.

Current Items.

The cotton mills at Albemarle, N.C., have just closed a contract with the Southern Power Company for the running of all their machinery. Albemarle is on the main line of the Southern Power Company, which extends from the power plant on the Catawba River to Salisbury. This line carries about 80,000 volts. The city may also be lighted with power from the company.

The Lewishon Bros., who have purchased the Iron Dyke property in the Seven Devils district, it is said, contemplate the construction of a smelter near Ballard's Landing on the Snake River to handle the ore from their mines and other mines in that district, and will also build an electric line from the Seven Devils district down the Snake River from Huntington to Lewiston. It is reported that they have also secured an option on the Ox River electric project on the Snake River near the proposed site of the smelter. The electric power plant when completed will have an output of about 30,000 h.p. A tunnel 35 ft. in circumference is being driven through solid rock for 2,000 ft., which will change the channel of the river. Work has been in progress more than three years and the total cost of the work is estimated at $3,000,000.

Merging for self-protection still goes on. The Kinloch Long Distance Telephone Company, which controls lines in St. Louis and suburbs, and which has traffic contracts with 150 independent companies in Missouri, Kansas, Illinois and Indiana, has taken steps to assure its independence of the American Telephone and Telegraph Company by pooling a majority of its stock for five years. The merger of about 100 independent telephone companies in Kentucky, with a total capital of $1,000,000, has also been resolved upon.

The barge canal to be built between Lake Erie and the Hudson River, if constructed with a downward slope, could be made to produce $500,000,000 worth of power, said Edward R. Taylor, of Penn Yan, N.Y., in a paper before the American Institute of Chemical Engineers in this city.

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ELECTRICAL INSTALLATION IN ITALY.

By ARTHUR MORRIS.

In the Valley of Toscolana, a river which rises in Austria and flows into the lake of Garda after a course of about 20 miles, are many old-established paper mills, which from time immemorial have made hand-made papers. The most important of these mills is that belonging to the Andrea Maffizoli A.G., and this company put in a paper machine in 1905, erecting a new mill for the purpose. This is close to the mouth of the Toscolana, and uses electrical power derived from the current of the river. The power station is at Camerate, about 3 miles from the river. The channel conveying the water is about $1\frac{3}{4}$ miles long, and has a section of about 50 in. square. It is usually full to a depth of about 40 in. For about 5 furlongs the channel runs through tunnels, and much of the rest of it passes over two aqueducts, one 100 yards long, the other 45 yards, where the water flows in a channel made of cement. The delivery of water varies according to the time of year, from 154 to 396 gallons per sec. From the sluice the water passes through a grating into the two pipes supplying the turbines. Each of these has a ventilating pipe 16 ft. high. There is a third pipe to carry off any water that may be in excess of that required for power purposes.

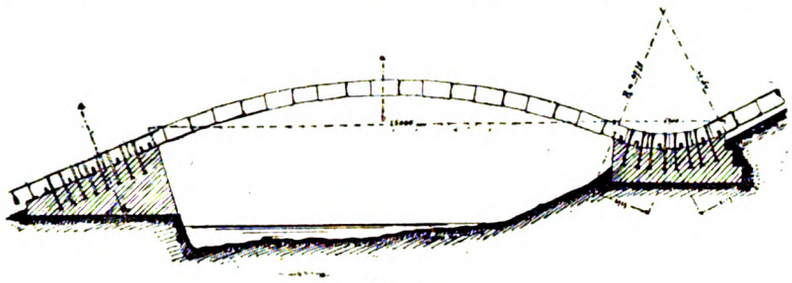

FIG. 1.

Each of the supply pipes is 245 yards long, and made of boiler plate, from $\frac{1}{8}$ inch to $\frac{1}{2}$ an inch in thickness. They rest on cement blocks, and are each 32 in. in diameter. It was necessary that they should cross the Toscolana, close to the station. As the river frequently changes its bed, tunnelling under it was out of the question, so that the pipes are bridged over the stream, as in Fig. 1. The radius of the arch is 38 yards. The central station building is constructed of stone and armoured cements. Its external dimensions are 22 yards by 11, and it houses three motors, each of 650 h.p. The water drives three high pressure (8 to 9 atmospheres) turbines. These turbines are governed to a constant speed of 630 revolutions. The governor opens an overflow pipe as soon as this speed is sensibly exceeded. The turbines are connected with the dynamos by the usual fly-wheel arrangement.

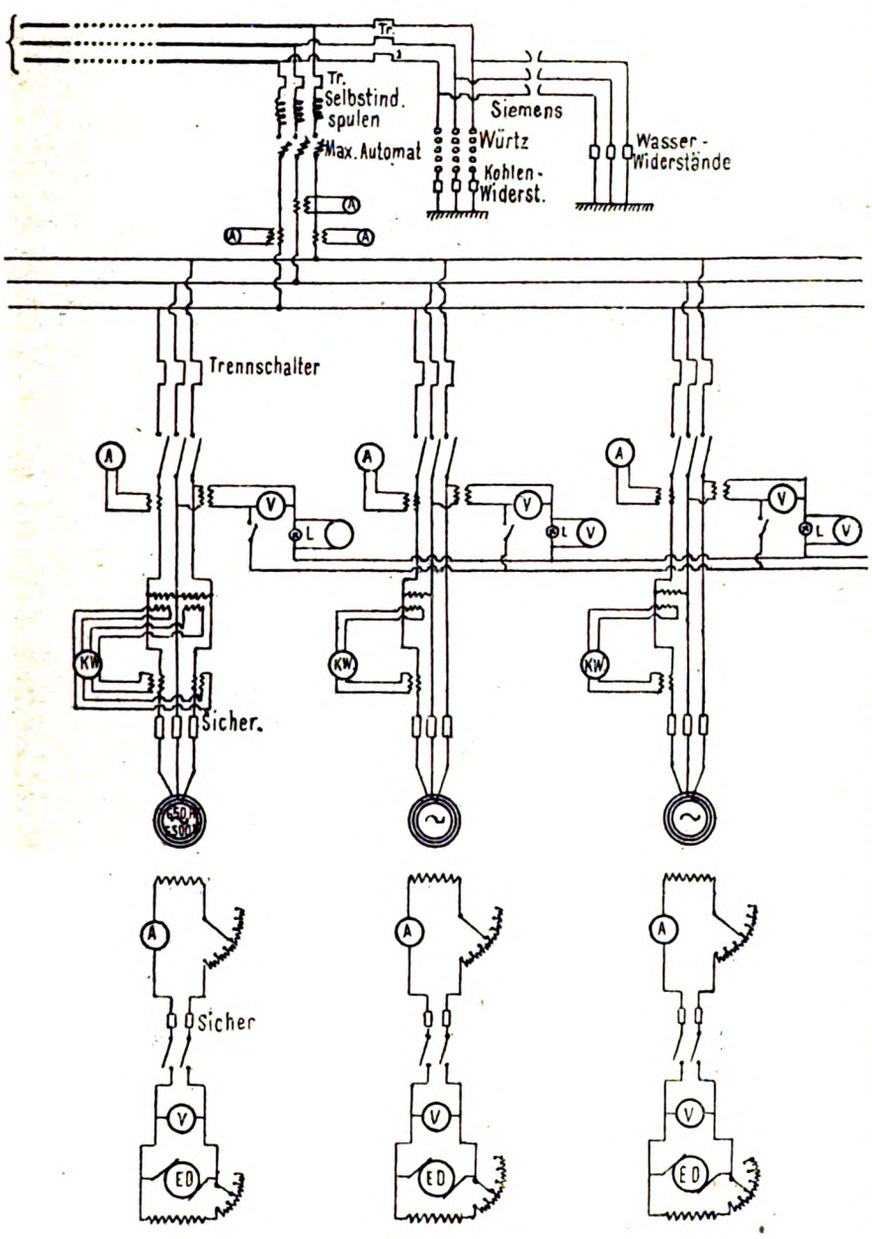

FIG. 2.

Wasserwidderstands—Water resistance. Kohlen—Carbon resistances. Trennschalter—Dividing Switch. Sicher—Safety tubes. Selbskind—Self induction coils.

The whole of the purely electrical part of the plant was supplied by the Unione Elettrotecnica Italiana of Milan. The generator gives at the speed of 630 revolutions, an alternating current of 6,300 volts, with 42 periods. The exciting machines coupled direct with the dynamos give 120 amperes, at the maximum voltage of 75. The alternators are connected by cables conducted through subterranean channels with the switchboard. The latter is in four compartments, three fields for the machines and one for transmission to a distance. The dynamo fields, shown in Fig. 2, each contain an alternating current meter, an exciter volt meter, a synchronism volt meter with lamp, two ampere meters, a kilowatt meter, a switch for the exciting machine with governor, regulation for pole exciting, and a hand chie switch in oil. The line field has three-phase ampere meters, and an automatic relay switch. All resistances, porcelain safety tubes, etc., are behind the switchboard. On the right behind are three cement cells, each containing the protection against lighting. Each pole passes a self induction, and is protected from atmospheric discharges by a Wurtz lightning conductor, with 28 rollers and carborundum resistance, and a Siemens' horn (10 mm. = two-fifth inch) with a water rheostat. A 10 kw. Siemens-Schukert transformer gives the lighting current for the station and the dwellings of the staff. For hoisting purposes, a 5-ton crane is provided.

The power is transmitted to a distance of 3 miles by means of open air copper cables. Each cable consists of 7 strands, each $\frac{1}{8}$ inch, with a total section of ·00764 square inch. The cables are carried on steel openwork masts on concrete foundations, and with interspaces not exceeding 273 yards. For smaller and larger spans there are two types of porcelain insulators, consisting, one of two, the other of three, parts. Forty inches below the cables run two telephone wires supported on green glass insulators.

(To be continued.)

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BUSINESS NOTES AND NEWS.

LIGHTING AND GENERAL—Home.

BATH.—The Bath Town Council have taken over the Electric Lighting Order from the Bath Rural District Council on terms mutually agreed.

BEXHILL.—At the Local Government Board inquiry on the application to sanction a loan of £3,058 for the electrical undertaking, the Inspector was told that £443 19s. 1d. represented the amount unexpended of a previous loan, which, with the loan now asked for, would leave £3,003 19s. 1d. available for prospective expenditure. In reply to a question the Electrical Engineer said that amount would not be sufficient to last the next two or three years. The Inspector suggested that if the Council had a further £1,500 it would meet the prospective expenditure for about 2½ years. The Town Clerk concurred, and asked the Inspector to put that in and consider it, leaving them a few days to get the resolution. The Engineer also thought £1,500 a satisfactory amount.—The Inspector: May I take it then that the Council will consider the further application to meet the further extension of mains during the next two or three years, and you will advise me as to what is done?—The Town Clerk: Yes.—The inquiry was shortly afterwards closed.

BISHOP'S STORTFORD.—Messrs. May & Hawes, consulting electrical engineers, Westminster, attended a special meeting of the Urban District Council and explained their scheme for the establishment of an electric department in the town. Thereupon Mr. Carruthers (Chairman of the Electrical Lighting Committee) gave notice that he would table a definite resolution and bring the same before the Council at its meeting on January 18.

BRIGHTON.—The Town Council have decided to spend £20,000 on new plant for the Southwick and North-Road Power Stations.

GRIMSBY.—The Town Council have applied to the Local Government Board to sanction a loan of £2,000 for street electric lighting.

HORNSEY.—The Borough Electrical Engineer reported that the number of consumers connected at October 31 was 1,657, and there had since been a net increase of 11, making a total of 1,668. The number of 30-watt lamps connected is 87,214, as compared with 86,603 on October 31. In regard to a letter received from the Associated Municipal Electrical Engineers it was agreed to authorise the Borough Electrical Engineer to expend the sum of £20 on the productions of the publicity organisation in the first year of its operation.

HULL.—The Sculcoates Guardians have intimated that they will not require a supply of Corporation electricity as a standby. The Hull and Barnsley Railway Co. have applied to the Electricity Department for a supply of electricity for power purposes at their new pier on the Western Reservation.

PORTSMOUTH.—With reference to the application of the Electric Light Committee to borrow £5,000 for purposes of public lighting, but which was refused, the sum being intended to include the money already spent in carrying out the lighting scheme adopted by the Council, the Committee reported that the arc lighting scheme had been completed at a cost of £2,490 2s. 3d. The remainder of the scheme for which it was proposed to borrow the £5,000, the Committee recommended should be abandoned. They further recommended that application be now made to the Local Government Board for sanction to borrow the sum of £2,490 2s. 3d. above mentioned. The report was adopted.

SWINTON AND PENDLEBURY.—At a meeting of the District Council's Tramways and Electricity Committee, the report of the Lancashire Electric Power Co. showed that for the five weeks ending November 24, 8,506 units were generated as against 5,592 for the corresponding period in 1908. Since the last report a number of applications had been received from tradesmen in the district, and also from St. Mary's Catholic Church, Swinton Hall Road, and Pollitt's Ropery, Swinton Hall Road (additional). The total number of applications was now 90 for the equivalent of 7,138 8-c.p. lamps. The clerk read a letter from Mr. Taite stating that he would recommend the directors of the Electric Power Co. to enter into an agreement for the management of the electricity undertaking.

TAUNTON.—Experiments are being carried out by the Electricity Committee in regard to street lighting, the tendency being to discard arc lamps for new lamps fitted with 100 c.p. Osram globes, these lamps being suspended at a lower level than the arcs. The type of lamp adopted is one containing five 100 c.p. lamps, the four outer being controlled by one switch, and the central one separately controlled, which enables considerable economy to be effected.

WORSLEY.—At the District Council meeting it was reported to the Finance Committee on December 6 that the Worsley Electric Lighting Order having been transferred to the Lancashire Electric Power Co., the latter had paid the sum of £469 14s. in respect thereof.

LIGHTING AND GENERAL—Overseas.

BRAZIL.—A decree has been issued authorising Mr. Richard J. Reidy to lay a submarine cable between Belém, in the State of Pará, and Nictheroy, in the State of Rio de Janeiro, the cable to pass by way of the Island of Fernando de Noronha and the town of Maceio in the State of Alagoas; also a cable between Nictheroy and Chuy (State of Rio Grande do Sul), passing by way of Santos (State of S. Paulo). The concession is for a term of 25 years. The cable between Belém and Nictheroy must be in operation within three years, and that from Nictheroy to Chuy nine months later. The cable will be used for telegraphic purposes, and the concessionaire may establish any land lines that may be required for joining up the cables with the telegraph stations.

INDIA.—According to *Indian Engineering*, electrical arrangements in connection with the drilling apparatus for the Malakand tunnel are so well advanced, that work can be begun very shortly.

ROME.—The Italian Ministry of Marine invite tenders for the supply of electric lamps and lamp-holders. The upset price is placed at 150,000 lire (£6,000), and 10% of this sum will be required as a deposit to qualify any tender. The competition will turn on the percentage of reduction offered on the upset price. Tenders should be enclosed in sealed envelopes, and addressed to the "Ministero della Marina," Rome, where they will be opened at 11 a.m. on January 11. The specifications and conditions may be seen at the Ministry in question, and at the Italian Admiralty offices at Spezia, Naples, Venice and Taranto. This contract is open to foreign competition.

TRACTION—Home.

LONDON: PADDINGTON.—The Borough Council have decided to oppose the London County Council's project of an electric tramway along Wood-lane to Harrow-road, *via* Westbourne Park.

MERTON.—At a meeting of Merton and Morden property owners and others, held at the Masonic Hall, Merton, to discuss the proposed electric railway between Wimbledon and Sutton, a resolution was passed that the proposed railway was urgently needed in the public interest, as it would greatly increase the trade and prosperity of Merton and Morden and improve the travelling facilities for residents in the district.

TRACTION—Overseas.

VANCOUVER (British Columbia).—A new unit, which will mean an increase of 10,500 h.p. for the British Columbia Electric Railway, has been installed at Lake Buntzen, and is now in partial operation, and has already carried over 8,000 h.p. with ease. This additional power unit brings the total number up to five, operating on four transmission lines. The machinery of the new unit includes an electrical generator, made by the Dick Kerr Co., of Preston, and a water wheel, the largest of its kind ever made, designed by the Doble Co., of San Francisco, and manufactured by the John McDougall Caledonian Ironworks, of Montreal, Quebec. From the entrance in the dam, a stave pipe line, 7 ft. diameter, runs to the crest of the hill, and from there a steel pipe of about the same diametrical dimensions takes the water to the new wheel in the power house.

COMPANIES' MEETINGS AND REPORTS.

SUNDERLAND DISTRICT ELECTRIC TRAMWAYS.

The report of the Sunderland District Electric Tramways, Ltd., for the year ended October 31 last, to be presented at the meeting on the 4th proximo, states that, after providing for interest on the Prior Lien bonds and First and Second Mortgage Debentures and loans, namely, £9,730, the accounts show a loss on the year of £780, bringing the loss to date up to £14,604. During the year the traffic receipts fell off by £1,319, but against this a saving was effected in working expenses of £2,108. This decrease in traffic is attributable to the exceedingly unsatisf ctory state of trade in the district served by the company during the past year following on the long shipbuilding strike of the previous year. In addition, the unfortunate weather of the past summer contributed to the decrease. Signs of improving trade are now discernible in the district, and the directors are hopeful that the coming year will show a very considerable improvement in the company's position. During the year Prior Lien bonds have been issued at par for cash to the value of £4,500, bringing the total issue up to £10,500. Out of this money the item of sundry creditors for £5,486, as shown in the last balance-sh°et, has been reduced to £1,278. The rolling stock has also been put into good order.

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COMPANIES REGISTERED.

COMPAGNIE GENERALE ELECTRIQUE DE LE CHAMPAGNE, LTD. Capital, £80,000, in £4 shares. Objects: To instal and exploit works for the distribution of electric power in the Valley of Guippe, Rheims, and in Aisne, Ardennes, Marne, all in France, and elsewhere; to build works and lines of transport in the Department of Marne, and the bordering Departments, for the production, transportation and distribution of electric power. The first directors (to number not less than two nor more than five) are: J. Bouchet and H. Lamort (managing director), and others (if any) to be appointed by the signatories. Remuneration of managing director, £240 per annum; of chairman, £150; of other directors, £100 each per annum. Registered office, 1 Broad-street-place, E.C.

ELECTRO METALLURGICAL SYNDICATE, LTD.—Capital, £1 250, in 2s. 6d. shares. Objects: To acquire certain options, to work and exploit patents, acquire land, and call for electrical power; to adopt an agreement with C. J. Head and W. D. Rock, and to carry on, either in connection with the above options or otherwise, the business of manufacturers of ferro-chrome or other alloys, etc. Minimum cash subscription, £10. The first directors are not named. Registered office, 25, Victoria-street, Westminster.

CONTRACTS OPEN.

HOME.

ERITH.—Urban District Council.—High-tension, three-phase, alternating current switchboard. Particulars (42s.) from Engineer, Electric Lighting and Tramway Offices. By January 10.

OVERSEAS.

CAPE TOWN.—Cape Government Railways.—G.P.O. and Table Bay Harbour Board.—Sale of machinery and electrical equipment. (Particulars from Agent-General for the Cape Colony, 100, Victoria-street, Westminster, S.W.)

DURBAN.—Municipality.—Proposed electric light and power supply works. Est., £100,000.

REVIEWS.

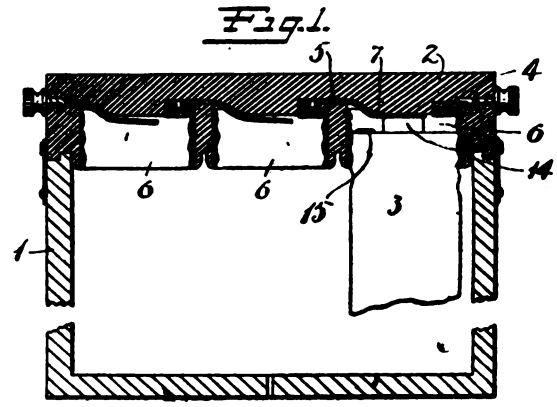
"The Practical Electrician's Pocket Book and Diary." Edited by H. T. Crewe, M.I.M.E. (London: S. Rentell & Co., Ltd. Price: leather, 1s. 6d. net; cloth, 1s. net).

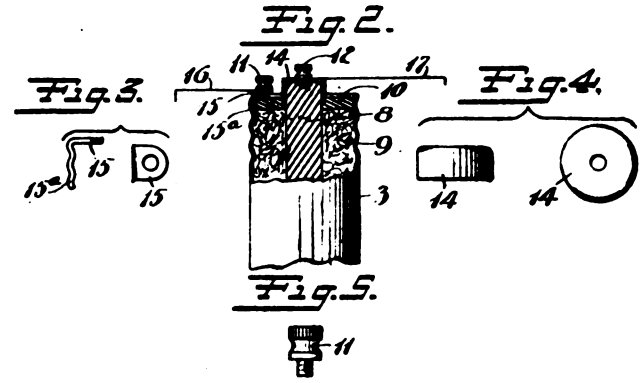
This popular annual makes its reappearance in thoroughly up-to-date guise, for it has undergone careful revision from cover to cover. Moreover, several new articles have been included, touching upon such recent departures and improvements as Siemens' O. S. Wiring System, Auto-transformers, Instructions to Chargemen, and other matters. It covers a multiplicity of subjects in a condensed form in a way that will appeal to the busy practical man. The Diary is printed on squared paper, so that curve plottings may be recorded. An excellent feature is embodied in the tear-out folios at the end comprising "Materials, Requisitions and Reminders required for Job at ——," and "Particulars for Estimating for Work at ——," both forms having printed lines covering all that is likely to be required.

PATENTS.

Galvanic Dry Batteries.

11155.—1909. G. L. PATTERSON, Manhattan, U.S.A. The main object of this invention is to improve a dry battery of the socket type so that it is readily convertible into a battery of the binding post type. Fig. 1 is a side elevation of the battery, partly in section, one cell only being shown in place. Fig. 2 is a side elevation, partly in section of a single cell when used after the manner of the ordinary dry battery cell of the binding post type. Fig. 3 illustrates one detail of construction; Fig. 4 illustrates another detail of construction; Fig. 5 still another detail of construction. 1 represents a case intended to protect one or more cells. 2 represents the socket element, in this instance operating as a cover for the box and being adapted to hold three cells. In this particular construction, the socket element 2 is provided with three internally threaded socket pieces 6 arranged to receive as many cells. 4 represents an outgoing terminal connector for one of the socket pieces 6. 5 represents the incoming terminal connector for the socket. In this instance the terminal 5 is provided with the integral contact piece 7. The cell 3 comprises a copper external part constituting one electrode, a carbon stick 8 constituting the opposite electrode, and an electrolyte 9 surrounding the stick. 10 represents a washer to seal in the cell. In the ordinary use of the battery cell, it requires merely screwing in the cell 3 to the socket piece 6 to secure the cell in place, and at the same time to put the two electrodes of the cell in operative electrical connection with the socket terminals. As it sometimes happens that the user is not provided with a socket to take a cell of this type, it is desirable that these cells be so constructed that they may be quickly and advantageously used after the manner of the ordinary dry battery cell of the binding post variety. Detachable connecting members are, therefore, provided to perform the function of binding posts so far as involves the connecting of wires to the cell, which will not interfere with the operation of the cell when used with a socket holder. The detachable wire connecting means are indicated at 11 and 12, and each comprises a head having a projected threaded stem so that they may be mechanically and electrically connected to the cell. In this particular instance, the connector 12 is adapted to be screwed into a threaded opening in the end of a metallic cap 14, carried by the outer end of the carbon electrode





8. This cap 14 constitutes the terminal end of the carbon electrode, whether the cell is to be used as one of the socket type or the binding post type. The other wire connector 11 screws into a threaded opening in a terminal piece 15 which stands within the cupper portion of the cell 3 and about flush with the upper end as best seen in Fig. 2. Whenever it is desired to use the battery cell after the manner of a cell of the binding variety, the end of each circuit wire may be attached in the usual manner by simply bending an eye at the end of each wire and connecting it to its proper electrode by means of one of the detachable binding posts 11 or 12. Whenever it is desired to use the cell after the manner of a socket cell, the members 11 and 12 are easily and quickly removed, leaving the upper ends of the cell unobstructed and ready for insertion in the socket.

Electric Indicators.

1985.—1909. J. SAX & CO., LTD., London, W.C. In electric indicators of the type in which a signal arm carrying a semaphore disc is released from a catch by an electro-magnet and is allowed to drop to give the signal, and is afterwards re-set in its non-indicating position by another solenoid or magnet, the improvement consists in providing a re-setting indicator very compact and cheap and simple to manufacture, and not liable to be operated accidentally by sudden jarring or vibration. It combines the advantages of both electrical and mechanical re-setting devices without the disadvantages of either. Figs. 1 and 2 are elevations taken from points at right angles to each other, showing the general arrangement of the parts of the indicator. Fig 3 is a plan, Fig. 4 is a detail sectional view to a large scale of the upper part of the re-setting solenoid. Fig. 5

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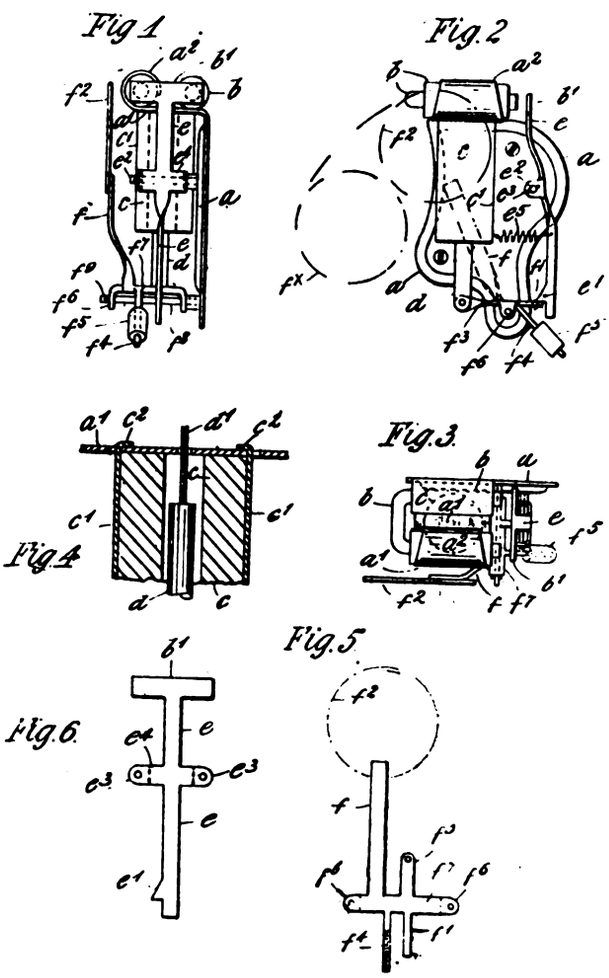
is a detail view showing the shape of the stamping from which the indicator arm with its pivots and associated parts may be formed. Fig. 6 is a corresponding detail view showing the stamping for the catch lever and the associated parts of the locking device. The back plate *a* may be stamped out of a plain piece of metal and be slightly dished as shown. This back-plate has at its upper part a rectangular extension a^1 bent over at right angles to it, and serving as a bracket to carry both a horse shoe electro-magnet *b* for releasing the locking device, and also a solenoid *c* for re-setting the indicator. The horse shoe magnet *b* is arranged parallel to the back-plate, and rests on the upper side of the shelf portion a^1, the outer end a^2 of which is bent over around one bobbin of the magnet, thus clipping it firmly and securely in position without any further fastening devices. The re-setting solenoid *c*, on the other hand, extends downwards from the underside of the bracket, and is held in a sheath c^1 which may be attached to the shelf as in Fig. 4, by means of small projections c^2 at its upper edge which pass through holes in the shelf part and are clinched over, thus giving a firm and simple connection. The plunger *d* of the re-setting solenoid has a small guide rod d^1 at its upper end working through a hole in the shelf piece, and at its lower end it is pivoted to an arm. In this way the plunger becomes a floating one as it were; that is to say, it moves in the solenoid freely without touching the inner tube thereof, thus obviating any friction at this part. The employment of a solenoid and plunger arranged in this way permits of a comparatively long range of motion with a fairly powerful action over the whole of the range. The locking device consists of an upright lever *e* having a catch e^1, and pivoted near its middle part on a pin e^2 projecting from the back-plate. The pivoting of this lever *e* on the pin e^2 is effected by a pair of small lugs or journals



e^3 carried by a cross-piece e^4. At its upper end the lever *e* carries the armature b^1 of the releasing magnet *b*. The tooth engages a finger f^1 on the same pivot as the signal arm *f* of the indicator, this being brought about by the action of a spring e^5 which serves to hold the tooth and catch in firm engagement, thus providing a positive lock which renders the indicator proof against the action of sudden shocks, so that it can be safely used in situations where it is liable to considerable vibration, such, for instance, as in engine rooms, on ships, on railway trains and in factories. The signal arm *f*, which carries the disc or semaphore f^2 has a short projection f^3 to which the core or plunger *d* of the re-setting solenoid is connected. As the core has a fairly considerable stroke, and as the arm *f* is of considerable length relatively to the projection f^3, the range of movement of the disc or other signal f^2 becomes correspondingly large. Hence a larger and, therefore, a more clearly observable disc can be used on the arm than would otherwise be possible. In addition to the above, the signal arm has a tail piece f^4 which may be screw-threaded and on which an adjustable balance weight f^5 is provided. This balance weight forms a ready means of adjusting the sensitiveness of the movement either for releasing or replacement. The pivots of the arm *f* may consist of a pair of perforated downwardly bent lugs f^6 which are carried by lateral projections f^7, and which are passed over a pin, axle or stud f^8 secured to the back-plate. The lugs f^6 are held in position against endwise movement by a pin f^9. Assuming that normally the parts are in the position shown in Figs. 1 and 2, then when a current is set through the magnet *b*, then the armature b^1 is attracted, the lever *e* moves on its pivot, and the tooth e^1 is drawn back away from and clear of the finger f^1. The latter being free, permits the arm f^3 and the plunger *d* to drop, which they do more or less suddenly according to the adjustment of the balance weight f^5. The arm *f*, of course, follows this movement, and the indicator disc f^2 is brought unto the position f^x, which is that in which it is displayed through the usual window or aperture of the indicator casing. When it is desired to re-set the indicator, it is only necessary to complete the circuit of the solenoid *e* by a press button provided in the usual way for this purpose. The plunger *d* is then drawn upward again and the parts resume the position shown in Figs. 1 and 2, whilst the catch *c* slips on to the end of the finger f^1 under the action of the spring c^5 and re-locks the indicator so that it cannot be operated until the magnet *b* is again energised by the sending of a fresh signal current.

Trolley Wires.

22681.—1908. H. SCHUTTE, Pittsburg. The longitudinal jaws of the trolley wire hangers have outwardly bent flanges and locking sleeves for pressing the flanged ends of the jaws inwardly, so that their lower ends will hold the trolley wire. This improved wire can be applied for single or double catenary constructions.

Collectors for Electricity.

22951.—1908. E. M. SCHOLLENBERGER, Chicago. In a combined trolley and sleet cutter, in which the trolley wheel comprises two recessed divisions mounted upon an axle, a central core is arranged between the two divisions. This core is rotatable and longitudinally adjustable upon the axle, and also fits into the recesses of the divisions. The divisions can be pressed towards the core and against the trolley wire, whereby the core and divisions can move longitudinally of the axle as a whole or independently.

Generation of Electrical Power and Means of Regulation in Speed of Vehicles.

23396.—1908. W. P. DURTNALL, Herne Bay. The invention consists in combining a high speed steam turbine, internal combustion engine, or other prime mover mounted in a self-contained vessel or locomotive, with a polyphase alternating current generator, and with continuous current exciter in connection with an electric power and periodicity mechanically driven transformer. This combination is to supply polyphase alternating current to polyphase alternating current induction motors.

Electric Switch.

28092.—1908. VERITYS, LTD., London. The carrier for the switch arm and stops, and the terminals and stop connections, are attached to a base plate, so that the switch arm is inwards and adjacent to the plate, while the terminals and stop connections are presented outwardly on the single carrier for easy and convenient wiring. A removable casing fits over the carrier and encloses it.

Electrolytic Devices.

28561.—1908. W. B. THORPE, Balham. This electrolytic device has two tubes, each having two cells separately connected in parallel with two similar parallel shunt resistances of a shunt arrangement that is connected across electric supply mains at opposite sides of a main shunting resistance in one of such mains, and comprises a high resistance common to and in series with the paralle shunt resistances. Each of the parallel resistances has a voltage drop greater than the back E.M.F. of the corresponding cell. Two corresponding electro-magnet devices are brought into action by the gases evolved in the cells, and work differentially on registering mechanism common to them.

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Electric Contact Breakers.

17436.—1909. J. A. SCHNEIDER, Lakeport, U.S.A. This is an electric contact breaker for internal combustion engines. Contact is made and broken between a number of stationary arms, and a revoluble member mounted eccentrically upon a rotating shaft. The hub of the revoluble member has a frictional device to retard its rotation.

Controlling Electric Switches.

7113.—1909. A. S. CUBITT, Schenectady, U.S.A. A plurality of actuating circuits are connected successively to successive switches by the co-operation of contacts controlled by the switches, with means which normally closes contacts in all of the actuating circuits, and is responsive to current through any actuating contrivance for temporarily interrupting the succeeding actuating circuit.

Trolley Wheels.

15895.—1909. G. KREBS & Co., G.m.b.H., Berlin-neu-Hohenschönhausen. This is an improvement in trolleys used in electric traction, and in which the felloes are connected with the bushes by lateral steel discs forming an oil chamber. The bush is connected with the wheel felloe by lateral discs arranged in grooves in the felloe to form an oil-tight joint. By this method of construction the size of the oil chamber is increased, and at the same time a saving in the material of which the wheels are made.

Polyphase Alternating Current Induction Motors.

14579.—1909. B. G. LAMME, Pittsburg, U.S.A. This is an improvement in controllers for polyphase alternating current induction motors, in which each phase circuit of the motor primary winding is divided into a plurality of sections, which are connected to one another in different series to form the starting and running connections of the primary winding. The object is to provide a controller of this class which shall obviate the necessity for employing auto-transformers. For this purpose, the change from a symmetrical starting connection of the primary winding to a symmetrical running connection of the winding is effected by varying the connections of the sections of each phase circuit successively, so as to form a series of unsymmetrical connections.

Periodical Interruption of Alternating Electric Current.

9502.—1909. L. J. B. DRAULT, Paris. The apparatus consists principally of the combination of a mercury jet interrupter, with a special electric motor, by means of which the interrupter can be started automatically and be rotated at a speed synchronous with the number of periods of the current. The interrupter comprises a hermetically closed vessel containing mercury, in which there dips a rotary core. This draws up the mercury by centrifugal action, and projects it through an orifice into a contact tooth. The moment the mercury comes in contact with the tooth it closes the circuit in which the interrupter is included.

Receiving Instruments for Electric Telegraphy.

6525.—1909. T. CLARK, Greenwich. In this instrument two opposite sides of a suspended coil are free to swing through narrow air gaps between the poles of a magnet and a soft iron core fixed between the poles. The coil is formed from fine wire, covered with an insulating enamel varnish, possessing sufficient plasticity to enable the wire to be wound and shaped into a coil without injuring the insulation.

Controlling the Speed of Electric Motors for Rolling Mills.

3588.—1909. SOCIÉTÉ ANONYME D'OUGRÉE MARIHAYE, Liege. An excitation system, provided with an automatic regulator, is employed in connection with the rolling mill motor. The regulator is controlled by the principal current for the purpose of preventing the interruption of the excitation taking place too rapidly.

Sheathing Electric Cables.

3257.—1909. E. WITZENMANN, Pforzheim. The sheathing head of the machine is positively connected to the winding up apparatus for the sheathed portion of the cable in such a way that the winding up apparatus simultaneously also provides for the feeding forward of the portion of the cable to be sheathed.

Electric Time Switches.

2605.—1909. W. E. RICHTER, Albuquerque, U.S.A. A slidably mounted rod is connected to the switch. A spring causes the rod to close the switch. A second rod and spring are adapted to open the switch. The action of the two sets of rods and springs is governed by pivotally mounted arms, which engage the rods when they are not in action. Yielding fingers release the arms from the rod at stated intervals.

Fittings for Incandescent Electrical Lamps.

430.—1909. F. W. SUTER, Upper Holloway. The lamp carrier is formed integral with the trough-like casing. The casing and the carrier are bent to form guides for the reception of the reflecting strips. Being in one piece, the guides are straight and uniform, so that there is very little risk of the reflectors being broken when inserted.

Dynamo Electric Machines.

24854.—1908. BRITISH THOMSON-HOUSTON Co., London. This is an improvement in dynamo electric machines of the split pole converter type, and consists in the use of commutating poles as auxiliary poles for changing the voltage ratio, as well as for commutating. The chief feature of the invention, however, is the variation of the voltage ratio, and the provision of a commutating field of a density which increases with the load. This is brought about by arranging that at full load the greater portion of the flux from the auxiliary poles must enter the armature on that side of the axis of commutation nearest the main pole of similar polarity.

Telephone and Electric Light for Divers.

26867.—1908. R. H. DAVIS, London. The telephonic equipment and the electric supply equipment are combined in a single apparatus, and obtain their energy from one source. The diverse equipment consists of a transmitter and a receiver located within the helmet, a bell push operated by pressure of the chin, and an electric lamp fitted to the helmet or dress. The attendant's equipment comprises a hand telephone set, a battery of secondary cells, and a signal bell, and a switch for controlling the lamp circuit. The whole of this equipment is arranged in a case. The two equipments are connected by a cable, the one extremity of which fits into a socket in the case, while the other extremity fits into a socket on the diver's helmet or dress.

Electric Ignition Device.

27212.—1908. C. CECIL, Lee. This is an improved make and break device for electric systems, and consists in the provision of a governor of the direct sliding weight type, the enclosure of the whole of the mechanism, and the variation of the spring of the governor from the exterior of the apparatus.

Electrical Wiring for Houses.

24533.—1908. J. S. HIGHFIELD, London. The object is to provide a cheap method for carrying out house installations. For this purpose the two insulated conductors are embedded in a strip of flexible material, which forms the basis of the installation. Where turnings occur, the tape containing the conductor is cut, the wires being left intact and the parts joined by special joint pieces.

Regulating Polyphase Electric Commutator Machines.

24581.—1908. ALLMANNA SVENSKA ELEKTRISKA AKTIEBOLAGET. Westeras. Improved means for regulating commutator machines of the induction type, wherein each phase of the armature winding, in series with an adjustable auxiliary winding provided on the stator, in the same axis and in series with a third winding or windings, by means of which a magnetising current is supplied to the armature, is closed by impedance or directly short circuited.

Alternating Electric Current Motors.

19299.—1908. BRITISH THOMSON-HOUSTON Co., London. The invention consists in arranging the motor controller to connect the motor to the source, with series repulsion motor connections, and providing auxiliary means for short circuiting the motor armature when starting under heavy loads. The motor controller opens the armature short circuit when the controller reaches a high speed position. Interlocking connections are provided between the short circuiting means and those contacts of the controller which impress the shunt voltage on part of the motor winding, so that when the short circuit is established the shunt voltage is removed and *vice versa*.

Electric Signalling in Connection with Mine Haulage.

21693.—1908. R. RUTHERFORD, Ferryhill. A number of indicators are located at different points of the installation, and illuminated by electric lamps so as to give visual indications, such as "ready," "change decks," "men," "riding," "shaft work," etc. The lamps are controlled by switches, and so connected that the illumination of corresponding parts of the indicators is rendered impossible, until the switches controlling the lamps illuminating each of the corresponding parts have been moved by the attendant in charge of the signalling portions into their proper position.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1909.	1908.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Dec. 22	1,165	1,275	— 110	— 1086	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940.	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Dec. 19	1,022	1,066	— 44	— 485	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Dec. 18	6,941	6,658	+ 283	—	56·792	58 52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Dec. 18	4,537	4,447	+ 90	+ 6,163	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	Dec. 19	702	719	— 17	+ 1,633	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Dec. 24	6,349	5,841	+ 508	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Dec. 25	1,110	1,388	— 278	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Dec. 18	251	250	+ 1	— 237	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Dec. 18	6,158	5,787	+ 371	—42,568	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Dec. 26	3,497	3,312	+ 185	+ 3,179	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Dec. 16	427	420	+ 7	— 635	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Nov. 19	1,476	1,249	+ 227	+ 4,544	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Dec. 24	125	151	— 26	+ 6	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Dec. 17	4,953	4,873	+ 80	+ 2,116	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Dec. 18	942	908	+ 34	+ 4,561	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Dec. 18	16,466	16,611	— 145	— 9,239	189	181	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	Dec. 25	2,852	2,800	+ 52	+ 4,088	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Dec. 18	472	431	+ 41	+ 1,371	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Dec. 15	12	120	—	— 238	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 5	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Dec. 22	929	1,151	— 222	— 934	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 6	10,803	10,687	+ 116	— 1,977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Dec. 19	1,247	1,330	— 83	— 163	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Dec. 11	38,298	34,162	+ 4,136	+ 64,980	127½	121½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Dec. 18	132	141	— 9	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Dec. 18	11,178	9,839	+ 1,339	+ 14,154	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Dec. 18	17,985	17,054	+ 931	— 1,174	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,710	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Dec. 18	3,885	3,893	— 8	— 1,212	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Dec. 16	554	585	— 31	— 156	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,596	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Dec. 19	5,594	5,510	+ 83	+ 2 328	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Dec. 15	950	982	— 32	— 346	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Dec. 11	126	114	+ 12	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	D c. 18	812	806	+ 6	+ 698	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Dec. 16	2,282	2,229	+ 52	+ 5,141	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21¾	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train Miles. *h* Half-year's figures.

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ALPHABETICAL INDEX TO ADVERTISEMENTS.

	PAGE
Abbott and Co.	—
Adams Manufacturing Co.	10–11
Aerators Limited	—
Allen, W. H., and Son	—
Ammon, A. F.	—
Andrews, R. W., and Co.	—
Auto Controller and Switch Co.	19
Babcock and Wilcox	3
Bailey, W. H., and Co.	—
Bastian Meter Company	—
Bates, C. G.	—
Belliss and Morcom, Ltd.	2
Bill, S., and Co.	—
Birkbeck Bank	19
Boddy, G. M., and Co.	—
Braulik, G.	—
British Insulated and Helsby Cables, Ltd.	6
British Mica Company	—
British Thomson-Houston Company	12
British Westinghouse Electrical and Mfg. Co., Manchester	7
Brockie-Pell Arc Lamp Company	—
Brook, E.	—
Browett, Lindley, and Co.	5
Callender's Cable & Construction Co.	19
Capell Fan Company	1
Cassell & Co.	—
Churton, T. H., and Co.	1
Concordia Electric Wire Co., Ltd.	1
Cort, A., and Co.	—
Croft and Perkins	1
Crossley Bros.	17
Crosby Lockwood & Son	—
Cryselco Limited	1
Derby and Co.	—
Dick, Kerr, and Co.	6
Dore, J., and Co.	—
D. P. Battery Co.	7
Dorman and Smith	—
Edison and Swan Company	2
Electrical Standardising, Testing, and Training Institution	—
Electric and Ordnance Accessories Co	—
Electric Construction Co.	—
Electrical Trades Supply Limited.	—
Electromotors Limited	—
Ellison, George	—
Everett, Edgcumbe, and Co.	9
Everitt and Co.	—
Evershed and Vignoles	—
Feld Bros. and Co.	—
Ferranti, Limited	17
Fischers Ball and Bearing Co.	12
Flexible Metallic Tubing Company	1
Foster Arc Lamp and Engineering Co.	—
General Electric Company	—
Gibbs, J., and Son	—
Gilkes, G., and Co.	—
Griffiths Bros.	1
Hardy Patent Pick Co., Ltd.	—
Harris, A. E., and Co.	—
Hart Accumulator Company	20
Harvey, G. A., and Co.	1
Heathman and Co.	19
Heenan and Froude	9
Hendry, J.	—
Henley's Telegraph Works Company	—
Home and Rowland	—
Hooper's Telegraph & Indiarubber Works	—
Hudson, J., and Co.'s Successors	1
India Rubber Company	4
International Correspondence Schools, Ltd.	—
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Kaye, J., and Sons	3
Key Engineering Co., Ltd.	—
Lancashire Dynamo and Motor Co.	—
Ledward and Beckett	20
Liverpool Electric Cable Co.	—
London Electric Firm Co.	19
London Electric Wire Co.	3
Lorrain, J. G.	19
Lundberg, A. P., and Sons	—
Lunken Valve Co.	1
Macintyre, J., and Co., Ltd.	1
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Mayer, H. G., and Co.	—
McClure and Whitfield	9
McGeoch, W., and Co.	16
Merryweather and Sons	2
Metallic Seamless Tube Company	—
Millar's Karri and Jarrah Co.	—
Mitcham Electric Fan Company	—
Morris-Hawkins, Ltd.	1
Moseley, D., and Sons	19
Mosses and Mitchell	—
Nalder Bros. and Thompson	—
New Brotherton Tube Company	—
Pass, C., and Son, Ltd.	19
Petter, J. B., and Sons, Ltd.	1
Phœnix Fire Office	—
Price, Powell, and Co.	9
Railway Passengers' Assurance Company	9
Reason Manufacturing Company	—
Reyrolle, A., and Co.	—
St. Helens Cable and Rubber Company	—
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Tormo Manufacturing Co.	—
Townshends, Limited	—
Traun, Dr. Heinr.	19
Tucker, J. H., and Co.	—
Tudor Accumulator Company	—
Turnbull, A., and Co.	—
Union Electric Co., Ltd.	5
United Electric Car Company	—
United States Metallic Packing Co.	—
Valor Co., Ltd.	1
Verey and Co.	9
Victoria Electrical Works	—
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Western Electric Company	3
Weston Electrical Instrument Co.	—
White, J. G., and Co.	—
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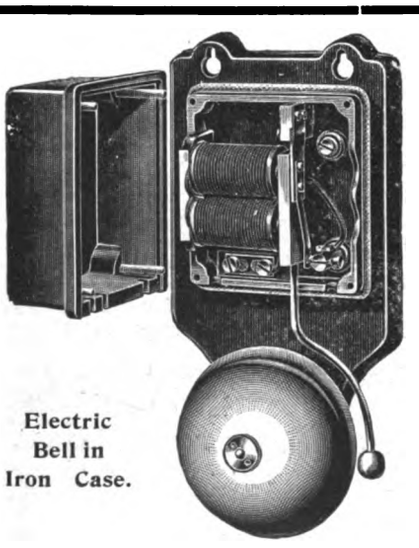

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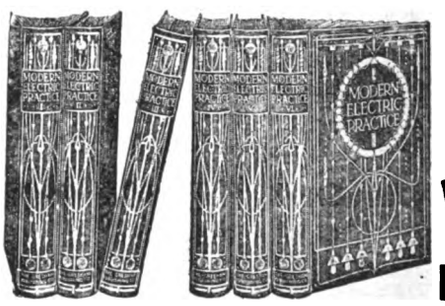

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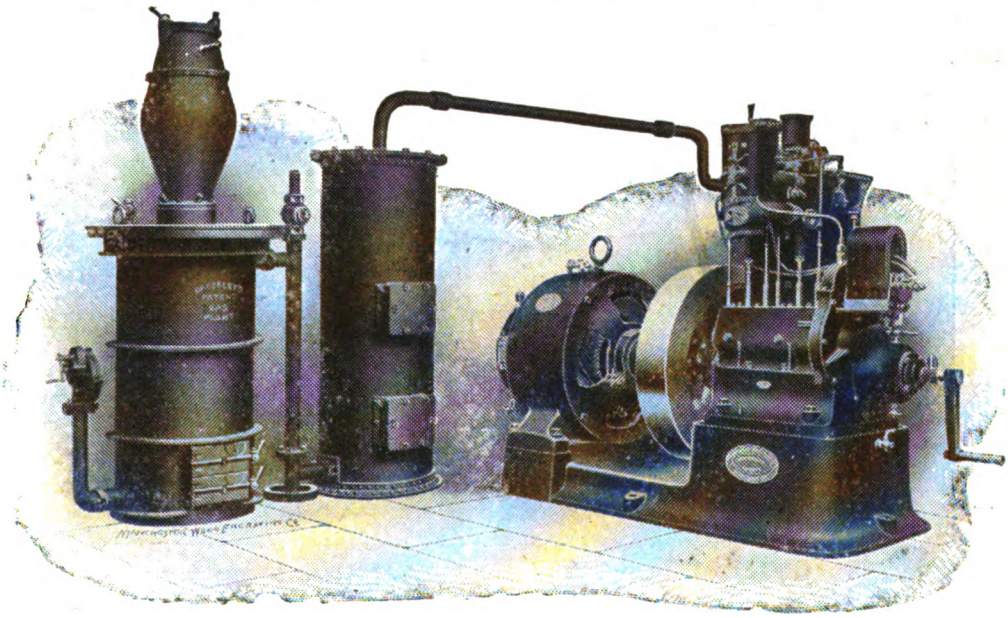

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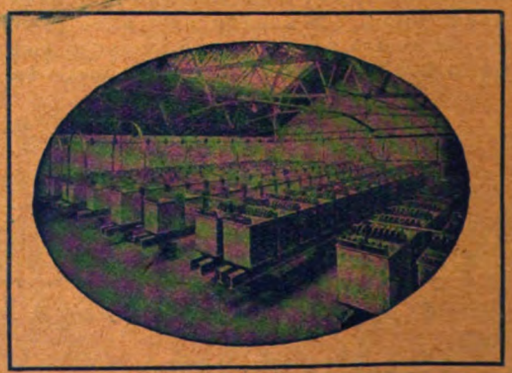

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